Federal Democratic Republic of Ethiopia
Ministry of Education
Special Capacity Building Training Program for Secondary School Teachers

Physics Trainees' Module

June, 2024
Ministry of Education
Addis Ababa

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Part I- Teaching Physics Trainees' Module

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Part I- Teaching Physics

Module Introduction

The aim of the Ethiopian general education curriculum is to produce citizens who have the competence essential for life, further learning and the world of work. It is also the aim to nurture citizens who have scientific and technological literacy, possess the ability to think creatively and critically, solve problems and act in morally responsible manners among many others. In the list of the aims is also found preparing individuals who would be competitive at national, regional and global levels. The aims comprise maximizing the individuality and potential of every student to achieve holistic development regardless of gender, ability or disability, ethnicity, religion, and geographical location.

Secondary school education is a period marking the beginning of developing abstract reasoning and logical thinking abilities helpful to understand and generate knowledge beyond the here and now. It is also time for widening and deepening knowledge, skills and attitudes obtained during previous learning and getting prepared for further education at the tertiary level, further technical training, and the world of work.

In grades 9 and 10, trainees take the three subjects constituting natural sciences namely physics, chemistry, and biology as separate subjects in order to understand more about natural elements and phenomena. In grades 11 and 12, the three subjects constituting natural science (Physics, Chemistry and Biology) are taken by students as general subjects useful for a better understanding and mastery of subjects specific to each of the five areas of career and technical education namely manufacturing, construction, agriculture, health sciences, and information technology and computer science.

Physics makes the human mind critical, analytical and creative. Learning Physics helps trainees to develop their creativity and strengthen their intellectual life. It provides the foundation for learning engineering and technology and developing the 21st century skills of creativity, critical thinking, innovation, competitiveness, and solving personal and social problems. It also provides the opportunity for trainees to learn on their own through enquiry and practical engagement which are essential to advance their life and national development. It is because of these personal and societal gains learning physics brings about that the subject justifies a place in the curriculum of secondary

education in Ethiopia. Therefore, Ethiopian trainees need to learn physics so that they will be able to acquire the capacity to solve problems of the society in every area of life.

To resolve the challenges of the previous teaching learning materials (TLMs), align the curriculum with the 21st century advancements, and meet the requirements of the sustainable development goals of 2030, a major revision of the existing curriculum was felt necessary. Thus, the new curriculum in physics, which is prepared based on the Curriculum Framework and Position Paper from MoE, is designed to alleviate the difficulties prevailed in the previous curriculum in order to produce a problem solver citizen who are equipped with logical reasoning, analytical thinking, creativity and ability to work with contemporary technology. After the implementation of new TLMs, the core competencies expected to be developed by all students at all levels are the following: learning to learn, critical thinking and problem-solving, creative-thinking and innovation, communication, collaboration, leadership and decision-making, digital literacy, and cultural identity and global citizenship.

Objectives of the manual

This module is developed for the purpose of:

- creating the awareness of Physics teachers on the use of different innovative teaching methods and assessment strategies that complies with the constructivist approach,
- producing competent physics teachers on the specific concepts they teach, and
- initiating teachers to use all available innovative teaching and learning methods.

Pedagogical approaches

Active and participatory teaching/learning approaches are employed throughout the module. Activities are mainly experiential in nature, and trainees are required to actively engage as participants in all of the lessons. In particular, physics teachers should follow approaches that match with constructivist approaches like:

- Identifying trainees' abilities and using the data to plan the methodology and teaching techniques suitable for teaching and learning
- Setting outcomes of learning in terms of competencies (knowledge, skills and attitudes) to be achieved
- Identifying learning activities which would help achieve the intended competencies by taking account of individual differences

- Creating conducive learning environment and providing the care and support necessary for students to learn through critical thinking, creativity, inquiry, investigation, experimentation, problem-solving, innovation, communication, and collaboration.
- Employing technologies appropriate to learning activities identified and selected
- Aligning indigenous knowledge and skills with the appropriate teaching-learning activities
- Assessing students' progress through observation, recording performance, and administering diverse tools of monitoring and evaluation
- Providing timely feedback for trainees on their classroom activities
- Providing feedback on progress trainees make towards the achievement of objectives for students, parents/guardians and the school
- Utilizing outcomes of continuous and periodic instructional assessment for own and trainees development
- Contextualizing contents to local realties

Assessment Recommendations

To ensure that the trainees have acquired the relevant knowledge, skills and attitudes, both formative and summative assessment techniques will be employed. Process evaluation will be carried out to appraise the implementation of the curriculum. This will help to identify challenges and successes on the delivery of the module, student receptivity and administrative support. Findings will identify areas for improving the curriculum and its delivery. End of course assessment will also be administered to gain a summative appraisal of the module. To have information about the impact, a follow-up evaluation will be conducted on trainees after they have graduated and after a reasonable time has elapsed. The follow-up may be conducted using a questionnaire.

Structure of the Module

The chapters as well as the contents to be included in this module are prepared based on the need assessment conducted by MoE. As a result, the module contains eleven chapters that are categorized thematically. The chapters are divided into different sessions, each session dealing with one main topic. The module in general and the sessions in particular are designed in such a way that trainees will become active participants in the teaching learning process. The objectives, activities, key ideas, some implications and takeaway resources are identified as follows.

- Each topic is linked to specific learning objectives which state the intended outcomes of working on particular topics. Learning objectives are defined and stated in the way the section can be implemented.
- Activities are provided to allow participants to be engaged in learning about the topics raised.
- The topics are followed by key ideas, which provide description or explanation for each major issue to be addressed.
- Implications of each topic are incorporated to indicate the conclusions that can be drawn from the sessions. This could be put either in the form of questions and/or in the form of specific recommendations.
- Takeaway resources are put in place in a way that gives trainees to have further information about the specific topic they have experienced.

Chapter 1

Physics and the how of teaching it

Introduction

As you all know, Physics is the science aimed at describing the fundamental aspects of our universe. This includes what things are in it, what properties of those things are noticeable, and what processes those things or their properties undergo. In simpler terms, physics attempts to describe the basic mechanisms that make our universe behave the way it does.

In this chapter, you will learn how to teach the definition and application of Physics. You will also learn about some innovative teaching methods used to teach Physics. You have 5 hours at your disposal for covering this chapter.

1.1 Physics: Definition and application (2hrs)

At the end of this session, trainees will be able to:

- develop interest towards physics subject,
- devise activities and strategies that makes them to teach physics concepts better,
- describe the crucial role of physics in science, technology and society,
- list with brief description of the various branches of physics,
- expand on interesting research pursuits in physics.

Before directly go to describing what Physics is all about, it is good to start the session with your teaching experience.

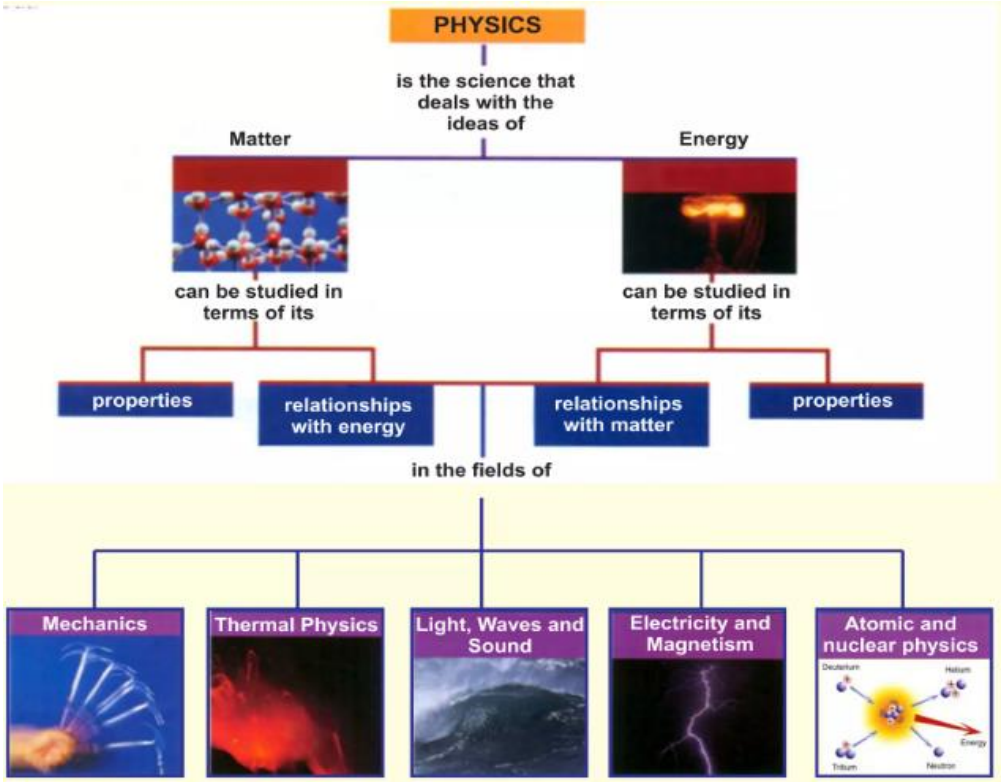
Activity 1

- How have you been teaching the definition and application of physics? Please, take a moment and share your experience to the whole class.
- Do you start your teaching through describing the things that are happening around them like propagation of light, propagation of sound, things falling towards ground, conversion of different states of matter, creation of rainbow and lightning, etc?

By doing so, try to understand that physics is not only a body of facts, but rather a process of asking questions, designing experiments and theories to answer questions which come in mind about the things and happenings around us. We can thus say that physics tries to explain how things work or why things happen.

Activity 2

- Have you used a concept map in your class? In groups, draw a concept map of physics and its various branches. Sample concept map is given below. After completion of the task, select one representative to present your work to the whole class.



From the above activity, you have noticed that the whole universe is constituted of matter and energy, and physics is that branch of physical sciences which explains the properties of matter and energy and their mutual relationship.

Activity 3

How could you help your students to explain the applications of Physics in their everyday life? Could you explain one example that might have used to explain to them?

- *You may select topics like expansion of metals when heated, movement of particles, propagation of light, conservation of energy, laws of reflection and magnetism.*

Activity 4

- Who are Physicists? How do you teach your students about Physicists?

By now, you have got some insight on how to teach about the definition and application of Physics.

Key ideas

- Physics is a natural science which deals with the study of properties of matter energy and their mutual relationship.
- Physics tries to explain how things work or why things happen. Discoveries in physics have led to the invention of thousand of machines that affect our everyday life. Thus, all product of modern technology are applications of the principles of physics.
- There are some branches of physics under which we study the combine concepts of physics and other branches of science, i.e., astrophysics, geophysics and biophysics.

Assessment

- Describe any other phenomenon occurring around you and explain the principles of physics it uses.
- Look at an area of Physics that you might find its application in your home and write a paragraph about that area of physics to answer the following questions:
  - ✓ Why is this field important?
  - ✓ How are scientists making discoveries in this field, are they conducting experiments, are the building models, are they doing calculations, etc.?
  - ✓ Who is a scientist that has played a major role in this field? What are they famous for?
  - ✓ What is one question in this field that you find particularly interesting?

Implications to teaching

- Many educators recognize the high potential of teaching Physics by starting from its application in their day to day life so as to attract the attention of our learners. Have you been inspired to use such kinds of teaching methods in your own session?

- What did you learn from this session and how will you apply the notion of this session to
  your life?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- Seven Myths About High School Physics: http://www.aps.org/programs/education/highschool/teachers/7myths.cfm http://www.aps.org/programs/education/upload/7-Myths-About-High-School-Physics.pdf
- Video: https://www.youtube.com/watch?v=5o49H76Y2Xc Trainees watch and take notes (see sample questions).

1.2 Innovative ways of teaching physics (3 hrs)

At the end of this session, trainees will be able to:

- consciously select appropriate teaching methods from the range of research based physics teaching methodologies**,**
- devise activities and strategies that help them to teach the concepts of physics better.

In the previous session, you discussed about the importance of teaching physics for school students. Now let us discuss about how we teach Physics.

Activity 1

- How have you been teaching physics topics in your school? Please, take a moment and share your experience to the whole class.
- Is there any best method for teaching Physics?

When learning physics, it is important to note that students don't just learn the conceptual ideas like a shopping list or song lyrics; we want them to see the physics all around them in their daily lives and see how studying physics can make the world seem more beautiful.

Students come to the classroom with a broad range of pre-existing knowledge, skills, beliefs, and attitudes, which influence how they attend, interpret and organize in-coming information. When trainees' prior ideas are very different to scientifically accepted knowledge, these ideas have classically been labeled as 'misconceptions', although many

educators now prefer to refer to these as ‘alternative conceptions’, recognizing that such ideas are simply trainees ’ attempts to make sense of their world using common sense. It is difficult for trainees to give up their alternative conceptions, so sessions and learning activities need careful design.

Activity 2

- When teaching Physics, how could you start your lesson?
- Could you try to identify the prior conceptions that had been held by the students?
- If that is so, what kind of prior conceptions had been commonly held by the students?

Before teaching any topic, we strongly recommend that you explore the alternative conceptual ideas that trainees commonly hold in that topic. According to the constructivist theory, trainees' prior conceptions play an important role in their process of knowledge construction and teachers must take those prior conceptions into account when designing learning activities.

It is claimed that traditional instruction is ineffective in improving conceptual understanding. The approaches promoting active participation of trainees in learning are believed to help trainees construct knowledge meaningfully and the trainees give meaning to new gained knowledge by associating them with their prior ones.

Activity 3

- What kind of active learning methods do you think are useful for removing the misconceptions that had been held by the students?

In the literature, there are instructional methods or strategies to achieve conceptual change. Use of conceptual change text, concept cartoons, 5E learning model, REACT strategy concept map, analogy and simulation applications are only some of them. In the following sections, you will discuss about these methods one by one.

Conceptual Change Text

Conceptual change text is one of the conceptual change instructional strategies. It is a written text that defines common misconception about a natural phenomenon and directly refutes misconception by providing scientifically acceptable ideas by asking students to make predictions about a given situation. Conceptual change text is highly effective for creating conceptual change, promoting meaningful learning and overcoming misconceptions. Testing students prior knowledge is the first step in conceptual change text strategy. Then, presentation of the examples and explanations to facilitate students’ understanding is the next step. The

written text supports the conceptual change process by indicating the inconsistencies between scientific knowledge and common misconceptions.

Concept Cartoons

Concept cartoons propose an innovative teaching and learning strategy through a constructivist view of learning in science. They are instructional tools presenting real-life scientific problem and the characters express their opinions related to the problem. The complex and abstract concepts can be explained easily by the characters in concept cartoons. They can be developed both as posters and worksheets and be used either as teaching method or instructional material in science courses. The use of concept cartoons are quite effective for uncovering students' ideas, remedying misconceptions, providing powerful stimulus for trainees to focus their attention on constructing meaningful explanations and sparking argumentation.

The 5Es Instruction Model

The 5E's instruction model (engage, explore, explain, elaborate, and evaluate) is a research-based teaching model that is both student centered and inquiry-based. In the engagement phase, students are activated, and their prior knowledge is assessed. Its purpose is to capture trainees' attention, interests and to determine their misconceptions. In the exploration phase, the disequilibrium of the engagement is solved through students' activities in their respective groups; their cognitive and physical abilities are developed. The teacher controls activities, provides adequate materials, and counters any misconceptions. During the explain phase, students present and explain their findings. The teacher is a shock absorber and directs students' attention to key aspects of the prior phases and uses their explanations to explain scientific concepts. For the elaboration phase, this is where students' understanding is trained with new challenges or daily life situations. Finally, in the evaluation phase, students assess their learning and receive feedback on the adequate progress and ability, which helps the teacher make the appropriate decision.

REACT strategy of context based instruction

The stages included in the REACT strategy of context based instruction are indicated below.

- **Relating**: learning in the context of one's life experiences or preexisting knowledge
- **Experiencing**: learning by doing, or through exploration, discovery, and invention

- **Applying**: learning by putting the concepts to use
- **Cooperating**: learning in the context of sharing, responding, and communicating with other learners
- **Transferring**: using knowledge in a new context or novel situation, one that has not been covered in class

Concept map

A concept map is a diagram or graphical tool that visually represents relationships between concepts and ideas. Most concept maps depict ideas as boxes or circles (also called nodes), which are structured hierarchically and connected with lines or arrows (also called arcs). These lines are labeled with linking words and phrases to help explain the connections between concepts.

Analogy

Analogy is defined as a comparison of certain similarities between things which are otherwise unlike. Analogies are suitable for teaching scientific concepts by comparing an unknown with a known. It is a constructivist-based teaching approach designed to provide a powerful means of bringing about this conceptual change in students which involves use of familiar situation (source or analog) to explain a similar unfamiliar phenomenon (target). Analogy must therefore be familiar if it is to be fruitful, it must be able to prove its competence in bringing about conceptual understanding of the needed concepts. For this reason, they are widely used by textbook authors or science teachers for different aims such as introduction, clarification, or discrimination of new concepts.

Simulation

Computer simulation is one of the technological advances and rapidly entered the science classrooms as digital instructional technology. Simulation is defined as the computerized version of a model that runs over a period to analyze results of predefined interaction. Engagements with simulations meet the needs of learner from diverse backgrounds. It is highly effective for training learners on a model of reality, when the model is dangerous, difficult and costly. It can be used as a complement to or alternative for other forms of instructions to facilitate students' understanding of scientific concepts, and accepted as an alternative approach to real hands-on laboratory exploration or expository instruction. Learners

can arrange the independent variables and observe the results instantly. The literature presents successful learning outcomes of simulation activities.

Activity 4

- Are you familiar with above mentioned teaching-learning methodologies? Which one is new to you? Please share your experience with one another.

In addition to the above specific teaching methods, there are a number of effective methods for teaching physics in high school. Some of the best methods include:

1. **Inquiry-based learning**: This approach involves guiding students through the process of asking questions, gathering data, and forming and testing hypotheses. This helps students develop critical thinking skills and a deep understanding of physics concepts.
2. **Project-based learning**: This method involves having students work on real-world projects that involve applying physics concepts and principles. This can be a highly engaging and effective way to teach physics.
3. **Hands-on learning**: Hands-on learning, also known as experiential learning, involves providing students with the opportunity to engage in hands-on activities and experiments that help them learn physics concepts and principles.
4. **Collaborative learning**: Collaborative learning involves having students work in groups to solve problems and complete projects. This can be a great way to promote critical thinking and collaboration skills.
5. **Problem-based learning**: This approach involves presenting students with real-world problems and challenges that they must solve using physics principles and concepts. This can be a highly effective way to engage students and encourage critical thinking.

Overall, the best methods for teaching physics in high school will depend on the specific goals and needs of the students and the specific concepts being taught. It is often helpful to use a combination of different teaching methods to provide a well-rounded and engaging learning experience.

Implications to teaching

- Literature support the importance of teaching trainees with active learning methodologies so as to enhance trainees understanding of concepts and also make the

teaching and learning process more attractive. Have you been inspired to use such kinds of teaching methods in your own session?

- What new things have you learnt from this session?

Takeaway resources

To know more about innovative Physics teaching learning methodologies, read the following material.

- ✓ https://www.researchgate.net/publication/304570933_PHYSICS_TEACHING_METHODS/link/577399fe08aeb9427e23dd5b/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19
- ✓ https://arxiv.org/pdf/2006.02190.pdf
- ✓ https://www.labster.com/blog/7-creative-ways-teach-physics
- ✓ https://files.eric.ed.gov/fulltext/ED504949.pdf

Chapter Summary

In this chapter, we have dealt with the importance of teaching physics and the how of teaching it. Specifically, we have considered the following aspects:

- Explanation of Physics as a science aimed at describing the fundamental aspects of our universe. This includes what things are in it, what properties of those things are noticeable, and what processes those things or their properties undergo. In simpler terms, physics attempts to describe the basic mechanisms that make our universe behave the way it does.
- Some innovative methods used in the teaching-learning of Physics.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 2

Physical Quantities

2.1 Measurement (2hrs)

Introduction

Dear trainees, in science, particularly in physics, you try to make measurements as precise as possible. Several times in the history of science, precise measurements have led to new discoveries or important developments. Any number or sets of numbers used for a quantitative description of a physical phenomenon is called a physical quantity.

In this chapter, you will learn more about how to teach these concepts using constructive approaches. Scales, standards, units and addition of vectors are the selected topics. You have 4 hours at your disposal for covering this chapter.

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to measurement and quantities better,
- identify measurement scales in their surrounding,

In your day to day lives, you come across many things which you need to measure. This shows that measurement plays a very important role in our daily life. Dear trainees, in this session you are going to learn about measurement and quantities concepts. Daily life and practical activities are included to make it more attractive. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching topics related to measurement in your school? Please, take a moment and share your experience to the whole class.
- Do you use things that are happening around you in your class?

You deal with numerous such quantities daily. Let's move to exploring measurable things in our area through doing the following activity.

Activity 2

- ✓ List some of the things that you measure in your surroundings.

These quantities are called physical quantities. Our people has a tradition of measuring these physical quantities using traditional as well as modern devices.

Activity 3

- What traditional measuring units do you know that are used to describe length, time and mass? Are they reliable?
- Are you familiar with modern measuring devices?

Although many measurable quantities are available in your day to day activities, let us only focus on the length, time and mass measuring devices for the sake of time.

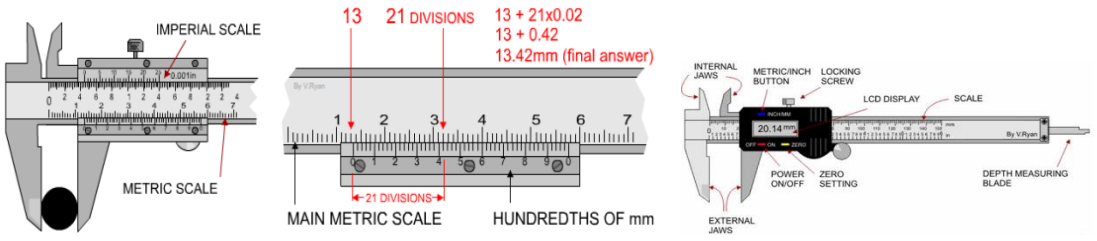
Activity 4

Form a group with your classmates and do the following activities.

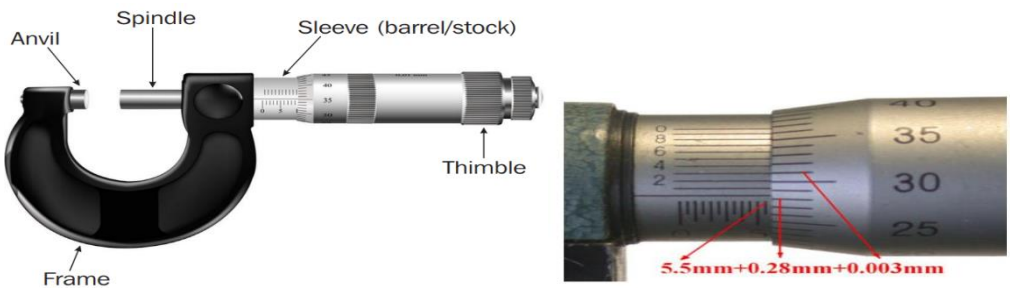
- Measure the length of different bodies using length measuring instrument and compare with the estimated values.
- Have you ever tried to measure the mass of a body using a beam balance? Visit a shop in your living area. Write down the procedures the shopkeeper uses to measure the mass of a body using a beam-balance. Report your observations to your class.
- Discuss how the sun rise and sun set is used to measure the time of a day. Draw a diagram of sundial at different times of the day.

Activity 5

You might have been familiar with most of the measuring devices. Do you know how to use devices like vernier caliper and micrometer?



Vernier caliper



Micrometer

If you are new to using devices like micrometer as well as vernier caliper, watch the following you tube video so as to properly understand how to read a vernier caliper and micrometer.

- https://www.youtube.com/watch?v=XQT6RSNN9sA

In all the above activities, you got an understanding of how to directly measure the length, time and mass of a body. You can see that some quantities are directly measured, while others are calculated by combining two or more measurable quantities.

Activity 6

- List other quantities which can be measured directly and not.

From your discussion on the above activity, you got an understanding of basic and derived quantities including their units. Now let's move to discussing about how these quantities are described. Let us do the following activity first.

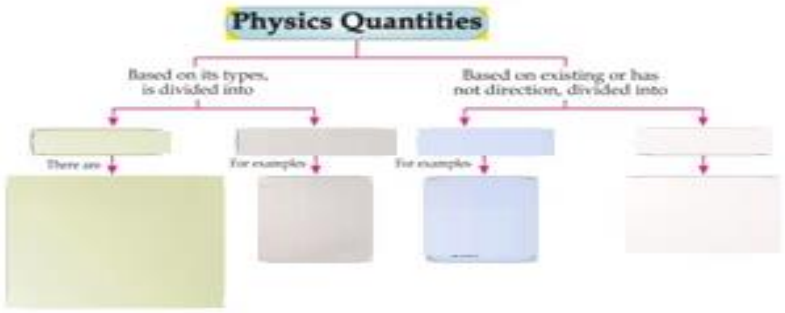
Activity 7

- Have you experienced traveling to an unfamiliar place, but after a while, you realized you were lost? When traveling from one place to another, it is not only important to know how far it is, but you also need to know the direction you should follow to reach your desired location. Today, simple street maps and online maps in your phones can easily give directions and instructions for you to reach your destination. In science, you will encounter varying physical quantities. Some of these quantities are accompanied by directions; others are not. What are these quantities, and why is specifying the direction important?

Now try to summarize what you learnt in this session using a concept map.

Activity 8

- In groups, draw a concept map on physical quantities or measurement lesson and share your diagrams with one another. A sample concept map is given below.



Key ideas

- The fundamental and derived quantities are the base for defining the standard units of each physical quantity. Earlier, People did not use a standard measurement system, and their units vary from region to region. This led to the setup of the International System of Units which resulted in the standardization of units. The derived quantities are extracted from the 7 fundamental quantities.
- A scalar quantity is a quantity that magnitude only. On the other hand, a vector is a quantity that has magnitude and direction.

Assessment questions

- ✓ What do you mean by physical quantity? Explain differences between fundamental quantity and derived quantity.
- ✓ Which of the following is a vector: a person's height, the altitude on Mt. Everest, the velocity of a fly, the age of Earth, the boiling point of water, the cost of a book, Earth's population, or the acceleration of gravity?
- ✓ What do vectors and scalars have in common? How do they differ?

Implications to teaching

- o Literature support the importance of teaching concepts practically and through the use of concept map so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- o What new things have you learnt from this session?
- o Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about this session, read the following material.

- https://portal.tpu.ru/SHARED/k/KOVN/eng/teaching/Tab2/5_Metrology_labs_tme1-112p.pdf
- https://www.isbe.net/CTEDocuments/TEE-L670067.pdf
- https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXI/physics/kelm102.pdf
- https://www.studocu.com/ph/document/dolores-national-high-school/general-physics-1/scalar-and-vector-quanitites/71732847

2.2 Addition of Vectors (2hrs)

By the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to addition of vectors,
- explain the graphical and analytical method of vector addition,
- identify common misconceptions related to the addition of vectors and take corrective measures.

Today, you'll dive into the fascinating world of vectors and learn how to perform vector addition. Are you ready to master this skill? Let's get started with your teaching experience.

Activity 1

- How have you been teaching about addition of vectors? Please, take a moment and share your experience to the whole class.
- Do you start your lesson through describing the things that are happening around you?

Let's begin by recalling what you know about vectors.

Activity 2

- Can someone give me a definition of a vector and some examples of vector quantities you encounter in your daily lives? Share your ideas with the class.

Now that we have a solid foundation, let's learn how to add vectors. Understanding vector addition is crucial in various fields, including physics, engineering, agriculture, and navigation, as it allows for the analysis and prediction of complex vector quantities and their effects.

You can add vectors using both graphical and algebraic methods. Let's first focus on the graphical method.

- ***Graphical method of vector addition***

Imagine you have vectors represented by arrows on a coordinate plane. To add them graphically using the triangle, parallelogram and polygon method of vector addition, these are the steps we need to follow:

1. Decide on an appropriate scale. Record it on the diagram.
2. Pick a starting point.
3. Draw first vector with appropriate length and in the indicated direction.
4. Draw the second and remaining vectors with appropriate length and direction.
5. Draw the resultant based on the specific rule you are using.
6. Measure the length of the resultant; use the scale to convert to the magnitude of the resultant.
7. Use a protractor to measure the vector's direction.
8. Express the resultant vector

Activity 3

- Study each of the graphical methods of vector addition.

A common mistake is attempting to add vectors head to head, or tail to tail. However, this approach is incorrect, and gives a different answer from adding the vectors head to tail. Now let us practice the rules of vector addition by doing the following activity

Activity 4

- Consider adding two vectors *A* and *B* graphically. The two vectors are shown in Figure 1.8. Using the above procedure of vector addition, add these two vectors using the triangle law as well as parallelogram law of vector addition if the angle θ is 30°.

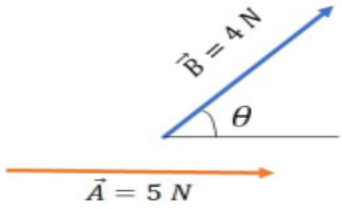


Figure 1.8 Two vectors $\vec{A}$ and $\vec{B}$.

- When should we use the polygon law of vector addition?

Well done, by now you have properly understood the graphical method of vector addition. Now let us discuss the algebraic or component method of vector addition.

- **Algebraic method of vector addition**

To add vectors algebraically, you'll break them down into their horizontal and vertical components. Then, you can add the corresponding components separately. Finally, you combine the components to obtain the resultant vector.

Given a vector v with magnitude m and direction θ:

1. the horizontal component of the vector: $v_x = m * \cos(\theta)$
2. the vertical component of the vector: $v_\gamma = m * \sin(\theta)$
3. Write the vector in component form: $v = v_x i + v_\gamma j$, where i and j are unit vectors along the x and y axes, respectively.

By resolving the magnitude of a vector into its horizontal and vertical components, you can represent the vector in its component form. This form is useful for algebraic operations such as vector addition and subtraction, as well as for analyzing vector quantities in different directions.

To add two vectors v_1 and v_2 algebraically, follow these steps:

1. Find the horizontal components of the vectors: $v_{x1} = m * \cos\theta$; $v_{x2} = m * \cos\theta$
2. Find the vertical components of the vectors: $v_{\gamma 1} = m * \sin\theta$; $v_{\gamma 2} = m * \sin\theta$
3. Add the horizontal components: $v_x = v_{x1} + v_{x2}$
4. Add the vertical components: $v_y = v_{y1} + v_{y2}$
5. Write the sum of the vectors in component form: $v = v_x i + v_\gamma j$
6. Find the magnitude m of the resultant vector v using the Pythagorean theorem: $m = \sqrt{(v_x^2 + v_y^2)}$
7. Find the direction θ using the inverse tangent function: $\theta = \tan^{-1}(v_y/v_x)$

By algebraically adding the horizontal and vertical components separately, you can find the resultant vector of the addition operation. This method allows for precise calculations and is particularly useful when dealing with multiple vectors or vectors in non-standard directions.

Now, it's time for you to practice! Some vector addition problems is provided for you to solve on your own or with a partner using graphical and algebraic methods.

Activity 5

1. A farmer wants to apply fertilizer to a field with a wind speed of 10 mph blowing from the east. The farmer plans to apply the fertilizer at a speed of 5 mph in a direction of 30 degrees north of east. Calculate the resultant vector of the fertilizer application velocity, taking into account the effect of the wind.

2. A drone is being used to spray pesticides on a rectangular field. The drone can fly at a speed of 15 mph in a direction of 60 degrees north of east (30 degrees). However, there is a crosswind blowing from the southwest at a speed of 12 mph (225 degrees). Calculate the resultant vector of the drone's flight path, considering the influence of the crosswind.

    ✓ *Have you obtained similar results using the graphical as well as algebraic methods? If not what makes you to obtain a different answer?*

As a final note, farmers use technology to optimize input applications (fertilizers, irrigation). Vector addition helps determine resultant vectors for equipment movement, wind speed, and crop traits, improving efficiency and reducing waste. When applying pesticides, considering wind direction and speed is crucial. Vector addition is used to calculate the resultant vector of wind speed and direction along with the vector representing spray application. This allows farmers to assess potential drift of pesticides and determine appropriate spraying techniques.

Assessment

1. Suppose you add two vectors $\vec{A}$ and $\vec{B}$. What relative direction between them produces the resultant with the greatest magnitude? What is the maximum magnitude? What relative direction between them produces the resultant with the smallest magnitude? What is the minimum magnitude?
2. Is it possible to add a scalar quantity to a vector quantity?
3. Is it possible for two vectors of different magnitudes to add to zero? Is it possible for three vectors of different magnitudes to add to zero? Explain.
4. If two vectors are equal, what can you say about their components? What can you say about their magnitudes? What can you say about their directions?
5. If three vectors sum up to zero, what geometric condition do they satisfy?
6. Explain why a vector cannot have a component greater than its own magnitude.
7. Is vector addition applicable to any two vectors?
8. Is it possible to follow similar steps for vector subtraction?

Key ideas

- Two or more vectors can be added using the geometrical as well as algebraic method of vector addition.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about addition of vectors, read the following material.
  - https://www.texasgateway.org/resource/52-vector-addition-and-subtraction-analytical-methods
  - https://pressbooks-dev.oer.hawaii.edu/collegephysics/chapter/3-3-vector-addition-and-subtraction-analytical-methods/
  - https://byjus.com/physics/addition-of-vectors/
- Learn how to add vectors using the following simulation.
  - https://phet.colorado.edu/en/simulations/vector-addition

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of measurement, quantities and addition of vectors. Specifically, we have considered the following aspects:

- Explanation of Physical quantities as a characteristic or property of an object that can be measured or calculated from other measurements.
- Explanation of the graphical as well as analytical method of vector addition.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 3

Motion in one and Two-Dimension

Introduction

Dear trainees, our study of physics opens with **kinematics**, the study of motion without considering its causes. Objects are in motion everywhere you look. Everything from a tennis game to a space-probe flyby of the planet Neptune involves motion. When you are resting, your heart moves blood through your veins. Even in inanimate objects, atoms are always moving.

In this chapter, you will learn more about how to teach these concepts using constructive approaches. Topics in one as well as two dimension are the focus of this unit. You have 10 hours at your disposal for covering this chapter.

3.1 Position, Distance and Displacement (2 hrs)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to position, distance and displacement,
- Identify common misconceptions related to this topic and take corrective measures,
- Differentiate distance and displacement from each other.

Dear trainees, in this session you are going to learn about the concept of position, distance and displacement. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching topics related to position, distance and displacement? Please, take a moment and share your experience to the whole class.
- Are there misconceptions that were commonly held by your students in relation to this topic?

Throughout the literature, many misconceptions were observed in relation to the topics distance, displacement and position. Before exploring such misconceptions, let us start our

class through probing your prior knowledge about motion through asking the following questions.

Activity 2

- When can we say that an object is in motion?
- How do you describe the motion of an object?
- When do you say that an object is moved? What are the ways of describing motion?

To help you understand this topic, let us look at situation that illustrates the position and reference point of an object. Try to do the activity in group.

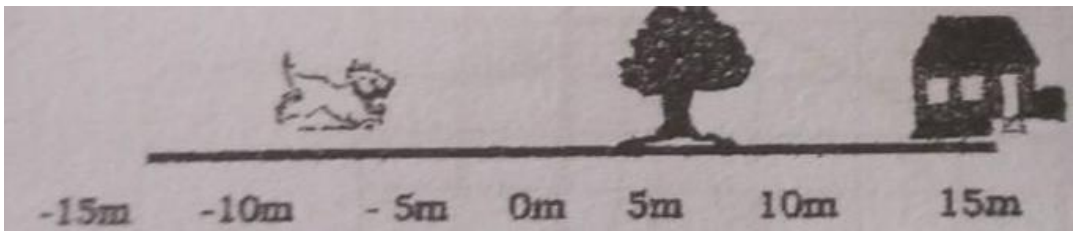
Activity 3

- Describe in words the position of an object within the room or the school ground. Were you able to find the object? Was it easy or difficult?

Based on your response, try to define point of reference and its importance in your own words. Let us now describe the position of an object through visuals like diagrams and graphs.

Activity 4

Consider the diagram below. The positions of the objects are described in the diagram by their coordinates along the number line.



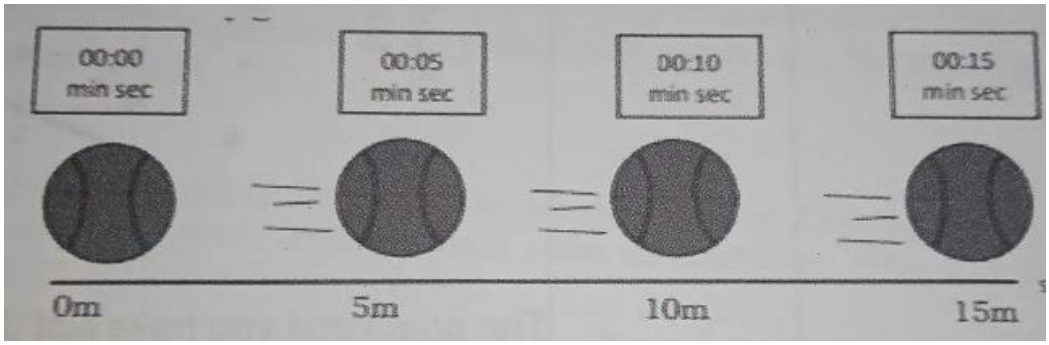
Based on the diagram, answer the following questions:

- What is the position of the dog?
- What is the position of the tree?
- What is the position of the dog with respect to the house?
- What is the position of the tree with respect to the dog?

Let us also look at the following example.

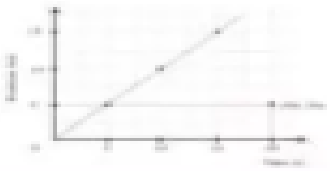
Activity 5

In this diagram, the position of the ball rolling are shown at equal intervals of time. Use the diagram to describe the position of the ball at any given time.



- What is the initial position of the ball? What is the final position?
- What is the position of the ball at 10 seconds?
- At what time is the position of the ball equal to 5 meters?
- Describe the motion of the ball using motion graphs and fill it in table 1. Plot the values in table 1 on the graphing board (note that time is plotted on the x-axis while position is plotted along the y-axis)

Time (s)	Position of the ball (m)
0	0
5	5
10	10
15	15



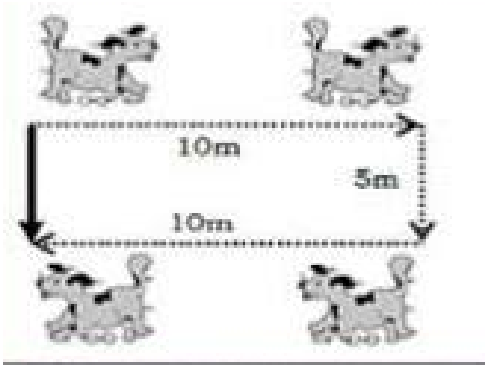
- ✓ At what time will the ball reach 20 meters?
- ✓ What is the position of the ball at 7.5 seconds?
- ✓ At what time is the position of the ball equal to 12.5 meters?

Now you have clearly understood the concept of a position. Let us move to exploring our understanding of distance and displacement. Students sometimes think that distance and displacement are just different names for the same quantity. However, distance and displacement are different concepts.

Activity 5

Start describing motion with the question, "how far did the dog travel?"

- What is the total length traveled by the dog from its point of origin to its final destination?
- What is the shortest distance of the dog relative to its points of origin?



Have you noticed about the two ways of answering this question?

- ✓ First is by getting the total length of the path travelled by the dog. The other way is by measuring the distance between the initial position and final position of the dog.

Notice that the first measurement gives the distance travelled while the second measurement gives its displacement. People sometimes think that distance and displacement are just different names for the same quantity.

Activity 6

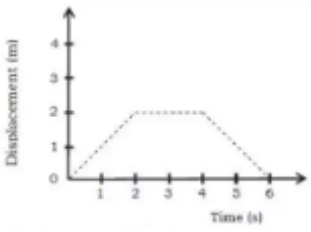
Answer the following questions as points for discussion.

- What have you noticed about the distance and the displacement in the given example?
- When can displacement be equal to distance?
- Can displacement be greater than distance? Why?
- What if the ball, the car, and the dog in the illustrations go back to their starting positions, what will be their total distances? What will be their displacement?

Have you understood the differences between distance and displacement? Let us now look at the distance-time graph and displacement-time graph**s** shown in the following activity.

Activity 7

By referring to the following graph,

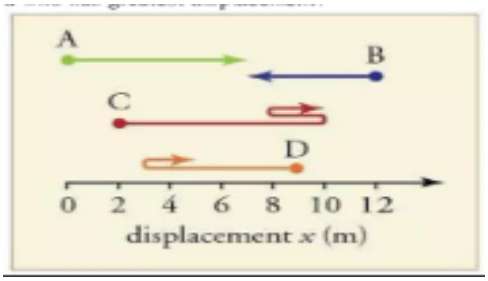


- What is the displacement of the object after 2 seconds?
- What is the displacement after 6 seconds?

- How will you describe the motion of the objects between 0s and 2s, between 2s and 4s, and between 4s and 6s?

Assessment

- ✓ Give an example in which there are clear distinctions among distance traveled, displacement, and magnitude of displacement. Identify each quantity in your example specifically.
- ✓ The arrows represent the different distances covered by students. Who among the trainees covers the longest distance? Who has greatest displacement?



- ✓ Can the magnitude of a particle's displacement be greater that the distance traveled?
- ✓ Under what circumstances does distance traveled equal magnitude of displacement? What is the only case in which magnitude of displacement and distance are exactly the same?

Key ideas

- The word position describes your location (where you are).
- A frame of reference is an arbitrary set of axes from which the position and motion of an object are described.
- Distance is the actual path that is travelled by a moving body, where as displacement is the change in position (final position minus initial position).

Implications to teaching

- o Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- o What new things have you learnt from this session?
- o Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about distance and displacement, read the following material.
    - https://flexbooks.ck12.org/cbook/ck-12-physics-flexbook-2.0/section/2.1/primary/session/position-and-displacement-phys/
    - https://amsi.org.au/ESA_Senior_Years/SeniorTopic3/3i/3i_2content_1.html
    - https://byjus.com/physics/distance-and-displacement/
    - https://courses.lumenlearning.com/suny-osuniversityphysics/chapter/1-1-position-displacement-and-average-velocity/
    - http://physics.bu.edu/~duffy/ns540_fall10_notes01/EP_ch02_2dash1to2dash4.pdf

3.2 Average Velocity and Instantaneous Velocity (2hrs)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to velocity,
- describe the difference between average velocity and instantaneous velocity,
- identify common misconceptions related to this topic and take corrective measures.

Dear trainees, your experience with traveling in daily life will be very helpful to investigate about speed and velocity. In this lesson, you will be working with speed and velocity. Daily life and practical activities are included so as to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching about speed or velocity? Please, take a moment and share your experience to the whole class.
- What were the common misconceptions that were held by your students in relation to this topic?

One of the most common misconceptions in physics is the idea that velocity and speed are interchangeable terms. While they may be related, they are not the same thing. So, what is the difference? Velocity is a vector quantity that describes both the speed and direction of an object's motion, while speed is a scalar quantity that describes only how fast an object is moving. In simpler terms, velocity is speed in a given direction.

Activity 2

- Are you familiar with the traffic signs? What are the units used for speed limit?
- What quantities do these units represent that are related to speed?

To further differentiate between velocity and speed, it's important to understand that velocity is always measured relative to a frame of reference.

Activity 3

- How can we differentiate these two quantities with respect to reference frames?

Activity 4

- Student M walks 2 km away from home in 30 minutes. He then turns around and walks back home along the same path, also in 30 minutes. Calculate M's average speed and average velocity.

Activity 5

1. What are the differences between speed and velocity?
2. What quantities did you measure for calculating speed and velocity?
3. How did you combine these quantities to determine how fast each participant was walking?
4. How did you use the result to determine who walked fastest?
5. What is instantaneous velocity?

Activity 6

1. Did you remember news that watched or heard on natural disaster occurred in the country?
    a. How do you think speed and velocity is related to this phenomenon?
    b. What other life experiences can you share wherein speed and velocity is applied?
2. "ACT NOW" perspective:
    a. Why do you think many people died in the Yolanda incident?
    b. How will you react if you heard valid news that our area will be hit by any particular natural disaster?

Assessment

Write your name if the statement is true and write the name of your crush if it is false.

1. Speed is defined as the distance travelled divided by the time of travel.
2. Speed without direction is referred to as velocity.
3. Speedometer is a device used to measure the instantaneous speed of a vehicle.
4. The velocity of an object in an instant is called average speed.

5. The velocity of a moving object at an instant is called instantaneous velocity. Alex ran with a speed of 0.5m/s. Matt says he is faster than Alex. He ran 100m in 3 minutes. What is Matt's speed, and is he faster than Alex?
6. How long does it take a horse to run 3km if it travels at a speed of 40 km/hr?
7. Joe can pitch a baseball at a distance of 48m in 1.5s. How fast is his pitch? Find the meaning of instantaneous speed, instantaneous velocity and average speed.

Key ideas

- Average velocity is change in displacement divided by time taken.
- Instantaneous velocity is the velocity of an accelerating body at a specific instant in time.
- The magnitude of instantaneous velocity is its instantaneous speed.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

To know more about velocity, read the following material.

- https://study.com/learn/session/average-vs-instantaneous-velocity-difference-uses.html#:~:text=Types%20of%20Velocity&text=Remember%20that%20instantaneous%20velocity%20is,longer%20period%20of%20elapsed%20time.
- https://scienceready.com.au/pages/instantaneous-and-average-velocity#google_vignette
- https://artofsmart.com.au/hsctogether/instantaneous-and-average-velocity/

3.3 Uniform Motion and Uniformly Accelerated Motion (2hrs)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to uniform motion and uniformly accelerated motion,
- differentiate between uniform and uniformly accelerated motions,
- identify common misconceptions related to this topic and take corrective measures.

Dear trainees, in this session you are going to learn about the concepts related to uniform motion and uniformly accelerated motion. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the definition of physics? Please, take a moment and share your experience to the whole class.
- What kind of misconceptions is held by your students?

Let us start our session by doing the following activity.

Activity 2

The motions of two bodies are measured and recorded in tables 'A' and 'B'.

A)

s(m)	6	12	18	24	30	36	42	48
t(s)	1	2	3	4	5	6	7	8
v(m/s)								

B)

s(m)	4	9	15	22	30	39	49	60
t(s)	1	2	3	4	5	6	7	8
v(m/s)								

i. **Calculate the speed of the two bodies and complete the tables.**
ii. **What is the difference between the speeds in A and B?**
iii. **What do you call the type of speed in A and in B**

In A, the body is moving with a constant velocity while in B, the body is moving with uniformly increasing speed. In uniform motion, an object moves at a steady speed in a straight line. Most moving objects, however, do not display uniform motion. Any change in an object's speed or direction or both means that its motion is not uniform. This non uniform motion, or changing velocity, is called **accelerated motion**. A car ride in a city at rush hour during which the car must speed up, slow down, and turn corners is an obvious example of accelerated motion. One type of accelerated motion, called uniformly accelerated motion, occurs when an object travelling in a straight line changes its speed uniformly with time.

Activity 3

✓ The following table shows five different sets of velocities at times of 0.0 s, 1.0 s, 2.0 s, and 3.0 s. Which of them involve uniform acceleration with an increasing velocity for the entire time? Describe the motion of the other sets.

	Time (s)	0.0	1.0	2.0	3.0
(a)	Velocity (m/s [E])	0.0	8.0	16.0	24.0
(b)	Velocity (cm/s [W])	0.0	4.0	8.0	8.0
(c)	Velocity (km/h [N])	58	58	58	58
(d)	Velocity (m/s [W])	15	16	17	18
(e)	Velocity (km/h [S])	99	66	33	0

Let us do some activities for you to understand Uniformly Accelerated Motion more. These activities are designed for you. The materials are easy to find and the procedures are easy to follow. You can also do these simple activities at home with the help of any home companion.

Activity 4

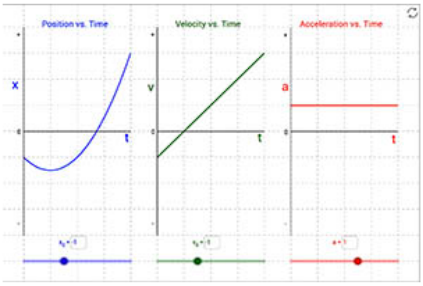
In this activity, identify bodies or objects that exhibit uniformly accelerated motion. Write UAM if it exhibits Uniformly Accelerated Motion, write Non-UAM if it DOES NOT.

_____ 1. A bike that is at rest.
_____ 2. A boy holding a book.
_____ 3. A girl walking leisurely.
_____ 4. A hanging picture frame.
_____ 5. A rock falling from a cliff.
_____ 6. A fruit dropping from a tree.
_____ 7. A rolling ball on an inclined plane.
_____ 8. A man standing still in an escalator.
_____ 9. A car increasing its velocity at a constant rate.
_____ 10. A truck running with a constant acceleration.

Now let us investigate the graphs of a uniform motion and uniformly accelerated motion using the following oPhysics: Interactive Physics Simulations.

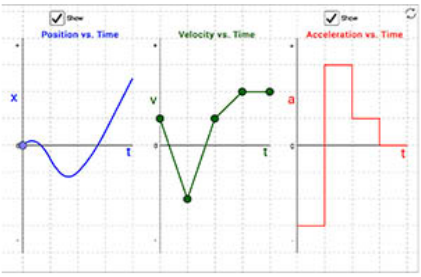
Activity 5

- Position, Velocity, and Acceleration vs. Time Graphs https://ophysics.com/k4b.html



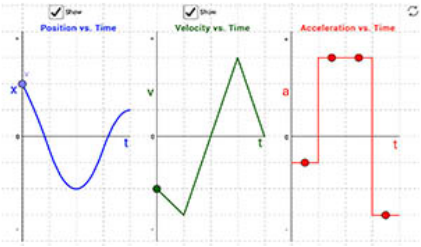
Uniform Acceleration in One Dimension: Motion Graphs

This simulation is intended to help students get a better understanding of the relationships between various quantities involved in uniformly accelerated motion. By adjusting the sliders (or input boxes), a student can change the initial position, the initial velocity, and the acceleration of an object, and can observe how each change affects the graphs of position, velocity, and acceleration vs. time.



Position, Velocity, and Acceleration vs. Time Graphs

In this simulation you adjust the shape of a Velocity vs. Time graph by sliding points up or down. The corresponding Position vs. Time and Acceleration vs. Time graphs will adjust automatically to match the motion shown in the Velocity vs. Time graph.



Kinematics Graphs: Adjust the Acceleration

This is a simulation that shows the position vs. time, velocity vs. time, and acceleration vs. time graphs for an object. Students can adjust the initial position and initial velocity of the objects, and then adjust the acceleration of the object during the four time intervals represented on all the graphs.

Activity 6

- What does the terms under the position-time, velocity-time and acceleration-time graph represents?
- The table shows a set of position-time data for uniformly accelerated motion.

Time, s	0	2	4	6	8
Position, m	0	8	32	72	128

a) Plot a position-time graph

b) Find the slopes of tangents at appropriate times.

c) Plot a velocity-time graph.

d) Plot an acceleration-time graph.

e) Determine the area under the line on the velocity-time graph and then on the acceleration-time graph. State what these two areas represent.

Key ideas

✓ **Uniform motion** is an object undergoing motion with a constant or unchanging velocity.

- ✓ **Uniformly accelerated motion** is the motion of an object undergoing constant acceleration that does not change with time.

Implications to teaching

- Literature support the importance of teaching concepts through engaging trainees in the teaching and learning process so as to make the trainees understand the topic and also to make the teaching and learning process more attractive. Using simulations are also preferable methods when the use of hands on approach is not practicable. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about the differences between uniform and uniformly accelerated motion, read or watch the following material.
  - https://youtu.be/mFmfHdLKQM0
  - https://youtu.be/0kQrz4dfxDw

3.4 Uniform Circular Motion (1 hr)

By the end of this section, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to uniform circular motion,
- Solve problems involving centripetal acceleration and centripetal force,
- identify common misconceptions related to this topic and take corrective measures.

Dear trainees, in this session you are going to learn about the concept of uniform circular motion. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concepts of uniform circular motion? Please, take a moment and share your experience to the whole class.
- Did you start your teaching through describing the things that are happening around you?

- What were the common misconceptions held by your students in relation to this topic?

In the literature, the most common misconception is the one that says an object undergoing uniform circular motion does not accelerate. Have you obtained similar misconceptions on your students?

Good, before we start to work through the material, here is a question you might like to ponder.

Activity 2

- Why study circular motion?

For the ancient Greeks, the circle symbolized perfection. The fact that the Sun, Moon and stars appeared to move around the Earth in circular paths was evidence of their status as 'heavenly bodies'. Circular motion was supposedly their natural state.

Although we don't regard movement in a circle with the same reverence as did the ancient Greeks, it is still a very useful concept. If we restrict our discussion to circular motion at constant speed (called uniform circular motion), then its mathematical description turns out to be quite straightforward.

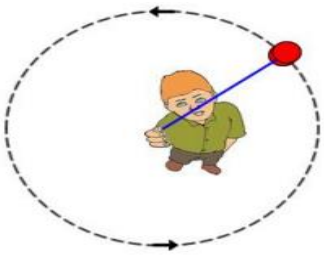
Activity 3

- What is uniform circular motion? Give examples of it.
- Would you list and explain situations in nature which approximate to uniform circular motion?

The second, minute, and hour hands of a watch is one example undergoing a uniform circular motion. It is remarkable that points on these rotating objects are actually accelerating, although the rotation rate is a constant. To see this, we must analyze the motion in terms of vectors.

Activity 4

1. A boy is whirling a yo-yo above his head in a counterclockwise direction. At the exact moment shown at left, he lets go of the string. In which direction will the yo-yo travel? Draw an arrow on the image to show the yo-yo's direction.
2. Do you think the released yo-yo's path will be straight or curved? Explain.



Here is a short experiment you can carry out to look at circular motion in a different context.

Activity 5

Take a piece of elastic about 20 cm in length and tie one end of it securely to a pencil rubber. Now, while holding the elastic, whirl the rubber round (carefully!) so that it moves in approximately horizontal circles at a uniform speed as in Figure a. You can check that it is moving at a roughly uniform speed by doing the experiment in fluorescent light. Because fluorescent light flashes on and off 100 times per second your eye should register a series of 'still' images of the elastic and rubber. If the images appear evenly spaced as in Figure b and the motion is circular, the rubber must be moving with a uniform speed.

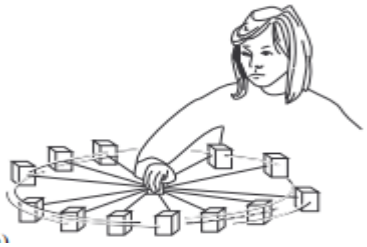
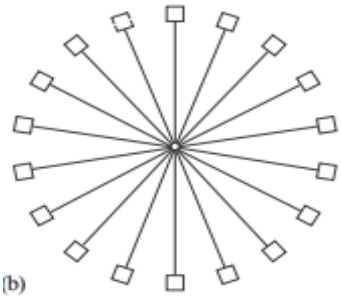
(a)  (b) 

Figure: The 'whirling pencil rubber' experiment. (a) How to do it. (b) What you should see in fluorescent light.

Now answer the following questions.

- What force causes the pencil rubber to move in a circle?
- How do the magnitude and direction of this force vary during the circular motion?
- What is the relationship between the direction of motion of the rubber and the direction of the force acting on it?

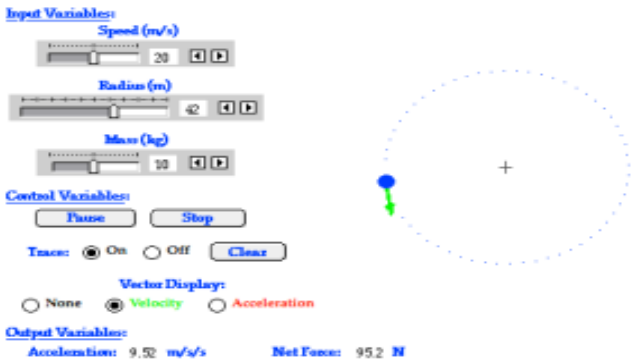
What you have been trying to show so far in this section is that the forces which cause uniform circular motion in two very different examples have certain things in common. In both cases the force has a constant magnitude and the direction of the force is always radially inwards towards the centre of the circle, which is to say perpendicular to the direction of motion.

Activity 6

- Draw a vector diagram to show that the acceleration of a particle moving with uniform speed.
- Derive the expressions used to calculate centripetal force and centripetal acceleration.

Now perform the following simulation software. This simulation allows you to alter the radius and speed of an object moving in uniform circular motion to see the effect upon acceleration and force. The direction of the velocity and the force are displayed as vector arrows. This simulation is accompanied by an activity sheet with directions and exploration questions.

- The Physics Classroom: Uniform Circular Motion Interactive Simulation http://www.physicsclassroom.com/shwave/ucm.cfm



Key ideas

- Uniform circular motion is a specific type of motion in which an object travels in a circle with a constant speed.
- An object moving in a circle at a constant speed is experiencing a force which is constant in magnitude and directed radially inwards towards the centre of the circle. This force, whatever its cause, is called the centripetal force.

Assessment

- Is there a net force acting on an object in uniform circular motion?
- What is the centripetal acceleration felt by the passengers of a car moving at 12 m/s along a curve with radius 2.0 m?

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?

- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about uniform circular motion, read the following material.
  - https://youtu.be/IawY86XveQE
  - https://youtu.be/j5nSGCsHUZY
- Perform available simulation experiments so as to understand the concept of uniform circular motion in a better way.

3.5 Projectile motion (2 hrs)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to projectile motion,
- use kinematic equations to analyze and solve angle-launched projectile problems.
- identify common misconceptions related to this topic and take corrective measures.

Dear trainees, have you ever wondered how far a ball can travel when you throw it? Or better yet, how hard you need to hit a baseball to get a home run? These are real questions that not only apply to baseball, but other real-life situations including the paths of meteorites and trajectories of rockets. In today's session, we will learn about a projectile motion. We see projectile motion in action almost every day. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concepts of projectile motion? Please, take a moment and share your experience to the whole class.
- Could you start your teaching through describing the things that are happening around them?
- What were the common misconceptions held by your students in relation to this topic?

In literature, there were misconceptions that had been held by the students. One of them is that the direction of a velocity vector of a projectile follows the curved path at every position. Have you came across such a misconception?

Let us now start our class through probing your everyday experiences that are related to projectile motion.

Activity 2

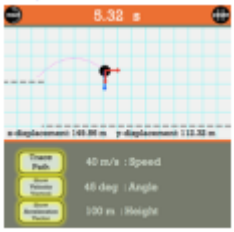
- Name everyday examples of projectile motion and explain why they are projectile motion.

Make sure that projectile motion is based on the trajectory of objects and their motions, not inertial forces. To help you understand these concepts in a better manner, perform the following simulation experiments.

Activity 3

1. Projectile Simulator TPC's Physics Interactive http://www.physicsclassroom.com/Physics-Interactives/Vectors-and-Projectiles/Projectile-Simulator

   This projectile simulator allows trainees to alter the launch speed, launch height and launch angle of a projectile. The trajectory, range, and time of fight are displayed. The velocity vector components, acceleration vector, and the trajectory trace can be toggled off and on. The simulator is accompanied by three separate exercises that emphasize various aspects of projectile motion. The simulation is an HTML5 simulation that was designed with iPads, Chromebooks, and smart phones as the target device.



Interactive Simulation

2. PhET: Projectile Motion http://phet.colorado.edu/en/simulation/projectile-motion

   In this simulation, trainees can fire various objects out of a cannon, including a golf ball, football, pumpkin, human being, a piano, and a car. By manipulating angle, initial speed, mass, and air resistance, concepts of projectile motion come to light in a fun and game-like environment. Can you set the initial conditions so that you hit the target? *Teachers: For a unique activity to accompany this simulation, here's a Problem-Based Learning exercise developed by a high school teacher. Trainees take the role of a military artillery officer with the task of explaining factors that affect the path of a projectile fired from a cannon. The lesson is aimed at beginners as they explore variables affecting trajectory.*

Projectile Motion Simulation: Problem-Based Learning Investigation

3. Projectile Motion with Angry Birds
   http://www.compadre.org/OSP/items/detail.cfm?ID=11562
   This resource uses the free Tracker Video Analysis tool to measure and analyze the motion of an angry bird projected from a slingshot to hit a pig. If you don't have Tracker yet, here's a link to the free download: Download Tracker Video Analysis and Modeling Tool.

Interactive Simulation

You can then proceed to deriving the equations used to calculate velocity, displacement, height and range of the projectile motion.

Activity 4

- In groups, try to recap your knowledge of deriving the equations of a projectile motion.

Assessment

- Why does a projectile follow a curved path?
- Why is 45 degrees the optimal angle for projectiles?
- Who first accurately described projectile motion and when?

Key ideas

- The properties of projectile motion are that the object's horizontal velocity does not change, that it's vertical velocity constantly changes due to gravity, that the shape of its trajectory will be a parabola, and that the object is not affected by air resistance.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. The use of simulation softwares also helps learners to better

understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?

- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about projectile motion, read/watch the following material.
  - https://byjus.com/physics/projectile-motion/
  - https://openstax.org/books/physics/pages/5-3-projectile-motion
  - https://openstax.org/books/college-physics-2e/pages/3-4-projectile-motion
  - https://www.toppr.com/guides/physics/motion-in-a-plane/projectile-motion/
  - https://youtu.be/8NLzuURxFwY
- The Physics Classroom Tutorial, Motion and Forces in Two Dimensions Chapter, Session 2 http://www.physicsclassroom.com/class/vectors/Session-2/What-is-a-Projectile

3.6 Rotational Motion (1 hrs)

At the end of this session, trainees are expected to:

- devise activities and strategies that help them to teach the concepts related to rotational motion,
- solve problems regarding rotational motion;
- describe, when a rigid object rotates about a fixed axis, the relationship between the translational counterparts of rotational or angular position, speed, and acceleration.
- differentiate translation and rotation.

Dear trainees, in this session, you are going to learn about the concept of image formation by mirrors. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

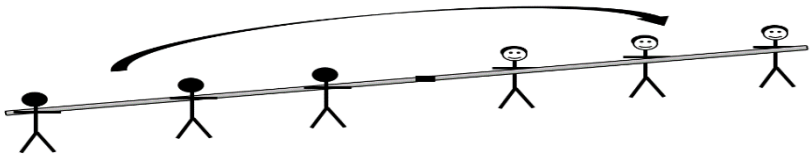
- How have you been teaching the concepts of rotational motion? Please, take a moment and share your experience to the whole class.
- Do you use the things that are happening around you to teach these concepts to your students?
- What were the common misconceptions held by your students in relation to this topic?

Let us start our discussion through recalling your previous session.

Activity 2

- Is everyone riding the merry-go-round moving at the same speed?
- Two 10-foot sections of small diameter PVC pipe are connected end to end with tape or a slip-fit connector. Mark the assembled pipe with painter's tape every 2.5-feet. Optionally, a 4-way connector and four 10-foot sections can be assembled to create a life-sized 4-spoke fidget spinner.
  - Move trainees to suitable location - outside is preferred on level ground. Take volunteer or assign students to stand holding the pipe assembly.
  - You should be facing in the direction of clockwise rotation.

    A drawing for reference...



  - Imagine that you are on a merry-go-round, and that the ride starts out slow.
  - Those of you who are on the outer perimeter to begin by walking at normal pace. Non-participant trainees need to make observations.
  - Now instruct the inner-most trainees to walk at a normal pace. All of you have to observe the new pace of the outer perimeter trainees.

Optional Method:

1. No supplies on hand? You can just lock arms or hold hands instead of holding onto the PVC pipe. Try to maintain straight lines as they rotate.
2. Now watch the short video presentation. Focus your observation on the movements of the skater in the video. Afterwards, you will answer some questions.

Have you observed that most of the skater's movements are in a circular path? The skater does it in either stationary or locomotive manner. The skater projects an example of rotational motion which will be the subject of our discussion today.

Activity 3

- In groups, try to derive a relationship between arc length, radius, and angle of rotation.

Now try to perform the following activity.

Activity 4

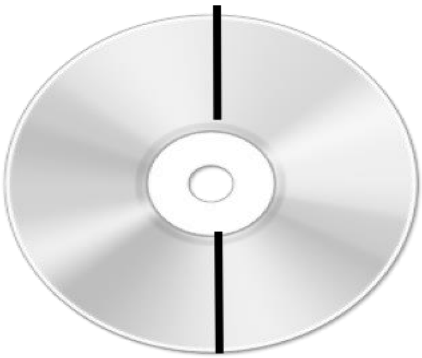
Prior to the session, prepare obsolete CDs or DVDs, at least one per group. A small ball of modeling clay can be used to secure a small length of wood dowel or permanent marker to center hole in the CD/DVD. A ruler should be used for this activity.

Copies of the attached worksheet should be made prior to the beginning of the session, and distributed through normal channels before or minimally after the hook activity, as they will be used for the inquiry portion (this portion) of the session.

The session begins with distribution of supplies and some brief instruction:

- Draw a radius line in one location on the non-printed side of the CD.
- Mount the disc on the marker using the clay like the picture below.

- Take a minute to review the phenomena from the opening exercise:
  - Rotate the disc using the pencil as an axis of rotation and observe the drawn line:
    - ✓ "Which part of the line is rotating fastest?"
- Have you noticed that all of it is rotating at the same speed?
- Now remove the pencil and clay from the CD.
- Draw a second radius line opposite of the previous location on the non-printed side of the CD, similar to the picture below.



- Using 2 pieces of string and a ruler, measure the arc length in *mm* for the outer edge of the CD and the inner edge of the CD's recording area.
- Compare the lengths and determine a hypothesis for the relationship between arc length, time of rotation, and velocity of a point on the outer and inner edges.
- Write your observations in worksheet.

You have already an idea of what rotational motion is.

Activity 5

- Who can tell us the definition of rotational motion? Any volunteer?
- Read the PowerPoint or watch the embedded video (indicated in the following links) that helps you to understand these concepts better.
  - ✓ https://www.slideshare.net/slideshow/rotational-motion-28888782/28888782
  - ✓ https://youtu.be/grMWAI1RdVs

Let's see whether you already know how to solve problems regarding rotational motion.

Activity 6

In group of 5 members, solve these problems for 5 minutes.

1. A wheel initially at rest undergoes constant angular acceleration for 10 seconds, reaching an angular velocity of 50 rad/s. What is its angular acceleration?
2. A wheel has an initial angular velocity of 30 rad/s. It undergoes a constant angular acceleration of -2 rad/ s^2 for 5 seconds. What is the angular displacement during this time period?
3. A wheel of radius 0.3 meters is rolling without slipping along a horizontal surface with a linear velocity of 5 m/s. Calculate its angular velocity.

Then, choose one representative from each group to present and explain the answer.

Key ideas

- Rotational motion is the motion of a rigid body which takes place in such a way that all of its particles move in circles about an axis with a common angular velocity of, it is the motion of a body turning about an axis.
- The centers of all circular paths in a spinning object define a line, called the axis of rotation.
- Angular displacement is the angle through which a rigid object rotates about a fixed axis. It is positive if it is counterclockwise and negative if it is clockwise.

Assessment

1. Differentiate rotational from translational motion.
2. A record has a diameter of 30.48 m. it rotates at the rate of 33.33 deg. Determine the distance measured along the arc that a point on the rim of the record has moved.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway resources

- To know more about rotational motion, read or watch the following materials.
  - https://openstax.org/books/physics/pages/6-3-rotational-motion
  - https://www.studysmarter.co.uk/explanations/physics/kinematics-physics/rotational-motion/
  - https://youtu.be/WQ9AH2S8B6Y
- Perform available simulation experiments so as to understand the concept of rotational motion in a better way.

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of motion in one and two dimensions. Specifically, we have considered the following aspects:

- Explanation of the differences between terms like distance and displacement, speed and velocity, uniform motion and uniformly accelerated motion.
- Discussion of uniform circular motion, projectile motion as well as rotational motion.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 4

Force, Work, Energy and Simple Machine

Introduction

Dear trainee, At the heart of all physical interactions lies the concept of force. Force is the push or pull that one object exerts on another, causing it to accelerate, decelerate, or change direction. Work is the mechanism through which energy is transferred from one system to another, enabling the accomplishment of tasks and the manifestation of change. Energy takes many forms and plays a central role in all phenomena. Simple machines, such as levers, pulleys, and inclined planes, amplify our force, alter our direction, and enable us to perform tasks beyond our natural capabilities.

In this chapter, you will learn how to teach some of the key concepts related to force, work, energy, and simple machines. You have 14 hours at your disposal for covering this chapter.

4.1 The Concept of Force (1 hr)

At the end of this lesson, trainees will be able to:

- use innovative techniques to teach the concept of force,
- identify some misconceptions related to the concept of force and take corrective measures.

Dear trainees, in this lesson you are going to learn about the concept of force. The lesson is related to your day to day experience so that you can easily define force and give its examples. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

Dear trainees,

- How have you been teaching the concept of force?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the concept of force. Some of them reported in literature are listed below.

- Force can always cause motion:

- Force requires physical contact.
- the larger the force acting on an object, the greater the effect
- force always acts in the direction of motion
- the use of terms "force" and "weight" interchangeably

Are the misconceptions that you identified match with those reported in literature? Now let us have some activities in relation to this lesson. Now let us do some activities in relation to this topic.

Activity 2

- Have you ever engaged your students in different practical activities such as kicking a ball, pushing a wall, stretching or compressing a spring, throwing a piece of chalk etc? How these activities are related to the concept of force?

Activity 3

- Consider the following figures which are your common day to day experience. What do you observe in each case? Take 2 minutes to think over the figures and discuss (first in pairs and then in groups) how each figure is related to force.

Have you properly understood the concept of force?

Key Ideas

- A force can act on a stationary object without changing its state of motion.
- It is important to understand that there are also non-contact forces such as electromagnetic forces, gravitational forces, and nuclear forces.
- The net force acting on an object is what determines its acceleration.
- Many people use the terms "force" and "weight" interchangeably, but they are not the same. Weight is a specific type of force (gravitational force) that acts on an object due to its mass and the acceleration due to gravity.
- Some people may believe that force always acts in the direction of motion. In reality, a force can act in any direction relative to an object's motion, affecting the object's path and speed.

Assessment

- Explain the different types of forces.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the concept of force, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.2 Newton's Laws of Motion (1 hr)

At the end of this lesson, trainees will be able to:

- use different scenarios to teach Newton's laws of motion,
- identify some misconceptions related to Newton's laws of motion and take corrective measures.

Dear trainees, in this lesson you are going to learn about Newton's laws of motion. The lesson is related to your day to day experience so that you can easily define Newton's laws of motion and give practical examples. Activities are also included to make the lesson more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching Newton's laws of motion?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to Newton's laws of motion. Some of them reported in literature are listed below.

- Objects in motion must have a force acting on them.
- Heavier objects fall faster than lighter objects.
- Action and reaction forces cancel each other out
- An object moving in the direction of a net force must be speeding up

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Mr. X observed a car accident while going to school. The accident was happened as a result of collision between small automobile and a Sinotruck moving in opposite directions. Out of three passengers in the automobile, one didn't wear a seat belt and he sustained severe brain injury during the sudden collision. The remaining two passengers sustained only slight injury. Moreover, the accident was more damaging to the automobile. Explain this phenomena in line with Newton's laws of motion first in pairs and then in large groups.

- Why the passenger who didn't wear a seat belt sustained severe injury than the remaining two passengers?
- Why the accident was more damaging to the automobile than to the sinotruck?

Activity 3

Watch the following video and discuss in groups what you understood from it.

https://www.youtube.com/watch?v=3KlZNzOwtug

Have you properly understood Newton's laws of motion?

Key Ideas

- In Activity 2, when the sinotrcuk and the automobile collide, the impact of the crash will be considerably greater for the automobile, because the mass of the sinotruck is so much larger, and therefore will take longer to stop. The seat belts are used to stop your body from moving forward in inertia and avoiding danger.
- Many people think that an object needs a constant force to keep moving. In reality, according to Newton's first law (the law of inertia), an object in motion will continue to move at a constant velocity unless acted upon by an external force.
- In reality, all objects in free fall accelerate at the same rate, regardless of their mass, when air resistance is negligible.
- Newton's third law of motion states that for every action, there is an equal and opposite reaction. This does not mean the forces cancel each other out in terms of the motion of the object. For example, when you push against a wall, the wall pushes back with an equal force, but that doesn't mean you don't experience a force.

- This misconception is related to the assumption that an object moving in the direction of a force must be accelerating in that direction. However, an object could be moving in the direction of a net force and still be slowing down if the force is acting opposite to its velocity

Assessment

- Explain the implications of Newton's laws of motion.
- A person is standing in an elevator that is initially at rest. The elevator starts to move upward with a constant acceleration. What happens to the apparent weight of the person while the elevator is accelerating upward? Explain your answer using Newton's laws of motion.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about Newton's laws of motion, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.
  https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.3 Forces of Friction (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concepts related to frictional force,
- identify some misconceptions related to the concept of force and take corrective measures,
- describe friction and how it opposes motion.

Dear trainees, in this lesson you are going to learn about frictional force. The lesson is related to your day to day experience so that you can easily define frictional force and give practical examples. Activities are also included to make the lesson more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of force?
- What kind of misconceptions have you identified in relation to this topic?

To remind you about the basic concepts of force and motion you learned in previous lessons, try to answer the following question.

Activity 2

- What do you understand by the term "force" and "motion" and give examples of forces in their daily life.

Next, for stimulating you curiosity and engage you in the lesson, try to examine the following two problem situations.

Activity 3

- The first problem could be about pushing a box across a floor, where the box doesn't move at first but starts moving once a certain amount of force is applied.
- In a car skidding on a wet road, explain why the car doesn't stop immediately when the brakes are applied.

Have you realized the importance of understanding frictional force in explaining various real-world applications? Engineers use the concept of friction to design brakes in vehicles, how the sports industry uses it to make shoes grip the ground better, or how it plays a crucial role in our daily activities like walking, driving, or even writing.

Now let us discuss two intriguing facts or stories related to frictional force.

- One could be about Leonardo Da Vinci's study on friction, where he discovered that friction is caused by irregularities on the surfaces of objects.
- The other could be a fun fact about how some animals, like the gecko, can walk on walls and ceilings because of the unique frictional properties in their feet.

These two scenarios are related to our today’s topic, frictional Force.

Activity 4

- To learn about frictional force, read a material about frictional force or watch a few short educational videos about friction. Then give three real-life examples where friction plays a significant role.

Activity 5

1. In small groups, perform an experiment where a small wooden block, a smooth surface (like a tile), and a rough surface (like sandpaper).
2. Predict which surface (smooth or rough) will have more friction with the wooden block. Write down your predictions along with the reasons for your choices.
3. Perform a simple experiment by trying to slide the wooden block on both the smooth and rough surfaces. Observe and record your findings.
4. Discuss your findings and compare it with your predictions.

Have you noticed how this simple experiment demonstrates the difference between static and kinetic friction? Now let us look at the following different scenarios where friction is involved.

Activity 6

1. A car sliding on a wet road, a skier going down a snowy hill, a person trying to start a fire by rubbing two sticks, or a person trying to push a heavy box across a room.
2. In your groups, analyze each scenario and identify the type of friction involved (static or kinetic) and the factors affecting the friction in each scenario (nature of the surface, weight of the object, etc.).
3. Present your findings to the class, and try to correct any misconceptions.

This activity helps you understand the practical applications of the concept you learned and encourages you to think critically about the role of friction in different situations. Now, as indicated in the following activity, discuss about the importance of frictional force.

Activity 7

- Investigate and report the importance of the topic for everyday life. How friction could affect your daily activities? Present your investigation to the class in an oral report and demonstrate how it is useful.

Through these hands-on activities, have you understood the concept of frictional force through also developing your critical thinking, problem-solving, and collaborative skills?

Assessment

1. The teacher asks the trainees to reflect on the day's lesson and write down their answers to the following questions:
    - What was the most important concept you learned today?
    - What questions do you still have about frictional force?
    - Can you think of any other real-life examples where friction is involved?

Key Concept

Friction is a force that opposes motion between two surfaces that are touching. It is greater when objects have rougher surfaces or are heavier.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic.
- Encourage the trainees to continue exploring the topic and to always be curious about the world around them, as many of the great discoveries and inventions in history have been made by people who were curious about why things worked the way they did.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To further strengthen your understanding of frictional force, read additional materials like "The Physics of Everyday Things" by James Kakalios or "Physics for Future Presidents" by Richard A. Muller, which explain the concept of friction in a fun and accessible way.
- You can also watch online resources like interactive simulations or more advanced videos for trainees who want to explore the topic in more depth.

4.4 Static equilibrium (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concepts related to static equilibrium,
- Identify and analyze static equilibrium situations for objects in equilibrium in various physical situations,
- Identify some misconceptions related to the concept of force and take corrective measures.

Dear trainees, in this lesson you are going to learn about static equilibrium. The lesson is related to your day to day experience so that you can easily understand about frictional force and give practical examples. Activities are also included to make the lesson more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of static equilibrium?
- What kind of misconceptions have you identified in relation to this topic?

Have you ever tried to balance on a curb or a tree limb or a bicycle? Was it hard? How did you stay on? People rely upon their sense of balance to keep from falling when they are standing or walking. Another word for balance is *equilibrium*. A massive frame hung on a wall using two cables is in static equilibrium. A horizontal beam supported by a strut is also in static equilibrium.

Activity 2

- What is the definition of static equilibrium, and when do objects fall under this category?

Static equilibrium can be commonly observed in everyday life. Whenever we talk about static equilibrium, it simply implies the resultant force (net force and net torque) acting on the system is zero and the object is not moving at all in either translational or rotational motion.

Activity 3

- List examples of bodies that are in static equilibrium from your surroundings.

Here are the examples that we can observe from our surroundings:

- An object, like a book, metal block, etc. lying still on the surface (floor or table surface).

- A weight balancing machine used to be in the state of static equilibrium initially because masses or weight on both sides are equal and hence there is no torque or moment acting.

The same situation happens when there is equal weight on both sides.

- A car parked in the parking lot.
- A man standing still during the National anthem.

Thus, it is clear from the above examples that the objects which are at rest are termed to be in the state of static equilibrium. Now let us move to our discussion about the two conditions of equilibrium and their expressions.

Activity 4

- Discuss about the two conditions of equilibrium.
- Also discuss about a general Method for Solving a Static Equilibrium Problem

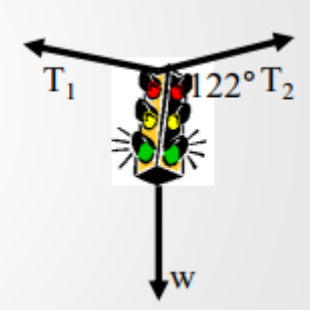
Objects in static equilibrium remain at rest, so both the acceleration and the angular acceleration are zero. This allows us to use special-case of Newton's second law and Newton's second law for rotation. The following are the steps that we use to solve problems related to static equilibrium.

1. Identify the object to be analyzed.
2. Draw a free-body diagram showing all the forces acting on the object.
3. Set up the equations of equilibrium for the object. Use the free-body diagram to write a correct equilibrium condition for
    a. force components in the x-and y-direction
    b. for torques along the axis of rotation
4. Evaluate the expressions for the unknown quantities that you obtained in your solution.
5. Simplify and solve the system of equations for equilibrium to obtain unknown quantities.

Let's apply the method in the following example.

Activity 5

1. A stoplight is suspended by two cables over a street. Weight of the light is 110 N and the cables make a 122° angle with each side of the light. Find the tension in each cable.



2. A uniform board with a weight of 240 N and a length of 2.0 m rests horizontally on two supports. Support A is under the left end of the board, while Support B is 50 cm from the right end (150 cm from the left end, in other words). (https://www.webassign.net/question_assets/buelemphys1/chapter10/section10dash11.pdf)
    a) Which support exerts more force on the board? Without doing the calculations to find the two support forces, come up with a conceptual argument to justify your answer.
    b) Find the two support forces.

Assessment

1. What does static equilibrium mean?
2. What conditions are necessary for static equilibrium?
3. Mention some examples of a rigid body that is in static equilibrium in your surroundings.

Key ideas

Static equilibrium is a type of equilibrium that occurs when a body is at rest and there is no net force or net torque acting on it.

- The first condition of equilibrium states that the sum of the forces acting on a body must add up to zero.
- The second condition necessary to achieve equilibrium is that the net external torque on a system must be zero.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic.

- Encourage the trainees to continue exploring the topic and to always be curious about the world around them, as many of the great discoveries and inventions in history have been made by people who were curious about why things worked the way they did.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- https://byjus.com/physics/conditions-of-equilibrium/

4.5 Planetary Motion and Kepler's Laws (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach the concepts of planetary motion and Kepler's laws,
- identify some misconceptions related to planetary motion and Kepler's laws and take corrective measures,
- design a 3D model to illustrate the motion of planets about the sun.

Dear trainees, planetary motion and Kepler's laws of motion are discussed in this session. Though contextualizing the topic to real life situation is difficult, you will be provided with PhET simulation software to better understand the lesson. You will perform virtual experiment to get clear with planetary motion and the three laws of Kepler. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching planetary motion and Kepler's laws?
- What kind of misconceptions have you identified in relation to this topic?

The following are some difficulties and misconceptions reported in literature concerning Kepler's laws and planetary motion.

- Planetary orbits are perfect circles.
- Planets move at constant speeds throughout their orbits.
- Kepler's laws apply only to Earth's orbit around the Sun.
- Kepler's third law, which relates the orbital period and semi-major axis of a planet's orbit, applies only to planets.

Are the misconceptions that you identified match with those reported in literature?

Activity 2

Use the following PhET simulation software on Kepler's laws and planetary motion.

- https://phet.colorado.edu/sims/html/keplers-laws/latest/keplers-laws_all.html
    - What did you learnt from the video?

Activity 3

Do you think that Kepler's laws of planetary motion apply to all planets in the solar system, as well as other celestial bodies orbiting around a central mass? Discuss in groups and report to the class via your group representative.

Have you properly understood the concepts of planetary motion and Kepler's laws?

Key Ideas

- In reality, Kepler's first law states that planetary orbits are elliptical, with the Sun located at one of the foci. This misconception may stem from simplified representations of the solar system in diagrams or illustrations.
- Kepler's second law states that planets sweep out equal areas in equal times, implying that their speeds vary as they orbit the Sun. This misconception overlooks the concept of angular momentum conservation.
- Kepler's laws of planetary motion apply to all planets in the solar system, as well as other celestial bodies orbiting around a central mass.
- While Kepler's laws accurately describe the motion of planets in their orbits, they do not provide a complete explanation of the underlying mechanisms governing planetary motion. Kepler's laws describe empirical observations rather than the fundamental causes of planetary motion.
- Kepler's third law applies to any two objects orbiting each other under the influence of gravity, including moons orbiting planets or artificial satellites orbiting Earth.

Assessment

Consider the following statements about planetary motion. Which of these statements is true according to Kepler's laws?

- The orbits of planets around the Sun are perfect circles.
- The speed of a planet in its orbit around the Sun is constant.
- The square of a planet's orbital period is proportional to the cube of its average distance from the Sun.
- A line drawn from the Sun to a planet sweeps out equal areas in equal times.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about Newton's laws of motion, read grade 12 physics textbook.

4.6 Law of Universal Gravitation (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach Newton's law of universal gravitation,
- identify some misconceptions related to the law of universal gravitation and take corrective measures,
- apply the concept of Newton's law of universal gravitation to solve physical problems.

Dear trainees, Newton's law of universal gravitation is discussed in this session. The topic is contextualized to real life situation. Moreover, you are provided with PhET simulation software to better understand the lesson. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the law of universal gravitation?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the law of universal gravitation. Some of them reported in literature are listed below.

- gravity only pulls objects downward, as observed on Earth

- the strength of gravity acting on an object depends on its weight
- gravity requires physical contact between objects to exert a force

Are the misconceptions that you identified match with those reported in literature?

Activity 2

Use the following PhET simulation software on Newton's law of universal gravitation. What did you understand from the video?

https://phet.colorado.edu/sims/html/gravity-force-lab-basics/latest/gravity-force-lab-basics_en.html

Activity 3

What do you think is the cause of tides which are very long-period waves that move through the ocean? Discuss in groups and report to the class through your group representative.

Have you properly understood the law of universal gravitation?

Key Ideas

- Newton's law of universal gravitation states that gravity is a universal force that attracts all objects with mass toward each other. Gravity acts in all directions, not just downward.
- Weight is a measure of the gravitational force exerted on an object. Gravity itself does not depend on an object's weight but rather on its mass and the distance between objects.
- While it is true that all objects fall at the same rate in a vacuum (as demonstrated by Galileo's experiment with different masses), some trainees may incorrectly extend this idea to all situations. In reality, in the presence of air resistance, lighter objects may experience greater air resistance and fall more slowly than heavier objects. However, in the absence of air resistance, all objects fall at the same rate regardless of mass, as stated by the equivalence principle.
- Gravity is a non-contact force that acts over distances without direct physical contact between objects. It is the curvature of space-time caused by mass that governs the gravitational interaction between objects.
- Gravitational force can cause tides which are very long-period waves that move through the ocean in response to the gravitational forces exerted by the moon and sun.

Assessment

If the distance between two objects is doubled, how does the gravitational force between them change?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about Newton's laws of motion, read grade 12 physics textbook.

4.7 Work (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach to teach the concept of work,
- identify some misconceptions related to the concept of work and take corrective measures.

Dear trainees, in this lesson, the topic work will be addressed. The lesson is related to your day to day experience so that you can easily understand the concept of work and give practical examples. Activities are also included to make the lesson clear. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of work?
- What kind of misconceptions have you identified in relation to this topic?

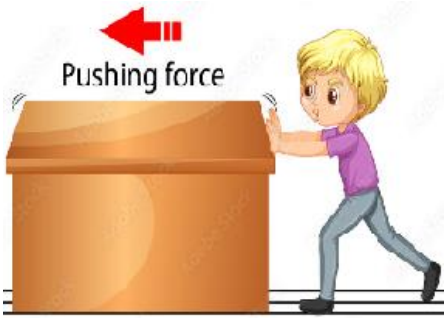
There are several common misconceptions related to the concept of force. Some of them reported in literature are listed below.

- work is done whenever there is an expenditure of muscular effort
- work is related to the time spent doing a task
- whenever force is applied, work is done
- moving an object a certain distance always involves work

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Consider the following figures. In which case is work being done? Why?



Activity 3

Watch the following video and discuss in groups what you understood from it concerning the concept of work.

https://www.youtube.com/watch?v=dBQ1BNhTEto

Have you properly understood the concept of work?

Key Ideas

- In physics, work is defined as the product of force and displacement in the direction of the force. Therefore, if there is effort without movement (e.g., pushing against a wall), there is no work done.
- Work is independent of time; it's only dependent on the force applied and the distance moved in the direction of the force
- Work is done only when there is displacement in the direction of the force. If there is no displacement, or if the displacement is perpendicular to the force, no work is done
- People sometimes believe that moving an object a certain distance always involves work. This is not true if there is no force applied in the direction of the movement. For example, if you carry a heavy object horizontally at a constant speed, no work is done in the physics sense, since the force (gravity) acts vertically and the displacement is horizontal.

Assessment

- Explain the scientific meaning of work.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the concept of work, read grade 9 and 11 physics textbooks.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.
  https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.8 Kinetic and Potential Energy (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach to kinetic and potential energies,

- identify some misconceptions related to kinetic and potential energies and take corrective measures.

Dear trainees, in this lesson, the topic kinetic and potential energy will be addressed. The lesson is related to your day to day experience so that you can easily understand the concept of kinetic and potential energies and give practical examples. Activities are also included to make the lesson clear. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching kinetic and potential energies? What real life situations have you been employing in the lessons of kinetic and potential energies?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the concept of kinetic and potential energies. Some of them reported in literature are listed below.

- kinetic and potential energies are the same concepts.
- Overlooking the factors that affect kinetic and potential energies, such as mass, height, velocity, and gravitational acceleration
- Overlooking the conversion between kinetic and potential energies in real-world scenarios
- Confusing kinetic and potential energies with force, leading to misconceptions about their relationship

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

In this activity, you should discuss and report the conversion between kinetic and potential energies for the following cases. Discuss how mechanical energy is conserved in each case

- Swinging pendulum
- Bouncing ball
- Spring loaded toy
- Hydroelectric power

Activity 3

What other conversion between kinetic and potential energies occur in your locality? Discuss in groups and report to the class though your representative.

Have you properly understood the concept of force?

Key Ideas

- It's essential to emphasize that kinetic energy is associated with motion, while potential energy is associated with position or stored energy.
- Students may overlook the factors that affect kinetic and potential energies, such as mass, height, velocity, and gravitational acceleration. Reinforcing the importance of considering these factors when calculating or analyzing kinetic and potential energies can help address this misconception.
- Students may overlook the conversion between kinetic and potential energies in real-world scenarios. Emphasizing examples of energy transformation, such as a swinging pendulum or a bouncing ball, can help illustrate this concept.
- Students may confuse kinetic and potential energies with force, leading to misconceptions about their relationship. It's essential to clarify that energy is a measure of the ability to do work, while force is a push or pull acting on an object.

Assessment

Describe a scenario where an object has both kinetic and potential energy. Explain how the energy changes as the object moves.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about Newton's laws of motion, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.9 Power (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach the concept of power,
- identify some misconceptions related to the concept of power and take corrective measures.

Dear trainees, in this lesson, the topic power will be addressed. The lesson is related to your day to day experience so that you can easily understand the concept of power and give practical examples. Activities are also included to make the lesson clear. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of power?
- What kind of misconceptions have you identified in relation to this topic?

The following are some common misconceptions reported in literature concerning power.

- Equating power with energy
- Neglecting the time factor in the calculation of power
- The belief that objects possess inherent power

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- Suppose that two devices are fabricated for the same purpose. Let us say that one device performs the work for which it is designed in a short period of time while the other takes longer time to do the same work. What do you think is the reason?

Activity 3

Discuss the following everyday examples where you encounter the concept of power in your lives. Interpret the power rating of the appliances or equipment.

- Electrical appliances (e.g., light bulbs, refrigerators, hairdryers)
- Vehicles (e.g., cars, motorcycles)
- Human activities (e.g., running, cycling)
- Machines (e.g., elevators, escalators)

Have you properly understood the concept of power?

Key Ideas

- While power does involve energy, they are distinct concepts. Energy refers to the capacity to do work, while power refers to the rate at which work is done or energy is transferred.
- Students may struggle with the units of power, such as watts (W), and may confuse them with other units of energy. Reinforcing the distinction between power and energy units is essential to avoid this misconception.
- Overlooking the importance of considering the time taken to perform work or transfer energy, leads to inaccurate interpretations of power.
- In reality, power is a measure of the rate at which work is done or energy is transferred and depends on the interaction between objects and external forces.

Assessment

- How is power defined in the context of physics?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about Newton's laws of motion, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.10 Impulse and Linear Momentum (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach impulse and linear momentum,

- identify some misconceptions related to impulse and linear momentum and take corrective measures.

Dear trainees, in this lesson, the topic power will be addressed. The lesson is related to your day to day experience so that you can easily understand the concept of impulse and linear momentum and give practical examples. Activities are also included to make the lesson clear. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of impulse and linear momentum?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to impulse and linear momentum. Some of them reported in literature are listed below.

- Equating impulse with force
- The belief that impulse and momentum are independent quantities rather than interconnected ones
- overlook the importance of considering the time interval over which a force is applied when calculating impulse

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- Suppose your throw a stone vertically upwards. You may sustain hand injury if you try to catch it abruptly when it falls back. However, if you try to catch it gently by making your hand relaxed and flexible, you may not feel pain. Explain why. Do you observe any difference if you catch the stone with two hands rather than with one hand? Why?
- How do you think soccer players easily control the ball during passes?
- Have you carefully observed the design of sports equipment? Why they are designed in such a way?

Activity 3

Discuss how the concept of impulse and linear momentum is applied to the following situation.

Suppose you encounter two car accidents. The first car crashed directly into a tree resulting in severe damage. The second car went through bushes and didn't sustain severe damage except

superficial damage to the exterior of the car. In relation to impulse and linear momentum, discuss why the first car sustained severe damage while the second car did not.

Key Ideas

- ✓ While impulse is related to force (impulse equals the average force applied over a given time interval), they are not the same. Students may incorrectly assume that a large impulse always requires a large force, which is not necessarily true.
- ✓ Some students may struggle to grasp the concept that impulse is directly related to the change in momentum of an object. They may incorrectly believe that impulse and momentum are independent quantities rather than interconnected ones.
- ✓ Students may overlook the importance of considering the time interval over which a force is applied when calculating impulse. They may mistakenly believe that only the magnitude of the force matters, ignoring the duration of the interaction.
- ✓ The effect of a force on an object depends on how long it acts, as well as the strength of the force. Impulse is a useful concept because it quantifies the effect of a force. In Activity 1,
- ✓ Allowing your hand to follow through with the stone's motion further dissipate the force. This makes the stone to make contact with your hand smoothly, reducing the rate of change of momentum and minimizing the impulse exerted on your hands. The use of both hands further spreads the force of impact over a larger area minimizing injury.
- ✓ Instead of trying to stop the ball abruptly, players often move with the direction of the ball to absorb its momentum gradually. This helps reduce the impulse and allows for better control over the ball's movement. Moreover, they aim to cushion the ball's impact by providing a soft touch.
- ✓ The design of sports equipment often considers impulse and momentum principles. For instance, in golf, the design of golf clubs and balls aims to maximize the transfer of momentum from the club to the ball upon impact. Similarly, in tennis, the design of rackets is optimized to maximize the impulse applied to the ball during a swing.

Assessment

Given the concepts of impulse and linear momentum, how does the time duration over which a force acts on an object affect the resulting change in the object's momentum.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about impulse and linear momentum, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

4.12 Simple Machines and their Purposes (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach simple machines,
- identify some misconceptions related to simple machines and take corrective measures,
- identify simple machines as a force multipliers, distance multipliers or direction changers.

Dear trainees, in this lesson, the topic the purpose of simple machines will be addressed. The lesson is related to your day to day experience so that you can easily understand the purpose of simple machines and give practical examples. Activities are also included to make the lesson clear. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching simple machines?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to simple machines. Some of them reported in literature are listed below.

- Simple machines generate energy
- Simple machines can make tasks easier by always reducing the amount of force needed

- Simple machines can amplify or increase the amount of energy output beyond what is inputted.
- Simple machines operate at 100% efficiency
- simple machines are always safe to use

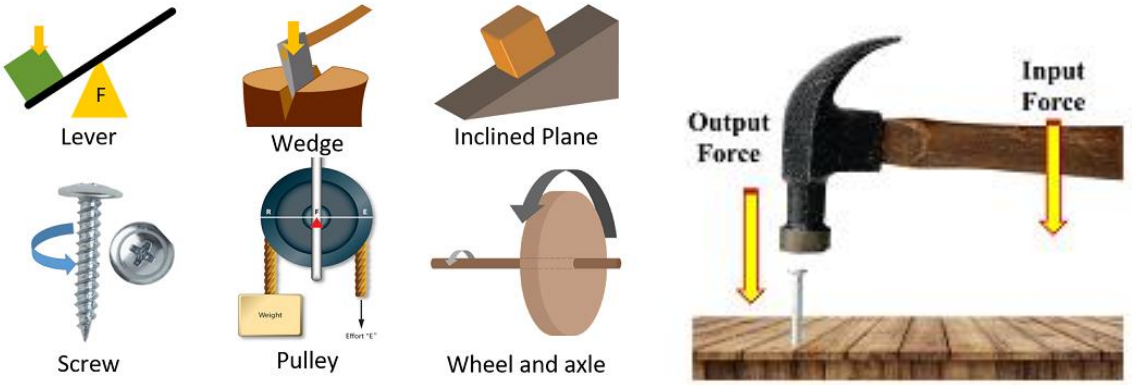
Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- What are the common simple machines people uses in your locality to make their life simple?

Activity 3

Discuss the purpose of the following simple machines. Identify each as force multipliers, speed multipliers and direction changer.



Activity 3

Conduct hands-on demonstrations to illustrate the concepts of mechanical advantage and velocity ratio with simple machines. For example;

- **Levers**: Use a lever (e.g., a seesaw) to demonstrate how the position of the fulcrum affects mechanical advantage. Have trainees experiment with different fulcrum positions to observe changes in force required and distance moved.
- **Pulleys**: Set up a simple pulley system with various configurations (single, fixed, movable) and different numbers of pulleys. Have trainees measure the force required to lift objects of different weights to understand the mechanical advantage gained.
- **Inclined Planes**: Use ramps of varying lengths and angles to demonstrate how incline planes reduce the force needed to lift objects vertically. Have trainees measure the height and length of the ramp to calculate the velocity ratio.

Have you properly understood the concept of simple machines?

Key Ideas

- Simple machines do not create energy; they only transfer or transform it from one form to another. For example, a lever does not produce energy but rather redistributes the input force applied to it.
- While simple machines can make tasks easier by reducing the amount of force needed, they do not necessarily reduce the total amount of energy input. In many cases, the mechanical advantage gained from using a simple machine comes at the expense of increased distance or time, resulting in the same amount of energy input overall.
- Some students may mistakenly believe that simple machines allow for the creation or destruction of energy, contradicting the law of conservation of energy. This misconception stems from a misunderstanding of how energy is transferred and transformed within mechanical systems.
- While simple machines can provide mechanical advantage by redistributing forces, they cannot create energy out of nothing. The output work of a simple machine is always less than the input work due to energy losses, such as friction.
- Students may incorrectly assume that simple machines operate at 100% efficiency, meaning that all the input energy is converted into useful output energy without any losses. However, in reality, simple machines are subject to energy losses due to factors like friction, deformation, and air resistance, resulting in less-than-perfect efficiency.
- While simple machines can make tasks easier, there's a misconception that they are always safe to use. In reality, improper use or maintenance of simple machines can lead to accidents or injuries.

- Simple machines come in various forms and configurations, each with its own unique properties and applications. Failing to recognize this variability can lead to misconceptions about their capabilities and limitations.

Assessment

- Develop a procedure to calculate the mechanical advantages of common simple machines in your locality.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about simple machines, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.
  https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of force, work, energy and simple machines. Specifically, we have considered the following aspects:

- Explanation of force as a push or pull acting upon an object as a result of its interaction with another object. It can cause an object to accelerate, decelerate, or change direction
- Explanation of the scientific meaning of work. Work is done when a force is applied to an object and the object moves in the direction of the force.

- Explanation of energy is the capacity to do work. There are two forms of energy discussed, including kinetic energy (energy of motion), potential energy (stored energy in the form of gravitational potential energy or elastic potential energy).
- Explanation of simple machines as mechanical devices that change the direction or magnitude of a force, making it easier to perform work.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 5

Mechanical Oscillation and Sound Wave

Introduction

Dear Trainee, mechanical oscillation, the back-and-forth movement of objects around a stable equilibrium position, lies at the heart of various natural and engineered systems. It manifests in phenomena as diverse as the swaying of a pendulum, the vibration of guitar strings, or the oscillation of atoms within a crystal lattice. Sound waves, characterized by their wavelength, frequency, and amplitude, traverse through substances such as air, water, and solids, carrying the vibrations that stimulate our ears.

Therefore, in this chapter, you will learn how to teach the basic concepts related to mechanical oscillation and sound wave. You have 5 hours at your disposal for covering this chapter.

5.1 Propagation of Waves (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach about propagation of waves,
- identify common misconceptions related to propagation of waves and take corrective measures,
- connect the common characteristics of waves to real life situation.

Dear trainees, in this lesson you are going to learn about the common characteristics of waves. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching propagation of waves?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the propagation of waves. Some of them reported in literature are listed below.

- Waves transfer matter

- All waves require a medium to travel through
- All waves are visible or audible
- Waves always decrease in amplitude over distance
- All waves travel at the same speed

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- What determines the color and brightness of light?
- What dictates how light interacts with objects, influencing phenomena like refraction, diffraction and interference?
- Does light require material medium for its propagation? Each trainee should think over this question for 2 minutes and discuss in pairs. Finally, they should present their report to the class.

Activity 3

- Go to lakes in your locality. If you don't have the chance of getting lakes, observe a video of water waves on lakes or seas.
    - what determines how often waves arrive at a shore, impacting coastal erosion rates and beach dynamics?
    - what affects the force with which it crashes against shores?
    - what affects the distance between successive wave crests, which influences surfing conditions and wave interference patterns?
    - are water waves mechanical or electromagnetic? why?

Have you properly understood the concept of propagation of waves?

Key Ideas

- Waves transfer energy, not matter. When you hear sound or feel the warmth of sunlight, it's not physical particles moving from the source to you, but energy being transferred through the medium (or through space in the case of electromagnetic waves).
- While it's true that some waves, like sound waves, do require a medium (such as air, water, or solid material) to propagate, other waves, such as electromagnetic waves (light, radio waves, microwaves, etc.), can travel through a vacuum, devoid of any medium.

- While some waves, like light and sound, are detectable by our senses, many others are not. For example, radio waves, microwaves, and X-rays are all types of waves that are not directly observable to our senses without specialized equipment.
- While some waves do experience attenuation (reduction in amplitude) as they travel through a medium, this isn't universally true for all types of waves. For instance, electromagnetic waves like those used in certain communication technologies can travel vast distances with minimal attenuation.
- Different types of waves travel at different speeds depending on the properties of the medium they are passing through. For example, sound travels faster in solids than in liquids or gases, and the speed of light varies depending on the medium it's traveling through (e.g., vacuum, air, water, glass).
- If you consider light waves,
    - ✓ Frequency determines the color of light. Higher frequency corresponds to bluer light while lowest frequency correspond to redder light.
    - ✓ Amplitude affects the brightness of light.
    - ✓ Wavelength dictates how light interacts with objects, influencing phenomena like refraction, diffraction and interference.
    - ✓ Light wave is electromagnetic wave and doesn’t require material medium for its propagation.

Assessment

- Consider seismic waves
    - ✓ what determines the magnitude of an earthquake?
    - ✓ what indicates the strength of the seismic activity?
    - ✓ what dictates the distance between successive peaks of the seismic waves?
    - ✓ are seismic waves mechanical or electromagnetic? why?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the common characteristics of wave, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.
  https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_en.html

5.2 Sound Waves (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach sound waves,
- identify some misconceptions related to sound waves and take corrective measures,
- compare the speed of sound in different materials.

Dear trainees, in this lesson you are going to learn about sound wave. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching sound waves?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to sound waves. Some of them reported in literature are listed below.

- The speed of sound is the same in all media
- Loudness and pitch are the same
- Sound waves carry physical particles

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- List the different sounds you hear in your locality. Explain how each sound is produced.
- What do you think are the advantages and disadvantages of sound? Concerning the disadvantages, do you suggest the development of sound policy for our country? Each

trainee should think over this question for 2 minutes and discuss in groups. Finally, they should present their report to the class.

Activity 3

A. Create a series of tubes (open on both sides) filled with different materials such as air, water, and solids (e.g., wood, metal). Use a sound source (such as a tuning fork or a small speaker) to generate sound waves. Place the sound source near one end of each tube. Let one trainee place his ear near the other end of each tube and observe how the sound propagates through different media. The trainees can observe how the sound changes in intensity and pitch as it propagates through different materials.
B. Place a sound source and a microphone at one end of a room. Then, position different materials (foam, cardboard, metal) on the walls and observe how they affect the reflection and absorption of sound waves. Measure the intensity of sound using the microphone. The trainees can observe how different materials absorb or reflect sound waves, leading to changes in the intensity and clarity of the sound. They can discuss the practical applications of sound absorption and reflection in designing concert halls, recording studios, and noise control barriers.
C. Use a simple musical instrument, such as a guitar or piano, to demonstrate the relationship between frequency and pitch. Moreover, try to get different musical instruments and play the same note (say C major) on each instrument. Observe the difference in the timbre.

Have you properly understood the sound waves?

Key Ideas

- The speed of sound varies depending on the properties of the medium it travels through. In general, sound travels faster in denser materials, such as solids, compared to less dense materials, such as gases. For example, sound travels faster in water than in air.
- Loudness refers to the perceived intensity or amplitude of sound waves, while pitch refers to the perceived frequency of sound waves. These are two distinct properties of sound, and they are perceived by different mechanisms in the human auditory system.
- In reality, sound waves transfer energy through the medium, causing particles of the medium to vibrate back and forth in the direction of the wave's propagation. The

particles themselves do not travel with the wave but oscillate about their equilibrium positions

Assessment

- The reflection of sound from hard surfaces is called an "echo". Discuss how echo is used in SONAR (Sound Navigation and Ranging) to find the depth of seas or distance of submarines.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the common characteristics of wave, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.
  https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_en.html

5.3 Superposition of Waves (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach superposition of waves,
- identify some misconceptions related to superposition of waves and take corrective measures.

Dear trainees, in this lesson you are going to learn about superposition of waves. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the superposition of waves?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the superposition of waves. Some of them reported in literature are listed below.

- Superposition is limited to two waves
- Superposition only applies to certain types of waves
- Waves always interfere constructively or destructively
- Superposition creates energy

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Suppose you are standing at the shoreline of a calm lake or pond, observing waves coming in from the lake or pond. Now, let you introduce two waves coming from slightly different directions. What do you think will happen as these waves approach the shore?

Activity 3

Fill a large shallow container with water until it is nearly full. Tap the water with your finger at opposite ends of the container. This is creating two sources of disturbances which in turn generate waves simultaneously from both sources. Make sure the waves generated are of similar frequency and amplitude. Observe the interference patterns that form as the waves interact. You should see regions where the waves reinforce each other (constructive interference) and regions where they cancel each other out (destructive interference). Now vary the frequency or amplitude of one of the sources and observe how it affects the interference pattern.

Have you properly understood the superposition of waves?

Key Ideas

- While superposition is often introduced with two waves, it applies to any number of waves. The principle of superposition states that when multiple waves are present, the net displacement at any point is the sum of the displacements due to each individual wave
- Some may think that superposition only applies to certain types of waves, like light or sound waves, but in reality, it applies to all types of waves, including water waves, seismic waves, and electromagnetic waves.

- When two waves meet, they always interfere either completely constructively (adding up perfectly) or completely destructively (canceling each other out). In reality, waves can interfere in various ways depending on their phase relationship, and the resulting interference can be anything from fully constructive to fully destructive.
- When waves interfere constructively, the resulting amplitude can be greater than either of the individual waves. However, this does not mean that energy is being created; rather, energy is redistributed in the wave system
- In activity 2,
    - ✓ at certain points along the shore, the peaks of the two waves align perfectly, resulting in constructive interference. In these areas, the heights of the waves add together, creating larger waves. In other areas, the peaks of one wave align with the troughs of the other wave, resulting in destructive interference. Here, the crests and troughs cancel each other out, creating smaller or even flat areas where the waves seem to "cancel" each other

Assessment

- Discuss about the application of the superposition of waves.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the common characteristics of wave, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of force in a better way.

https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_en.html

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of mechanical oscillation and sound wave. Specifically, we have considered the following aspects:

- Explanation of oscillation as a to and fro motion around a central point called equilibrium point.
- Explanation of sound waves as longitudinal mechanical wave.
- Explanation of the characteristics of sound waves such as amplitude, frequency, wavelength, speed of sound
- Explanation of wave phenomena such as interference, reflection, refraction, diffraction.
- Explanation of the transmission of sound through different mediums such as solids, liquids, gases.
- Explanation of the principle of superposition resulting in constructive or destructive interferences.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We havenhared our experiences sand suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 6

Fluid Mechanics

Introduction

Dear trainee, Fluid mechanics is the study of fluid behavior (liquids, gases, blood, and plasmas) at rest and in motion. Fluid mechanics has a wide range of applications in mechanical and chemical engineering, in biological systems, and in astrophysics

In this chapter, you will learn more about how to teach these concepts using constructive approaches. Topics associated with fluids and pressure is included in this lesson. You have 7 hours at your disposal for teaching the chapter.

6.1 Density and Specific Gravity (1hr)

At the end of this lesson, learners will be able to:

- devise activities and strategies to help your trainees learn the concepts related to density and specific Gravity
- Apply the concept of density to identify for an objects float or sink
- Identify the misconception's associated with density of substance

Density is an intensive property, meaning that it is a property that is the same no matter how much of a substance is present. Density is an important concept because it allows us to determine what substances will float and what substances will sink when placed in a liquid. Dear trainee, in this session, we will discuss about density and specific Gravity.

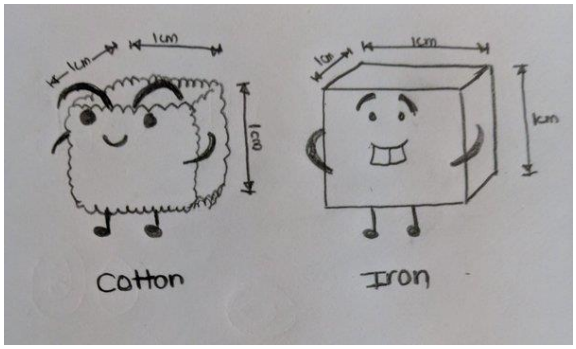
Activity 1

- How have you been teaching the concepts of density and Specific Gravity? Please share with your friends.
- What misconceptions did you identified when you teach about density and specific gravity?

There is a common misunderstanding that objects of equal size (dimension) weigh the same. However, this is not true as the property of density is what determines the weight. To support this concept, please take into account the following anecdotes.

Activity 2

I want you to meet my two friends. Mr.Cotton and Mr. Iron. They are childhood buddies. And you know what? They were born on the same day. So, basically they have the same size. Which means, they look somewhat similar? But if you'll weigh them, you will see that mr. cotton is very light and iron is very heavy.



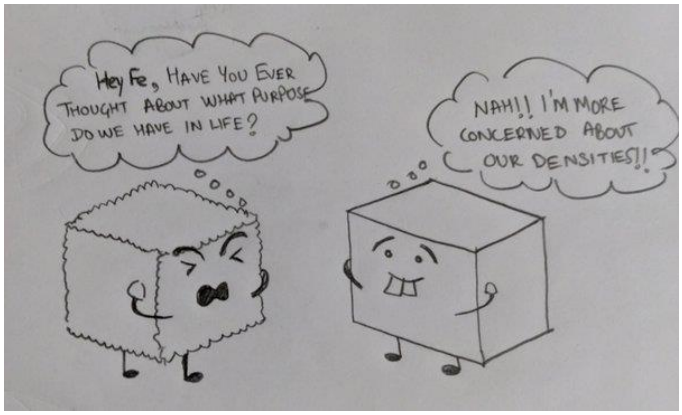
- Did i tell you how they look like? They both are cubey. Which means both of them look like a small cube? They have a side of 1cm.

But that's not how mathematicians say how big they are. One way to say how big they are or what their size is, by saying what volume they occupy. So, as both of them are cubey of side 1cm. Their volume is 1cm x 1cm x 1cm. So, the total volume they occupy is $1cm^3$

I'll refer to 1cubic cm as cc.

So, both of them are 1cc big.

One day, both of them had the same doubt as that of you.



So, they went to a physicist and asked him to find out their density.

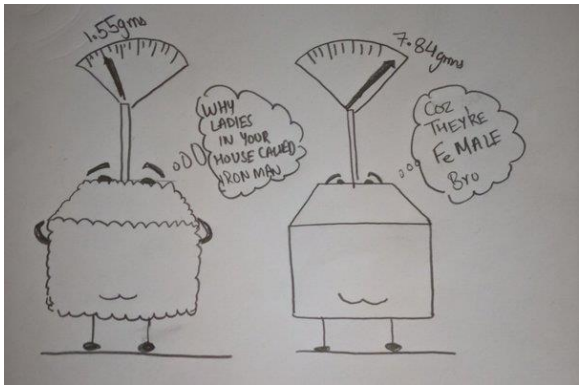
Wise physicist said - Your density is nothing but how heavy you are for your size. Say an object has a weight of 3g for a size of 2cc. Then, by definition, its density is 3g for 2 cc or 3g/2cc or 1.5g/cc.

But I'm cruel to students so i like to put this sentence in the most despicable way possible which goes like.

Density is the ratio of the mass of the object to the volume they occupy.

Cotton and Iron laughed and were relieved at the same time that this evil physicist was not their teacher.

So, they quickly found out their respective weights.



Cotton - 1.55gms

Iron - 7.84 gms

And divided those weights with their sizes.

So, density came out to be 1.55gm/**1** cc and 7.84gm/**1** cc for cotton and iron respectively.

They got their answers and they happily lived ever after.

Wait!! Its not over yet. There are no happily ever after in life.

Conclusions time

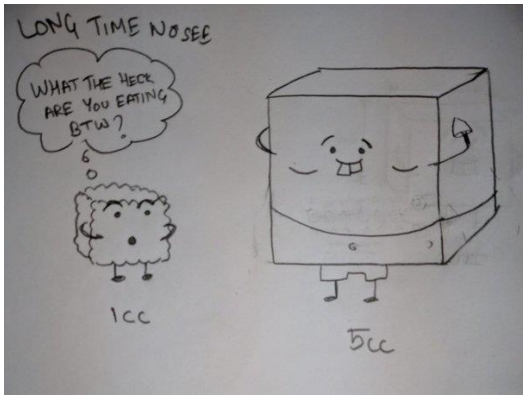
- Density tells me how heavy something, no matter what their size is is. Just by looking at the numbers you can get a better picture of "whose heavy" and by how much?

Q - Now tell me who's heavier out of cotton and iron? Hint- Just has a look at their densities.

A- Iron is heavier. Or i should say iron is 5 times heavier than cotton.

Now, coming back to the story.

Years, passed by. Mr. Iron had a very good diet. So he became very heavy with time. And his size increased too. But Mr. Cotton remained same.



2. Density tells me weight for 1unit volume (here - 1cc). What if something is bigger than 1 unit, say 2 units? Then what?

- I ask you, if 1 unit of something weighs 10kg., how much 2 units of same thing will weigh? Come on, pick up pen and paper. Write it down.

  It'll be 20 kgs right?

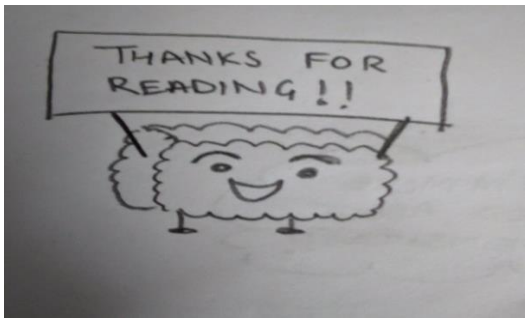
- So**,** density can tell me what will be the size of object if its current weight is given. Or vice versa.

Q- Mr. iron is now 5cc big. Thanks to mumma iron's tasty dishes. Can you tell me how heavy is he now? (assuming his weight didn't increase only his size increased)

A- Okay, I remember. 1cm3 of iron weighed 7.84gms.

So, 5cc of iron would weigh 7.84*5=39.2gm

Yayy!! You've done It. Now you know density.



Activity 3

Think about why can boats float when they are made out of material that is denser than water?

- An object made from dense material can float if its volume is made large enough. Here's an example: If you have a cube of clay that is 3 cm on each side, the cube has a volume of 3 cm × 3 cm × 3 cm = 27 cm^3. Let's say that the cube has a mass of 60 grams. The density of the clay cube is 60 g/27 cm^3 = 2.2 g/cm^3. Since the density of water is 1 g/cm^3, the clay cube sinks.
- But you can take the same cube of clay and press it down into a thin pancake and form it into a bowl that is like half a sphere. If it has a diameter of 8 cm, the clay bowl will have a volume of about 134 cm^3 or more than four times the volume of the cube. The density of the bowl is now 60 g/ 134 cm^3 = 45 g/cm^3. The density of the clay itself doesn't change but the density of the object does. The increase in the volume of the object decreases the density so that the density of the bowl is less than the density of water so the bowl floats.

Assessment

1. Why heavy boats do floats?
2. What is the difference between the density and specific gravity
3. The density of a substance is 1.63 grams per milliliter. What is the mass of 0.25 liters of the substance in grams?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Take away resources

- https://phet.colorado.edu/en/simulations/density
- https://phet.colorado.edu/sims/html/density/latest/density_en.html

6.2 The Young Modulus (2hrs)

At the end of this lesson, trainees will be able to:

- ✓ devise activities and strategies to help your trainees learn the concepts related to elasticity.
- ✓ Demonstrate elasticity of biological materials and those made by humans, and measure changes in length with different forces.
- ✓ Determine the effects of temperature and water (hydration) on length changes.
- ✓ Calculate Young's modulus for different materials

Many materials and substances can return to their original shape and size after being pulled on or twisted. This property is called elasticity. This is also a property of substances that make up the human body – an example is a strand of hair –as well as materials made by humans. Elasticity causes our skin to stretch when pulled or pinched, and then go back to its original shape, and it also explains why rubber balls bounce. Cellular components, such as the mitotic spindle which is present during division, have also been shown to have elastic properties – for example, the mitotic spindle can regain its shape after partial squashing.

In this session, we will demonstrate the elasticity of biological materials, as well as materials made by humans. You will measure changes in length of materials under normal conditions and under conditions that cause changes in their elasticity.

Activity 1

- How have you been teaching the concepts of Young's modulus, Elasticity? Please share with your friends.
- What misconceptions did you identified when you teach about Elasticity?

The ability of materials or substances to undergo a reversible increase in length, similar to a spring, is a property that can be measured. This property is known as the elastic modulus or Young's modulus. The following activity will help you to understand more about Young's modulus.

Activity 2

Materials

- Strand of hair (~15-25 *cm* = ~6-10 inches long)

Use a strand of your own hair or ask a classmate for one. If asking a classmate, be sure to obtain permission first and let him or her provide you with a strand of hair, rather than taking it yourself

- Silk thread (~15-25 *cm* = ~6-10 inches long), Rubber band, Other materials (String, Rope, Cord, Wire) can also be used. Ruler, Rod to suspend materials, Hooks to attach weights

  Paper clips can be used instead of hooks, Weights (~100 *g*, ~200 *g*, ~300 *g*, ~400 *g*)

  Weights can be made using small vials or bottles filled with water or nails; be sure to measure the exact mass of each weight before use.

1. Take a single strand of hair, a piece of silk thread and a rubber band, and examine their overall elastic properties. Materials are elastic only up to a certain pulling force, after which they will not return to their original shape. This point is called the elastic limit. Increasing the force even more will cause the material to break – this is called the breaking point. Try stretching each material by pulling on them gently – don't pull too hard or they will not return to their original shape, or break!
   - Which of the materials do you think is the most elastic? Which do you think is the least elastic?
2. Now soak the strand of hair and silk thread in water for 5-10 minutes and put the rubber band in the freezer or on ice for 5-10 minutes. Try stretching the wet hair and wet silk thread; then try stretching the cold rubber band.
   - Are the wet hair and wet silk thread still elastic? Are they harder or easier to stretch than they were when they were dry?
   - What about the cold rubber band – is it harder or easier to stretch than when it was at room temperature?
   - What do you think the effects of soaking in water (this is called 'hydration') are on the elasticity of hair and silk? What about the effects of cold temperature on the elasticity of a rubber band?
3. We can measure the elasticity of each material by seeing how much it stretches when different weights are added. When doing these experiments, we want to measure each material within its linear elasticity range, which is the range before you reach the elastic limit.

- Don’t add a weight that is too large – you may reach the elastic limit of the material, or even its breaking point!

4. Attach the strand of hair to a rod and measure its starting length with a ruler. Write down your measurement. Then measure the starting length of the silk thread and rubber band in the same way. Don’t forget to write down your measurements!
    - The hair and silk thread can be tied or taped at the ends, then looped over a rod – measure from the edge of the knot or tape to the bottom of the loop to find the starting length; straighten the loop and make sure both sides are the same length before you do the measurement. The rubber band can just be looped over a rod, as shown in Figure 1, and measured.
5. Attach a weight of ~100 g to the bottom of the strand of hair, as shown for the rubber band in Figure 1. Make sure that the weight extends the strand as much as it can without your pulling on it! Measure the length of the strand of hair with the weight and write it down.
    - Has the strand of hair increased in length with the weight? If the strand is longer, how much did it increase in length? If the strand is the same length, try a heavier weight.
6. Change the weight to ~200 g, then to ~300 g and ~400 g, and repeat your length measurements.
    - Be sure to write down the exact mass of the weight you used, together with your measurements.
7. Now try the same measurements, but under conditions that affect the elasticity of the materials. Soak the strand of hair and silk thread in a small container of water for 5-10 minutes, then repeat the measurements with each of the weights.
    - Don’t let the strand of hair or silk thread dry out between measurements! Soak them again in water for a few minutes between each measurement, if necessary.
    - Are the lengths (with the weights) of the wet hair strand and silk threading the same as for the dry hair strand or silk thread? If they are different, are the lengths longer or shorter for wet hair and wet silk thread?
8. Put the rubber band in a freezer or on ice for 5-10 minutes. Then repeat the measurements with each of the weights and record your measurements.
    - Don’t let the rubber band warm up between measurements! Freeze it again or put it on ice for a few minutes between each measurement to keep it cold.

- Are the lengths (with the weights) of the cold rubber banding the same as for the rubber band at room temperature? If the lengths are different, are they greater or smaller than for the rubber band at room temperature?

9. Advanced trainees will be able to calculate the Young's Modulus for each material and difference in conditions, as follows:
   - First, calculate the force, F, for each of the weights that you used in your measurements using the exact mass of each weight and Newton's second law: F = ma where F is the applied force, m is the mass of the weight you added, a is acceleration due to gravity = 9.81 m/s^2 and then convert to Newtons (N), which is the same as $kg \cdot m/s^2$.

     The example shown below is for a weight with a mass of 100 g:

     $$F = ma = 100\ g \times 10^{-3}\ kg/g \times 9.81\ m/s^2 = 0.981\ kg \cdot m/s^2 \text{ or } N$$

   - Now determine the cross-sectional area, A, of the single strand of hair, silk thread and rubber band that you used in your experiments. To do this, measure the diameter in mm as accurately as you can, then divide by 2 to find the radius and use the equation for the area of a circle ($A=\pi r^2$) to find the cross-sectional area. If you are using a rubber band that has a rectangular cross-section, find the area after measuring the width, w, and height, h, of the rectangle (A=w h). The area units should be mm2.
   - Human hair can range from ~0.02 to 0.18 mm in diameter. If you are having trouble measuring the diameter of the strand of hair, try using an average value of 0.08 mm for the diameter instead. The diameter of a silk thread also varies, but the range is ~0.01-0.025 mm in diameter. Try using an average value of 0.02 mm for the diameter of your silk thread, if it is too small for you to measure it accurately. The rubber band has a cross-sectional width of 1 mm and length of 5 mm – its cross-sectional area is 5 mm^2.
   - Now find F/A by dividing the force for each of your weights by the cross-sectional area of the material. Since the weight is pulling on both sides of the rubber band, the total cross-sectional area for both sides is 2 x 5 mm^2, or 10 mm^2. If you made loops of the strand of hair and silk thread and put the weights at the bottom of the loop, you should multiply the cross-sectional area for each strand by 2 to find the total area. After you divide the force corresponding to each weight by the cross-

sectional area of the material to find F/A , the units will be N/mm^2, which is the same as milli Pascals (mPa).

- For each weight, you should also find a value for **Δ**L/L0 where
  - ✓ **Δ**L is the change in length with the force (subtract the starting length from the length with the weight)
  - ✓ L0 is the starting length
- For each material, make a table like the one shown below – be sure to insert the exact mass for each weight rather than the approximate ones shown:

Material: Hair strand	Mass of Weight	*F*	*F/A*	*L* (with *F*)	ΔL (=L-L_0)	$\Delta L/L_0$
A=	0					
L_0=	~100 *g*					
	~200 *g*					
	~300 *g*					
	~400 *g*					

- Plot your values for F/A and **Δ**L/L_0 for each material to obtain a graph like the one shown in Figure 2. The quantity F/A is also known as stress and **Δ**L/L_0 is referred to as strain. You should have one graph for each of the materials that you measured.

  The slope of the initial, linear portion of the line is the Young's Modulus, E, which is also defined as

  $$E = \frac{F/A}{\Delta L/L_0}$$

  Where F is the applied force, A is the cross-sectional area, ΔL is the change in length with the force (subtract the starting length from the length with the weight), L0 is the starting length
- Find the slope by calculating the change in y divided by the change in x, or Δy/Δx, from your graphs.
- How do your values for Young's modulus compare with those in the table?

  The Young's modulus values are smaller for materials that are more elastic than those that are less elastic. Is wet hair or silk more elastic or less elastic than dry hair or silk? What about cold rubber compared to rubber at room temperature?

Key ideas

- Measurements of the Young's modulus of materials take into account two quantities, stress and strain. **Stress** is the force causing the material to change; *F/A*. **Strain** is the

measure of deformation of the materials, or D*L/L0*. Young's modulus is the ratio between stress and strain, and can be determined by plotting stress vs strain, and determining the slope of the initial, linear part of the curve.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- To know more about Young modulus, read the following material.
  - https://www.biophysics.org/Portals/0/BPSAssets/Education/Documents/LessonPlanElasticity.pdf

6.3 Fluid Statics (1 hr)

At the end of this session the trainee will be able to

- ✓ devise activities and strategies to help your trainees learn the concepts related to fluid statics
- ✓ Identify the misconception associated with fluid statics.
- ✓ Set a concept map to teach the properties of matter
- ✓ compare pressure in fluids in terms of force and cross sectional area

Dear trainee in this session we will learn about fluid statics with is the study of incompressible fluids at rest in fluid mechanics. It involves the study of fluids in stable equilibrium rather than fluid dynamics, the study of fluids in motion. In this session, we will learn more about teaching fluid pressure systematically.

Activity 1

- How have you been teaching the concepts of pressure? Please share with your friends.
- What misconceptions did you identified when you teach about properties of matter?

Misconception at a pressure of solids found in question number 1, which is about the relationship between the surface area of the press pressure on the solids, where students assume that the surface area of the two beams are different but the pressure generated will always

remain the same. Dear trainees the following ideas will help you to teach about pressure, which is simple and understandable.

Activity 2

Begin with some simple questions in order to find out what students know about pressure and so determine a starting point for the topic. This series of questions describes four pairs of events. The items in each pair are similar, but with a difference. For example, in pair A, the shoes are different.

A

A girl stands on soft sand in flat shoes

A girl stands on soft sand in high-heeled shoes

- How would the marks in the sand be different?

B

A boy presses his thumb on the flat top of a drawing pin

A boy presses his thumb on the point of the drawing pin

- What difference would his thumb feel?

C

The flat side of a knife is pressed against butter

The sharp edge of a knife is pressed against butter

- What difference would you see?

D

A saucer is carefully placed flat onto water in a bowl

A saucer is lowered edge down into water

- What difference would you see?
- Illustrate your answers with diagrams if you want.

Activity 3

- Please compare the properties of matter interims of Volume, shape, Distance between particles attraction between particles, motion of particles, expansion during heating and their densities.

Key Ideas

- "You stand with your bare feet on a smooth concrete floor. Then someone sprinkles gravel around you so that you have to walk across the gravel. Why does the gravel hurt while the concrete does not? (Because the gravel sticks to your feet. Is that the

whole answer?)" This should lead to a discussion of load and area comparisons leading on to a need for a new concept: pressure.

- Other examples might include pressing on the bench and then a corner of the bench with the flat of your hand; holding a ruler by squeezing the edges and the flat surface; leaning against a wall with the flat of the palm of your hand and then a finger.

Assessment

1. What physical characteristic distinguishes a fluid from a solid?
2. Which of the following substances are fluids at room temperature: air, mercury, water, glass?
3. Why are gases easier to compress than liquids and solids?
4. How do gases differ from liquids?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://www.accessengineeringlibrary.com/content/book/9780071363723
- Schaum's Outline of Fluid Mechanics and Hydraulics, 4th Edition
- Perform PHET experiment simulation so as to understand the concept of Fluid statics in a better way.

6.4 Properties of Pressure in fluids (1 hr)

At the end of this lesson, learners will be able to:

- Devise activities and strategies to help your trainees learn the concepts related to properties pressure in liquids.
- Identify the misconceptions associated with pressure in liquids.
- Apply Pascal's principle to teach about hydraulic lift
- Relate the Pascal's law with real life phenomenon

Dear trainee in this session we will more focus on systematic method for teaching properties of pressure in fluids and Pascal's principle.

Activity 1

- How have you been teaching the concepts of properties of pressure in liquids? Please share with your friends.
- What misconceptions did you identified when you teach about properties pressure in liquids at rest?"

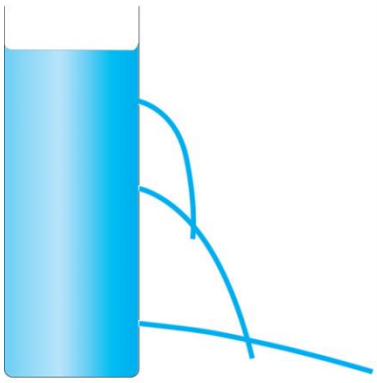
When students use a straw, they will observe liquid rising and may assume that sucking on the straw is pulling the liquid through. When asked about why the liquid rises, they will often fail to include ideas about pressure in their explanation. Students are unlikely to correctly explain that sucking on the straw lowers the pressure inside the straw and your mouth to below atmospheric pressure which then pushes the liquid further up the straw.

Activity 2

- When you drink with a straw, is the atmospheric pressure pushing the water or me sucking it? Please try to discuss the reason and report in group

Activity 3

a. Refer the figure and discuss the question in box



Why does the lower water have a higher velocity than the higher water?

1. Explain your answer.
2. Use variables in the language
3. Give context to the example, where have you seen this?

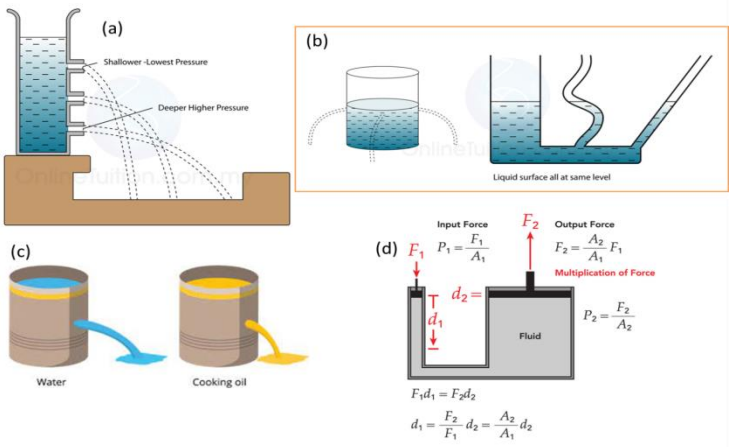
b. What is the relationship between liquid pressure and its depth? Draw a labeled diagram showing that the pressure of a liquid (such as water) varies with its depth.

c. Explain why a dam's bottom wall is thicker than the top wall.

d. Suppose the master cylinder in a hydraulic system is at a greater height than the cylinder it is controlling. Explain how this will affect the force produced at the cylinder that is being controlled.

Key Ideas

- The weight of the liquid causes pressure in the container. It also causes pressure on any object in the liquid. The pressure caused by a liquid has the following characteristics:
  - ✓ Liquid pressure increases with depth.
  - ✓ Liquid pressure remains the same in all directions at a given depth.
  - ✓ Liquid pressure depends upon the density of the liquid. P =ρgh
  - ✓ Liquid exerts pressure on the sides of the container.
  - ✓ A liquid seeks its own level.
- **Pascal's principle**, in fluid (gas or liquid) mechanics, statement that, in a fluid at rest in a closed container, a pressure change in one part is transmitted without loss to every portion of the fluid and to the walls of the container. The principle was first enunciated by the French scientist Blaise Pascal.



Different properties of pressure in liquids (a) Dependence of pressure in depth (b) Pressure exerts equally in all direction and pressure independence with shape of the container (c) Dependence of pressure on density of liquid (d) Pascal's principle (Hydraulic pressure)

Implications to teaching

- ✓ Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- ✓ Have you been inspired to use such kinds of teaching methods in your own lesson?
- ✓ What new things have you learnt from this lesson?

Takeaway resources

- https://www.thephysicsaviary.com/Physics/Programs/Labs/PascalsPrincipleLab/
- https://openstax.org/books/university-physics-volume-1/pages/14-3-pascals-principle-and-hydraulics
- https://phet.colorado.edu/sims/html/under-pressure/latest/under-pressure_en.html

6.5 Archimedes Principle (2hr)

At the end of this lesson, trainees will be able to:

- Devise activities and strategies to help your trainees learn the concepts related to Archimedes principle.
- Identify the misconceptions associated with pressure in liquids.
- Apply the Archimedes principles to teach practical works
- Reason out why objects floats or sink
- Relate real life phenomenon associate with Archimedes principle

The main focus of this session is how we teach the Archimedes principle to secondary school trainees. A brief summary of key ideas, activities to be completed by trainees and finally takeaway resources are included in the session

Activity 1

- How have you been teaching the concepts of Archimedes principles? Please share with your friends.
- What misconceptions did you identified when you teach Archimedes principles?

Activity 2

- Do you explain why heavy objects easy to lift them when they are found in liquid?
- Why is it easier to swim in sea water than in river water? Please discuss briefly about it
- More force is required to pull the plug in a full bathtub than when it is empty. Does this contradict Archimedes' principle? Explain your answer.
- Marbles dropped into a partially filled bathtub sink to the bottom. Part of their weight is supported by buoyant force, yet the downward force on the bottom of the tub increases by exactly the weight of the marbles. Explain why

Activity 3

Step 1: Discuss the following questions

a. **Heavy objects in water:** - Discuss why it is easier to lift a heavy stone under water than in air.
b. **Submarine :-** Discuss the reason why submarines are always underwater
c. **Hot-air balloon:-** Discuss the reason why hot-air balloons rise and float in mid-air
d. **Hydrometer:-** Discuss briefly the working principle of Hydrometer
e. It is easier to swim in sea water than in river water. Explain the reason.

Key Ideas

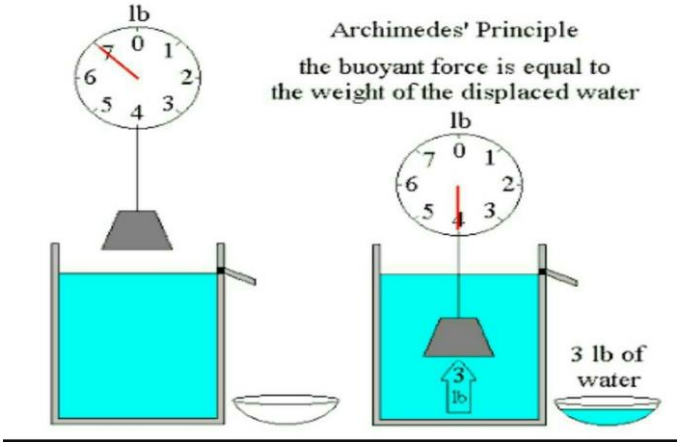
Archimedes' principle states that:

"*The upward buoyant force that is exerted on a body immersed in a fluid, whether partially or fully submerged, is equal to the weight of the fluid that the body displaces and acts in the upward direction at the center of mass of the displaced fluid*"**.**

The value of thrust force is given by the Archimedes law which Archimedes of Syracuse of Greece discovered. When an object is partially or fully immersed in a liquid, the apparent loss of weight is equal to the weight of the liquid displaced by it.

- When an object is partially or fully submerged in a fluid, the magnitude of the buoyant force acting on the object equals to the weight of the fluid displaced by the object. Hence the buoyant force is acting in an opposite direction on the weight of the object; as such the weight of an object submerged in a fluid is less than its weight in air. The difference b/n the weight of the object in air and the weight when it is submerged in a fluid equals to the buoyant force of the fluid acting on the object. For an object totally submerged in a fluid the volume of the object equals to the volume of the displaced fluid. If the object is partially

submerged the volume of the submerged part of the object only is equal to the volume of the displaced fluid.



Apparent weight= Weight of object (in the air) – Thrust force (buoyancy)

Assessment

- ✓ State Archimedes principle.
- ✓ What is Archimedes' principle also known as?
- ✓ Give examples where Archimedes' principle is applied?
- ✓ What is thrust force?
- ✓ How is the Archimedes principle mathematical written?

Implications to teaching

- ✓ Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- ✓ Have you been inspired to use such kinds of teaching methods in your own lesson?
- ✓ What new things have you learnt from this lesson?

Takeaway resources

- ✓ https://phet.colorado.edu/en/simulations/balloons-and-buoyancy
- ✓ https://phet.colorado.edu/sims/density-and-buoyancy/buoyancy_en.html
- ✓ https://www.youtube.com/watch?v=_p-hwElkrlk
- ✓ https://www.youtube.com/watch?v=16HDJNoXQII

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of fluid dynamics. Specifically, we have considered the following aspects:

- density and specific gravity are explained.
- The concept of fluid statics which is associated with the factors affecting the fluid pressure are included and discussed in activities.
- The concept of Archimedes principle is also discussed by taking the real life phenomenon

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

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- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
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- *Hewitt, P.G. The Concepts of Physics, 3rd ed.; PEK: Herakleion, Greece, 2004; (Greek Translation).*
- *Haliday, D.; Resnick, R. Physics; Wiley: New York, NY, USA, 1978.*
- *Psillos, D.; Kariotoglou, P. (Eds.) Iterative Design of Teaching-Learning Sequences: Introducing the Science of*
- *Materials in European Schools; Springer: Berlin/Heidelberg, Germany, 2016.*

Chapter 7

Temperature and Thermometry

Introduction

Dear Trainee, Temperature is a fundamental concept that permeates various aspects of our lives, from the comfort of our homes to the vast reaches of outer space. It dictates the behavior of matter, the efficiency of industrial processes, and even the viability of life forms. Understanding temperature and its measurement, known as thermometry, is crucial in fields as diverse as physics, chemistry, engineering, meteorology, and medicine.

Therefore, in this chapter, you will learn how to teach the basic concepts related to temperature and thermometry. You have 5 hours at your disposal for covering this chapter.

7.1 Temperature and our life (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach temperature and our life,
- identify some misconceptions related to temperature and our life and take corrective measures.

Dear trainees, in this lesson you are going to learn about temperature and our life. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching temperature and our life?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to temperature and our life. Some of them reported in literature are listed below.

- Cold weather makes you sick
- Hot water kills germs better

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Discuss in groups and present to the class how temperature affects the following real life situations.

- Cooking, Food Preparation and storage
- Health and Comfort
- Thermoregulation in Living Organisms
- Industrial Processes
- Energy Consumption
- Environmental Impact
- Recreational Activities

Activity 3

Human beings and other living creatures adapt different temperature conditions in our planet Earth. Particularly for human beings, this challenge creates room for innovation of temperature related devices. What are these temperature related devices? Discuss in groups and present it to the class.

Have you properly understood temperature and our life?

Key Ideas

- While cold weather is often associated with the flu season, it's not the cold itself that makes you sick. Viruses, such as the flu virus, spread more easily in colder weather due to factors like people spending more time indoors in close proximity to others. Cold weather can weaken the immune system temporarily, making it easier for viruses to take hold, but it's not the direct cause of illness.
- There's a common belief that using hot water is more effective for killing germs when washing hands or cleaning surfaces. While hot water can help dissolve oils and dirt, the temperature required to kill most germs is much higher than what's typically used for hand washing.
- Temperature affects what clothes we wear, how we plan our day, and even our mood. Understanding temperature patterns helps us prepare for different weather conditions, such as dressing warmly during cold temperatures or staying hydrated during hot temperatures. Human beings and other living creatures adapt different temperature conditions in our planet Earth. Particularly for human beings, this challenge creates room for innovation of temperature related devices.

Assessment

Discuss how temperature plays a crucial role in our lives and how it affects many aspects of our daily experiences and well-being.

Implications to teaching

- Addressing these misconceptions can help individuals make more informed decisions about how they perceive and respond to temperature-related situations in their daily lives.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about temperature, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of temperature in a better way.
  https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html

7.2 The concept of heat and its transfer mechanisms (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach the concept of heat and its transfer mechanisms,
- identify some misconceptions related the concept of heat and its transfer mechanisms and take corrective measures.

Dear trainees, in this lesson you are going to learn about the concept of heat and its transfer mechanisms. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of heat and its transfer mechanisms?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to heat and heat transfer mechanisms. Some of them reported in literature are listed below.

- Metal objects are colder than non-metal objects at the same temperature
- Thicker Clothing always provides better insulation

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

When a hot cup of tea is left in a room in contact with the enveloping air, you know that the cup of tea will gradually cool down over time. What is happening over the course of time to cause the tea to cool down? How heat transfer plays a crucial role in cooking?

Activity 3

Discuss in groups and present to the class how heat and its transfer mechanisms are related to the following real life situations.

- Home Heating and Cooling
- Thermal Comfort
- Electronic Devices
- Transportation
- Clothing and Textiles
- Medical Applications
- Environmental Processes

Have you properly understood the concept of heat and heat transfer mechanisms?

Key Ideas

- Metals conduct heat away from our skin more effectively than non-metals. When we touch a metal object at room temperature, it quickly conducts heat away from our skin, making it feel colder. However, both the metal and non-metal objects are at the same temperature.
- While thicker clothing may provide more insulation in some cases, the effectiveness of insulation depends on factors such as material composition, air pockets within the fabric, and fit. In some situations, thinner layers of clothing made from high-quality insulating materials can provide better thermal protection than thicker, less insulating fabrics.

Assessment

Discuss the mechanisms of heat transfer in conduction, convection and radiation.

Implications to teaching

- Understanding and correcting these misconceptions can lead to a better understanding of heat transfer mechanisms and their applications in various real-life situations.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about temperature, read grade 9 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of heat and its transfer mechanisms https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html

7.3 Heat capacity and specific heat capacity (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach heat capacity and specific heat capacity,
- identify some misconceptions related to heat capacity and specific heat capacity and take corrective measures.

Dear trainees, in this lesson you are going to learn about the concept of heat capacity and specific heat capacity. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching heat capacity and specific heat capacity?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to heat capacity and specific heat capacity. Some of them reported in literature are listed below.

- Specific heat capacity is constant
- Specific heat capacity determines how hot or cold a substance feels
- Specific heat capacity is a measure of a substance's ability to conduct heat

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Cooking pots made of materials like copper or cast iron are preferable for cooking compared to those made of aluminum or stainless steel. What do you think is the reason? What is the advantage of using materials like concrete or bricks in building construction?

Activity 3

Discuss in groups and present to the class how heat capacity and specific heat capacity are related to the following real life situations.

- Thermal Comfort
- Automobile Engines
- Thermal Insulation
- Food Preservation
- Thermal Energy Storage

Have you properly understood the concept of heat capacity and specific heat capacity?

Key Ideas

- While specific heat capacity is often treated as a constant value in basic calculations, it can vary with temperature and pressure. This is especially true for materials undergoing phase changes (like melting or boiling), where additional energy is required to change the substance's state rather than just its temperature.
- Specific heat capacity is not directly related to how hot or cold a substance feels to the touch. Factors such as thermal conductivity (how quickly heat can move through a material) and heat transfer mechanisms (conduction, convection, radiation) play a more significant role in determining how quickly heat is exchanged between objects and their surroundings.
- Specific heat capacity is related to a material's ability to absorb or release heat, but it's not the same as thermal conductivity, which measures how well a material conducts heat. Materials with high specific heat capacities can store more heat energy per unit mass, while materials with high thermal conductivity can transfer heat more quickly.

Assessment

What does it mean by saying a substance has a heat capacity of 500 J/°C.

Implications to teaching

- Understanding heat capacity and specific heat capacity helps in designing more efficient systems and processes across various industries, contributing to energy savings, improved performance, and enhanced comfort in everyday life.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about heat capacity and specific heat capacity, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of heat capacity and specific heat capacity. https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html

7.4 Thermal expansion (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach heat capacity and specific heat capacity,
- solve problems associated with thermal expansion

Dear trainees, in this lesson you are going to learn about thermal expansion. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching thermal expansion?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the concept of thermal expansion. Some of them reported in literature are listed below.

- All materials expand at the same rate
- Expansion is uniform in all directions
- All changes in size are due to thermal expansion
- Thermal expansion is always undesirable

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- Have you observed that gaps are left between concrete slabs and other materials when constructing a building? What do you think is the reason?
- What is the purpose of expansion joints used in bridges and highways? What do you think will happen if the expansion joints are missing in bridges and highways?

Activity 3

Take a thin metal rod and measure its initial length using a ruler. Hold one end of the thin metal rod with tongs and heat the other head for sufficient amount of time (say 3 minutes) using heat sources such as candle flame. Now measure its final length. Do you observe any change in its length? How much is the change in length of the metal rod? What factors determine the amount of expansion?

Have you properly understood the concept of thermal expansion?

Key Ideas

- In reality, different materials have different coefficients of thermal expansion, meaning they expand or contract at different rates when subjected to temperature changes. For example, metals generally have higher coefficients of thermal expansion compared to nonmetals like ceramics or plastics.
- While some materials may expand uniformly in all directions, such as isotropic materials like gases, others may exhibit anisotropic expansion, meaning they expand more in one direction than another. For example, many crystalline materials expand more in certain crystallographic directions than others.
- While thermal expansion is a significant factor in size changes with temperature, other factors can also contribute. For example, mechanical stress or phase transitions (like melting or solidification) can also cause changes in size.
- While thermal expansion can sometimes lead to issues like warping, buckling, or structural failure if not properly accounted for, it can also be harnessed for beneficial purposes. For instance, bimetallic strips are used in thermostats precisely because they exhibit differential thermal expansion, allowing them to bend and trigger switches at specific temperature thresholds.
- In Activity 2,

- ✓ Different materials used in construction expand and contract at different rates. For instance, when constructing a building, gaps are left between concrete slabs and other materials to allow for expansion and contraction with temperature changes. This prevents cracks from forming in the structure due to thermal stress.
- ✓ Expansion joints are also used in bridges and highways to accommodate thermal expansion and contraction. Concrete and metal structures expand and contract with temperature changes, so expansion joints are essential to prevent cracking and structural damage.
- ✓ Railroad tracks are made of metal, typically steel. During hot summer days, the tracks expand due to the heat, causing them to become longer. If the tracks were laid tightly together without any allowance for expansion, they could buckle or warp. Therefore, expansion joints are used to allow for the thermal expansion without damaging the tracks.

Assessment

- ✓ A metal rod is initially 1 meter long at 20°C. The rod is then heated to 100°C, causing it to expand to 1.001 meter. Calculate the linear expansion coefficient of the metal rod.

Implications to teaching

- o Thermal expansion is a fundamental aspect of everyday life, influencing the design and operation of various objects and structures. Understanding and accounting for thermal expansion is crucial in engineering, construction, manufacturing, and many other fields to ensure the durability and functionality of materials and systems.
- o Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- o Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about **thermal expansion**, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand **the concept of heat capacity and specific heat capacity.**

https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_all.html

7.5 Change of Phase and Calorimetry (1 hr)

At the end of this lesson, trainees will be able to:

- use innovative techniques to teach change of phase and calorimetry,
- identify some misconceptions related to change of phase and calorimetry.

Dear trainees, in this lesson you are going to learn about change of Phase and Calorimetry. The lesson is related to your day to day experience and real life situation. Practical activities are also included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concept of force?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to change of phase and calorimetry. Some of them reported in literature are listed below.

- All substances melt or freeze at the same temperature
- Boiling and evaporation are the same
- All heat energy absorbed or released goes into changing temperature
- Neglecting the heat capacity of the calorimeter

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

- Have you observed what happens when water in a container is placed in a freezer?
- What do you think is the cause of freezing rain? As the freezing rain makes contact with the ground, it melts into liquid water. Why?

Activity 3

Fill an insulated container with a known quantity of water (say 150 ml) and measure the initial temperature of the water with thermometer. Take any metal object and measure its mass. Now heat the metal object for sufficient amount of time so that it is heated uniformly. Transfer the heated metal object to the water and stir the water gently to ensure uniform temperature distribution. Using your thermometer, record the maximum temperature reached by the water and the final temperature of the metal object a after it has been in water. Finally use the measure data to calculate the specific heat of the metal object.

Have you properly understood the concept of change of phase and calorimetry?

Key Ideas

- In reality, the melting and freezing points of substances vary depending on factors such as molecular structure, intermolecular forces, and pressure. For example, water freezes at 0°C (32°F), but substances like ethanol freeze at a lower temperature.
- While both boiling and evaporation involve the conversion of a liquid to a gas, they differ in the mechanism and rate of the process. Boiling occurs throughout the entire liquid when its vapor pressure equals the external pressure, while evaporation occurs only at the liquid surface and is influenced by factors like temperature and surface area.
- In calorimetry experiments, it's crucial to recognize that heat energy can be absorbed or released not only to change the temperature of a substance but also to undergo phase changes. Failure to account for latent heat during phase changes can lead to incorrect conclusions about the heat energy involved in a process.
- The heat capacity of the calorimeter, including its container and any surrounding materials, can affect the accuracy of calorimetry measurements. Failure to account for the heat capacity of the calorimeter can lead to errors in calculating the heat exchanged during a process.
- The change of phase occurs due to changes in temperature and pressure, which affect the arrangement and movement of particles within a substance. This phenomenon refers to the transition of matter from one physical state to another.
- In Activity 2,
    - ✓ Freezing rain occurs when the air temperature is above freezing at higher altitudes but below freezing at the surface. When the raindrops fall through the atmosphere, they encounter a temperature gradient where they are cooled below the freezing point.
    - ✓ When freezing rain reaches the surface, it comes into contact with objects that are at or above freezing temperature, such as the ground, trees, or structures. These surfaces transfer heat to the freezing rain.
    - ✓ The absorbed heat energy raises the temperature of the ice, causing it to transition from a solid phase (ice) to a liquid phase (water). This phase change continues as long as the freezing rain remains in contact with the warmer surface and receives enough heat energy to maintain a temperature above the melting point of ice.

Assessment

Why does temperature remain constant during a phase change?

Implications to teaching

- Understanding phase changes is essential in various fields, including chemistry, physics, and environmental science, as they play a crucial role in natural processes, industrial applications, and everyday phenomena.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about thermal expansion, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the concept of change of phase and calorimetry
- https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_all.html

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of mechanical oscillation and sound wave. Specifically, we have considered the following aspects:

- Explanation of temperature as a measure of the degree of hotness or coldness of an object. It quantifies the average kinetic energy of the particles within the substance.
- Explanation of thermometry as the science of measuring temperature using various instruments and scales.
- Explanation of the expansion of substances when heated.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 8

Electricity and Magnetism

Introduction

Dear trainees, a physical phenomenon associated with the presence and flow of electric charge is known as electricity. In Ethiopia and elsewhere around the world, people depend on electricity to provide power for most appliances in the home, at work and out in the world in general. For example, lights, electric heating and electric stoves that you use in our home all depend on electricity to work. To realize just how big impact electricity has on our daily lives, just think about what happens when there is a power failure or load shedding. Thus, electricity has an important place in modern society. It is a controllable and convenient form of energy for a variety of uses in homes, schools, hospitals, industries and so on.

In this chapter, you will discuss more about how to teach these concepts using constructive approaches. Topics related to static and current electricity are the focus of this unit. You have 16 hours at your disposal for teaching the section.

8.1 Discharging a Body (1 hr)

By the end of the lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concepts related to electricity
- Explain that charged objects in an electrostatic system possess potential energy
- List safety precautions that should be taken during thunder and lightning storms

A sudden flow of electrons from one charged object to another is called static discharge, electrical discharge, or electrostatic discharge. Remember that objects become charged when excess electrons either build up on the object (giving the object a negative charge) or when electrons are removed from the object (giving the object a positive charge). In static discharge, electrons move from a negatively charged object to a positively charged object. Typically, this

balances the charge in both objects so that they return to neutral. Examples of static discharge include lightning and the shock you sometimes feel when you touch another object. Dear trainee, in the upcoming session, we will focus on the key aspects of discharging and explore effective methods to educate your students on this subject matter.

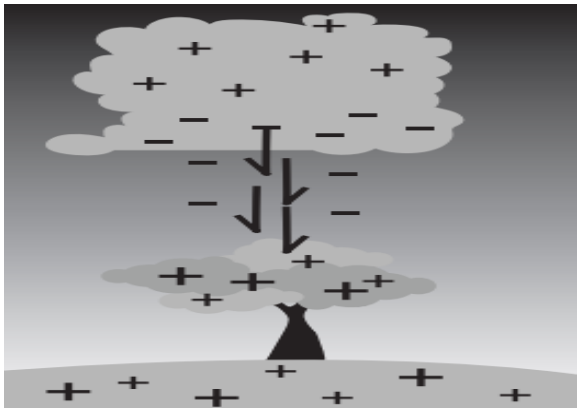
Activity 1

- How have you been teaching the concepts of discharging a body? Please share with your friends.
- What Causes Lightning and Thunder?
- What misconceptions did you identified when you teach lightening?

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. The following activities will help you to understand more about lightening.

Activity 2

Now please write and draw the following onto the paper



Answer the questions based on the diagram:

Task 1

1. What force causes the formation of the electrostatically charged particles shown?
2. Explain the formation of the positive and negative charges in the diagram.
3. Name two possible consequences of the build-up of electrostatically charged particles, as shown in the diagram.

Task 2

4. Write a paragraph in which you describe the formation of lightning from the time a cloud has formed to the time the lightning strikes.

Now please share what you understand about the lightening from the paragraph that you write after you see the diagram.

Activity 2

Discuss the following in groups

- In your community, what did people do when they encountered a person struck by lightning?
- List two safety precautions you could take to protect yourself against lightning.

Assessment

a) What force causes the build-up of electrically charged particles in a cloud?
b) What charge (positive or negative) builds up at the bottom of a cloud
c) What is the correct scientific term for the discharge of an electrostatic charge between clouds, or between a cloud and the Earth's surface?
d) You have learned about three field forces.
e) Which of these forces is constantly exerting a force on us?

Key ideas

- Lightning is an example of the effects of electric charge on a very large scale.
- Clouds are made up of water molecules, ice and air. The movement of the water, ice and air particles as they rub against each other causes friction.
- You know that friction can cause particles to become positively or negatively charged.
- The positive charges build up at the top of the cloud and the negative charges build up at the bottom of the cloud.
- When the electrostatic charge becomes high enough, it discharges in the form of a lightning bond.
- Lightning can occur within a cloud (between the top and bottom of the cloud), between clouds, and between a cloud and the ground.
- Lightning causes thunder. A lightning bolt opens up a channel in the air. Once the light is gone, the air expands into the channel and creates a sound wave that we hear as thunder. We see lightning before we hear thunder. This is because light travels faster than sound.

- Safety precautions against thunder include: installing a lightning conductor; seeking shelter in a car or building; staying away from water and tall trees and structures; avoiding swimming, showering and bathing; avoiding using appliances that conduct electricity.

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios like the one we used in Activity 2 so as to make the teaching and learning process more attractive and also understand the topic.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway Resources

In addition, further reading, listening or viewing activities related to this sub-topic are available
through the following web links:

- http://environment.nationalgeographic.com/environment/natural-disasters/lightning safety-tips/ [Lightning Safety Tips]
- http://www.weatherwizkids.com/weather-lightning.htm [Lightning]

8.2 Coulomb's law of electrostatics (1 hr.)

By the end of this section, trainees will be able to

- ✓ devise activities and strategies that helps them to teach the concepts of Coulomb's law.
- ✓ Apply the expressions to solve problems involving Coulomb's law.

Dear trainees, this session explains and illustrates Coulomb's law of electrostatics in a systematic manner. Step-by-step activities are provided to make the teaching methodology that you have to follow to teach your students in the class room. In this session, you will find the activities that you will use to teach this lesson with your friends along with the key ideas that contain the main ideas.

Activity 1

- How have you been teaching the concepts of basic laws of electrostatics? Please share with your friends.
- What misconceptions did you identified when you teach Coulomb's law?

The study of properties of charges at rest is known as electrostatics. Various misconceptions have been mentioned in different literatures regarding this concept. Engaging in the following activities will aid in gaining a better understanding of these misconceptions

Activity 2

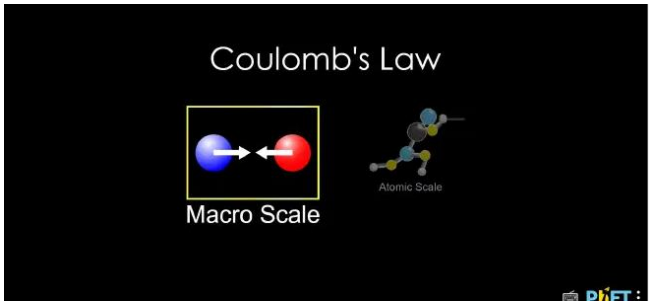
- What is the nature of electrostatic forces between two similar and opposite charges?
- What are factors that affect the magnitude of the forces?
- What motivates coulomb's to discover this law?

The truth about Coulomb's law is that it describes the force between two charged particles, which is proportional to the product of the charges and inversely proportional to the square of the distance between them. The following activities will help you to understand more about the misconceptions. In order to help you understand this concepts better let us do the following simulation.

Activity 3

By clicking the link blew follow the steps and do the simulation and answer the following questions

https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html



By changing the magnitudes of the charges, signs of the charges and distance between the charges, investigate the electrostatic force between the charges.

Assessment

- What happens to the magnitude of the force as the distance between the charges is doubled?
- What happens to the electrostatics force when the magnitude of the same charges doubled?

Key Ideas

- Coulomb's law states that the magnitude of the electrostatic force of attraction or repulsion between two electrically charged bodies is directly proportional to the product of the charge of the charred bodies and inversely proportional to the square of the distance between the centers of the charred bodies.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://youtu.be/NXMgvrS8Gr8
    - https://www.lehman.edu/faculty/anchordoqui/guide02.pdf
    - https://openstax.org/books/physics/pages/18-2-coulombs-law
    - https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html
    - https://www.physicsclassroom.com/Physics-Video-Tutorial/Static-Electricity/Coulombs-Law/Video
    - http://www.compadre.org/OSP/items/detail.cfm?ID=9683

8.3 The electric field (2 hr)

At the end of this lesson, trainees will be able to:

- Devise activities and strategies that help them to teach the concepts of electric field.
- distinguish the elements that determine the strength of the electric field at a given location;
- Calculate the strength of an electric field at specific location

The "electric field" is a vector field. When acting on a charge, you get a force. For example, an electric field acting on an electron produces the force which is directed in the opposite direction as the field vector, because the electron is negatively charged. Dear trainees, in this session we will discuss about the concept of electric field by stating what you know about it before we go to discuss about electric field in key ideas. The lesson contains the step by step activities, key ideas and takes away resources that you read more about electric field.

Activity 1

- How have you been teaching the concepts of electric fields? Please share with your friends.
- When do we say that there is a field produced by a body around it?
- What misconceptions did you identified when you teach about electric field?

Field is nothing but an area around an object in which when another object is placed is going to have some physical effect on its state, momentum and energy. An electric charge is said to be producing electric field because it is due the electric properties of it. Any change in that property will bring same type of effect on another body. Sometimes "Why?" thing is senseless in physics. But that doesn't mean that we shouldn't question at all. It is a fundamental property that nature or god has given to it. The following activities and sections will help you to understand more on electric fields.

Activity 2

- What happens to a very small mass positive test charge placed around point charge?
- Try to draw the direction of force experienced from positive and negative point charge on test charge?

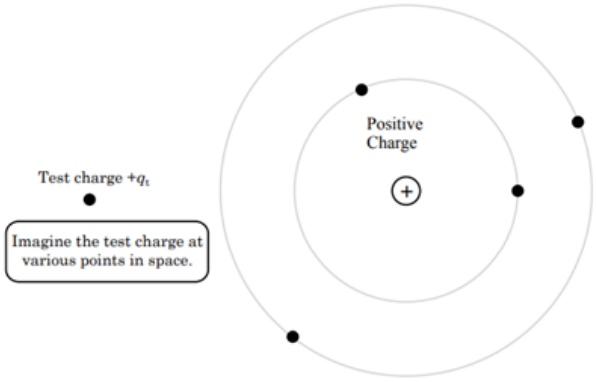
Activity 3

To investigate the vector nature of an electric field, you have to do an experiment using a PhET simulation called Charges and Fields. It can be found at:

http://phet.colorado.edu/simulations/sims.php?sim=Charges_and_Fields

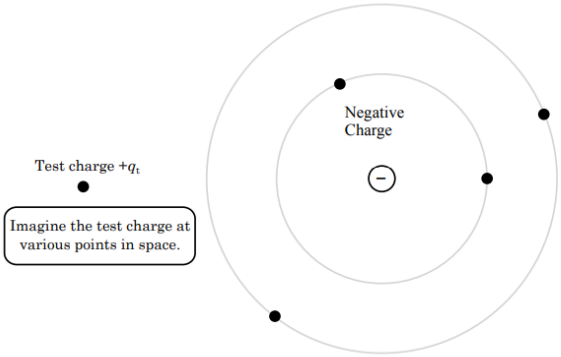
Activity 4

Electric Field Vectors from a Positive Charge Make a qualitative sketch of some electric field vectors around a positive charge. To do so, run the PhET Charges and Fields simulation and place E-Field sensors around a positive point charge at locations corresponding to the black dots shown in the diagram below. The length of each vector roughly indicates the relative magnitude of the field (i.e. if the E-field is stronger at one point than another, its vector will be longer). The direction of the vector indicates the direction of the field at that point in space.



Activity 5

Electric Field from a Negatively Charged Rod Make a qualitative sketch of some electric field vectors around a negative charge. To do so, run the PhET Charges and Fields simulation and place E-Field sensors around a negative point charge at locations corresponding to the black dots shown in the diagram below. The length of each vector roughly indicates the relative magnitude of the field (i.e. if the E-field is stronger at one point than another, its vector will be longer). The direction of the vector indicates the direction of the field at that point in space.

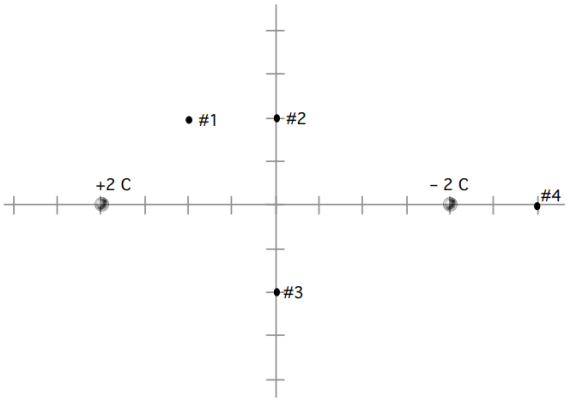


Assessment

i. Use a spreadsheet to calculate the magnitude of the electric field (in N/C) at distances of 0.5, 1.0, 1.5, ... , 10.0 cm. from a point charge of 2.0 C. Be careful to use the correct units (i.e., convert the distance to meters before doing the calculation). Save your file for later reference.

ii. The graph below shows two point particles with charges of +2C and –2C that are separated by a distance of 8.0 cm. Use the principle of linearity to draw the vector

contribution of each of the point charges to the electric field at each of the four points in space shown below. Use your spreadsheet results and a scale in which the vector is 1 cm long for each electric field magnitude of 1.0 × 1013 N/C. Then use the principle of superposition and the rules of vector addition to draw the resultant € r E vector at each point. You do not need to find the vector components. A drawing of the vector addition at each location is sufficient.



Key Ideas

An electric field is a region around an electrically charged object where another charged object experiences a force. It is created by electric charges and can be either positive or negative. The strength of the electric field is determined by the amount of charge creating the field and the distance from the charged object. The direction of the electric field is the direction a positive charge would move if placed in the field. Electric fields play a crucial role in the behavior of electrically charged particles and are fundamental to understanding electricity and magnetism.

Implications to teaching

- ❖ Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- ❖ Have you been inspired to use such kinds of teaching methods in your own lesson?
- ❖ What new things have you learnt from this lesson?

Takeaway resources

- https://phet.colorado.edu/en/simulations/charges-and-fields
- https://www.sfu.ca/phys/141/ActivityGuide/old/Unit19_old.pdf
- Grade 10 text book

8.4 Potential difference (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concept of electric potential.
- recognize some of the innovative approaches used to teach the concepts of potential difference,
- Realize the real life applications of potential difference,
- Appreciate the applications of potential difference in their daily life.

This session focuses on the how to teach the concept of potential difference.

Activity 1

- How have you been teaching the concepts of electric potential? Please share with your friends.
- What makes electric charges to flow in a circuit? In pairs, discuss and share us your response.
- What are the main misconceptions encountered you when you teach about electric potential.

Electric potential is actually defined as the work done to bring a unit positive charge from infinite distance to a specific point in the electric field where the potential had to be measured. It is a quantity describing the energy required for the charge to move to that point where the potential has to be measured and the charge from where it moves from is assumed to be 0 volts. Now do the following activity so as to help you understand the concept of potential difference better.

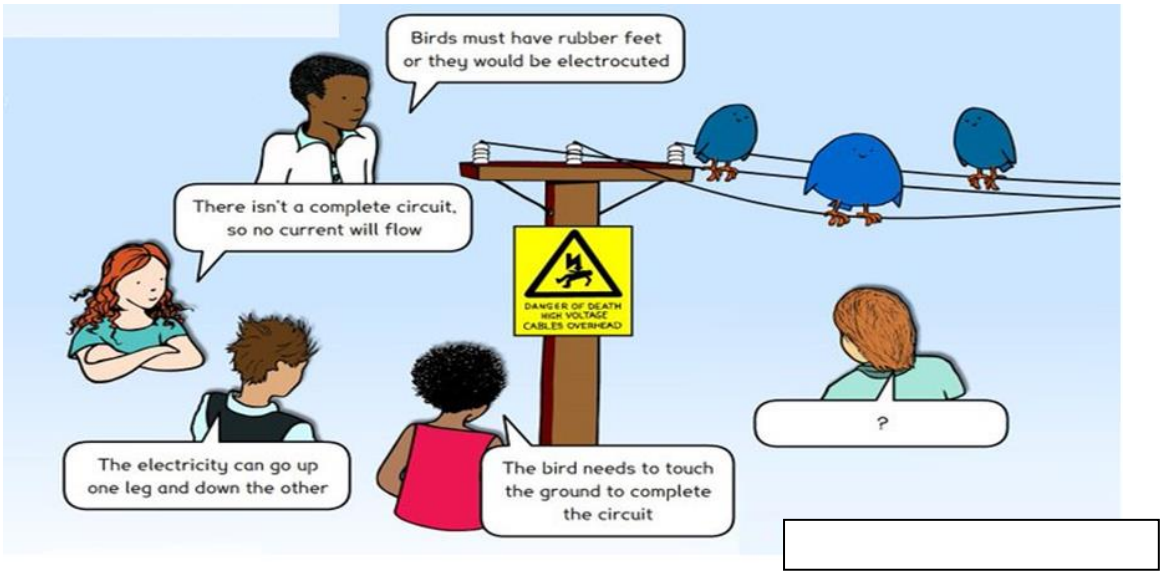
Activity 2

You might have seen birds sitting and even running along electric line wires high in the air. There are times when these wires can be filled with dozens of birds.

- How can birds sit on those wires in Figure and not get an electric shock? Discuss in pairs and tell your response to your instructor.

Please justify your answer. ……

You can record your trainee's response in the form of concept cartoon like the one shown below.



- The most common wrong answer to that question is that "_____." Okay, what is
  your answer? Now, let's read the following text.

Let's see if your answer is correct

Since birds are not good conductors, that is one reason they don't get shocked when they sit on electrical wires. The energy bypasses the birds and keeps flowing along the wire instead.

There is another reason why birds can sit on a wire without getting shocked. There is no voltage difference on a single wire. There must be a difference in electrical potential for electrons to move. For example, energy flows from areas of high voltage to areas of low voltage. If it flows

through a single power line at 35,000 volts, it will continue along the path of least resistance. That means it will bypass birds because there is no difference in electrical potential.

It would be a different story if a bird is connected to the ground through some means (like a tree) while sitting on the wire. That would cause it to get shocked. This would also happen if a bird touched another wire with a different voltage. In these cases, the bird's body would become a path for electricity. It would move through the bird to reach either the ground or another place with a different voltage. This is why power lines tend to be high in the air with plenty of space between the wires.

Did you change your mind after reading the text? If you did, explain your views again in the light of the text and give relevant examples.

……

……

Assessment

- What is a potential difference?
- Why is the bird not caught when sitting in an electric wire? etc
- Suppose a parachutist lands on a high-voltage wire and grabs the wire in preparation to be rescued. Will the parachutist be electrocuted? If the wire breaks, why should the parachutist let go of the wire as it falls to the ground?
- How much work is done in moving a charge of 2 *C* across two points having a potential difference 12 *V*? Give a meaning for your response.

Key Ideas

Charges do not flow in a copper wire by themselves, just as water in a perfectly horizontal tube does not flow. A battery supplies energy to an electric circuit by converting chemical energy to electric potential energy. The chemical action within a cell generates the potential difference across the terminals of the cell, even when no current is drawn from it. When the cell is connected to a conducting circuit element, the potential difference sets the charges in motion in the conductor and produces an electric current.

The electric potential difference (*V*) between two points in an electric circuit carrying some current is defined as the work done to move a unit charge from one point to the other.

$$V = \frac{\text{Work done (W)}}{\text{Charge (Q)}} = \frac{W}{Q}$$

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios like the one we used in Activity 2 so as to make the teaching and learning process more attractive and also understand the topic.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- To know more about potential difference, read the following material. https://www.physicsclassroom.com/class/circuits/Lesson-1/Electric-Potential-Difference
- Perform PHET experiment simulation so as to understand the concept of potential difference in a better way.

8.5 Current, Voltage and Ohm's law (1 hr)

At the end of this lesson, trainees will be able to:

- ✓ devise activities and strategies to help your trainees learn the concepts related to Ohms law
- ✓ Show how the ammeters and Voltmeters connected in circuit element.

Dear trainees this session focuses on the Current, Voltage and Ohms law to teach our trainees in more systematic way. The session incorporates activities before key idea introduction and key ideas on the topic and finally the resources to be read by trainees.

Activity 1

- How have you been teaching the concepts of Ohm's law? Please share with your friends.
- What misconceptions did you identified when you teach Ohms law?

The following article reading activity will help you to correct the misconception seen from the students.

Activity 2

- **Dear trainee for the Ohm's law misconception read the article with title "**OHM'S LAW: MISCONCEPTIONS OF THE STUDENTS AT SECONDARY AND SENIOR SECONDARY LEVEL" or https://www.ijeast.com/papers/88-91,Tesma512,IJEAST.pdf and ?" Student conception of Ohm's law" you can get the basic concept.

Activity 3

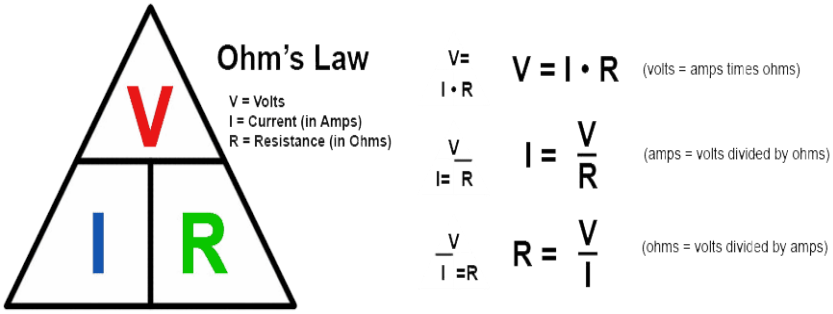
- **Please do the following virtual experiment individually. The link is found below**

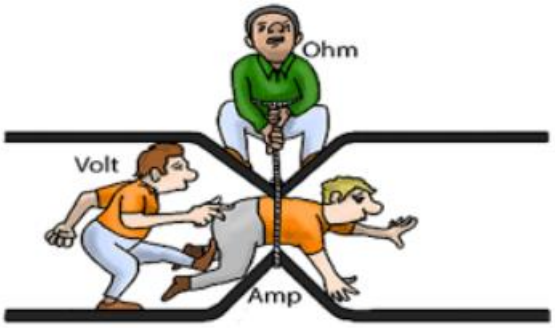
➢ PhET interactive simulation tool (Circuit Construction Kit: DC - Virtual Lab) https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab

- For guidance on how to use the simulation, tool, see PhET Simulation Tool Instructions for Electric Circuits Labs.

Key Ideas

Ohm's law relates the three basic parameters of electricity – Current, voltage and resistance and this formulation may result in several other formulation and basic concepts of like conductance, resistance, current density, relaxation time etc. The basic statement of ohm's law is "Potential difference (V) is directly proportional to the magnitude of flow of current (I), provided the physical conditions remains constant". Mathematically expressed by





Assessment

1. The IR drop across a resistor means that there is a change in potential or voltage across the resistor. Is there any change in current as it passes through a resistor? Explain.
2. How is the IR drop in a resistor similar to the pressure drop in a fluid flowing through a pipe?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://phet.colorado.edu/sims/html/ohms-law/latest/ohms-law_en.html
- https://www.scribd.com/document/641074091/Experiment-6-Ohms-Law-Using-PhET-simulation
- https://www.fluke.com/en-us/learn/blog/insulation-testers/troubleshoot-failed-motors-with-insulation-resistance-testing
- Grade 10 Text book

8.6 Voltmeter and ammeter connection in a circuit (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concepts related to electrical quantities measuring devices.
- Reason out the why the Ammeters connected in series and Voltmeters connected in parallel to circuit element .
- Show how voltmeter and ammeter used to measure the voltage and current in an electric circuit, respectively;

Dear trainee this session focuses on the measuring instruments Ammeter and Voltmeter to measure quantities like current and voltage respectively. The lesson proposed to teach our trainees in simple way in order to understand the Ammeter and Voltmeter. The session contains key ideas and activities to be done by trainees in order to understand the lesson. Finally the resources are cited.

Activity 1

- How have you been teaching the concepts of Devices like Ammeter and voltmeter? Please share with your friends.
- Why ammeter connected in series and voltmeter connected in parallel?

Here, in order to know why ammeter connected in series and voltmeter connected in parallel; we need to know the basics of short circuit & open circuit. The following activity is hopefully help you to understand about the Ammeter and Voltmeter.

Activity 2

- How do we connect the ammeter and voltmeter in an electrical circuit? Draw a circuit diagram in order to justify your answer. What will be happening if the positions of these instruments are interchanged? Specify the reasons

Activity 3

Please do the following virtual lab work found d in the following link and do the in activity 3

✓ https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html

Assessment

- Simple circuit Let's start with a simple circuit - a 10v battery is connected to a resistor (10 Ω) through a switch. A voltmeter can be used to measure the voltage across any component in the circuit as shown. (Tap the battery to edit voltage.)

Table 1: Voltage and Current for a given resistor

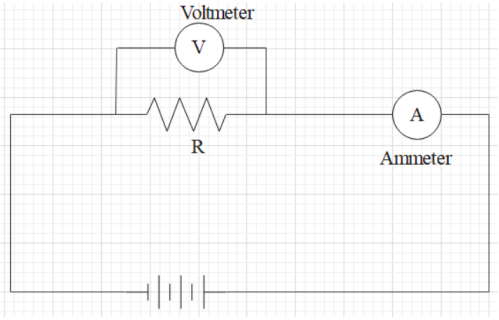
Voltage	Current
10 V	
15 V	
20 V	
25 V	
30 V	

Analysis: Use Excel to create a graph of voltage vs. current. Afterward, add a linear trend line and be sure to display the fit equation on the graph. Then, use the fit parameters to determine an experimental value for the resistance of the resistor

Key Ideas

- A voltmeter has been defined as a device used for measuring the electrical potential difference between the two points in an electric circuit. An ammeter has been a measuring instrument which will be useful for measuring the electric current in a circuit. An

ammeter will be always connected in series as it has a low resistance and the Voltmeter will be always connected in parallel because it will be having a high resistance. On interchanging their position, An ammeter is usually connected in parallel. Since it will be having a very low resistance, most of the current will be flowing through it and will be resulting in a short circuit and can also damage the circuit. Now, if the Voltmeter has been connected in series as it will be having a high resistance no current will flow through it, and the voltage indicated will be zero.



Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://phet.colorado.edu/en/simulations/circuit-construction-kit-dc
- https://www.cliffsnotes.com/study-notes/4634816

8.7 Electric projects (2 hr)

By the end of the lesson, learners will be able to:

- devise activities and strategies to help your trainees learn the concepts related to combination of resistors.
- Explain that the lighting system in homes is usually connected in parallel
- Explain that resistors are designed to have accurate resistance to control the current strength.

In order for the trainees to perform the electric project works, it is good to remind them what they already learnt about series circuits. To do this you can ask different questions that can help

them to recall the concepts that they learnt before. In addition to this, you can also ask your trainees to tell you a project that they have undertaken, if any.

Activity 1

- How have you been teaching the concepts of combination of resistors and their benefits? Please share with your friends.
- What are the misconceptions associated when you teach combination of resistors.

Dear trainees the following activity will help you to teach about the electric project. So first try by yourself.

Activity 2

1. Explain Task 1 to the learners as follows:

a) Work with the person sitting next to you.

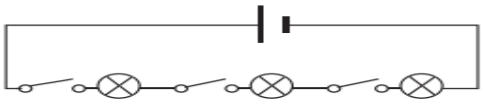
2. Give learners some time to complete Task 1 in their workbooks.
3. Ask learners to share their answers to Task 1 with the class.
4. Write the answers on the chalkboard.
5. *Model answer: Task 1*
6. Next, get the learners to do Task 2.
7. Explain Task 2 to the learners as follows:
   a) Work on your own.
   b) Answer the questions in Task 2.
8. Give learners some time to do Task 2.
9. Ask learners to share their answers to Task 2 with the class.
10. Discuss the answers with the learners.
11. *Model answer: Task 2*
12. When the learners have completed Task 2, hold a short class discussion to revise the following:
    a) Resistors can control the voltage and current in parallel and series circuits.
    b) For two circuits that have the same total voltage, the circuit with the lower resistance will have a higher current and the circuit with the higher resistance will have the lower current.
    c) The lighting system in our homes is usually connected in parallel.

Activity 3

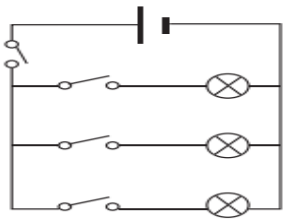
1. Write the following onto the chalkboard

Abeba is building her house and decided to draw a plan (diagram 1) of how she is going to wire the lights in her house. Her friend, Chaltu told Abeba that it is not a good idea to wire her lights in that way. Chaltu told Abeba to redraw her plan (diagram 2)

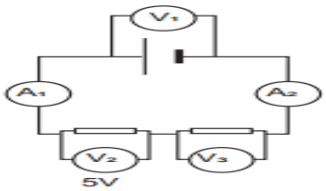
Circuit Diagram 1



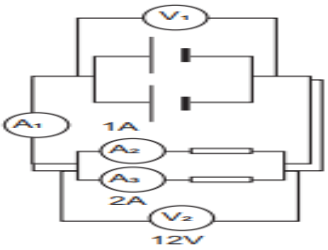
Circuit Diagram 2



Circuit Diagram 3



Circuit Diagram 4



TASK 1

1. Look at circuit diagrams 1 and 2 and copy them into your workbooks.
2. Do you agree with Chaltu telling Abeba to change her plans? Explain.

TASK 2

1. Look at circuit diagram 3 and copy it into your workbooks.
   a) What is the voltage reading on voltmeter V_3?
   b) What is the ammeter reading on ammeter A_2?
2. Look at circuit diagram 4 and copy it into your workbooks.
   a) What is the voltage reading on voltmeter V1?
   b) What is the ammeter reading on ammeter A1?

Watch the following you tube and Phet simulation to understand more on parallel and series combination of lamps.

Activity 4

Watch the following you tube and write briefly what you understand from the lesson

https://www.youtube.com/watch?v=z4ggGPQbArI

Key ideas

- Resistors can control the voltage and current in parallel and series circuits.
- Resistors are designed to have accurate resistances in order to control the current through the electrical system. For example, for two circuits that have the same total voltage, the circuit with the lower resistance will have a higher current and the circuit with the higher resistance will have the lower current.
- Electric circuits are used for the wiring in our homes, cars and even in toys.
- The lighting system in our homes is usually connected in parallel.
- If one light bulb **fuses** (the filament breaks), the rest of the lights will stay on, because they are each connected to the mains circuit by their own parallel path

Assessment

a) Compare and contrast series and parallel circuits
b) If two circuits each have a voltage of 4 volts, but the one circuit has a resistance of 3 Ω and the other has a resistance of 6 Ω, which circuit will have the lower current?
c) Which circuit is suitable for electric wiring in a house?
d) When 3 bulbs are connected in parallel if one bulb goes out what will happen to the remaining bulbs?
e) Light Bulbs in Series and in Parallel. Two light bulbs have constant resistances of 400Ω and 800Ω. The two light bulbs are connected in series across a 120-V line. Afterwards, the two light bulbs are connected in parallel across the 120-V line. In each situation, which of the two bulbs glows the brightest?

Implications to teaching

- Literature support the importance of practice based teaching so as to make the teaching and learning process more attractive and also understand the topic.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson? Allow trainees to describe verbally what they have understood from this simple electrical project.

Takeaway Resources

In addition, further reading, listening or viewing activities related to this sub-topic are available
through the following web links:

- https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc [Phet simulation: Circuit Construction Kit]
- https://www.youtube.com/watch?v=O8GgRIIB1Yc (5min 46sec) [Series vs parallel circuits]
- https://www.youtube.com/watch?v=Az7VRuTA8dQ (4min 23sec) [GCSE Physics Revision Current in Parallel circuits]
- https://www.youtube.com/watch?v=x2EuYqj_0Uk (8min 04sec) [Series and parallel circuits]

8.8 Magnetic field (1 hr)

At the end of this lesson the trainee will be able to

- devise activities and strategies to help your trainees learn the concepts related to magnetic field
- Reason out the why the direction of the compass always points north
- Explain the significance of the directions of magnetic field lines.
- Draw the shape of magnetic field lines around a permanent magnet

In this session we will learn how we teach the concept of magnetic field in the class room. The session includes the session objectives, the basic activities, and key ideas about the magnetic field and takes away resources.

Activity 1

- How have you been teaching the concepts of magnetic fields and share it with your friends
- What are the misconceptions associated when you teach magnetic fields.

The magnetic field is a region around a magnetic material or a moving electric charge within which the force of magnetism acts. A magnetic field is a force field that is created by moving electric charges and magnetic dipoles and exerts a force on other nearby moving charges and magnetic dipoles. The following activity will help you to understand more on the topic.

Activity 2

Magnetic Race: dear trainees please perform the following activity. A magnet, a paperclip, a short piece of string or thread, and a piece of cardboard will be needed by each team**.**

- During this activity, the teacher explains and demonstrates the steps. As a first step, trainees attach a paperclip to one end of the string and the other end of the string to a piece of cardboard, creating a vertical pendulum.
- The magnet should be placed under the pendulum without touching it. The goal is to make the paperclip "race" up and down the string without touching the magnet or the cardboard**.**
- Trainees will manipulate a magnet to achieve this objective, and the team with the fastest swinging paperclip wins.
- Trainees will manipulate a magnet to achieve this objective, and the team with the fastest swinging paperclip wins.

Activity 3

Tracing Magnetic Fields: This activity will allow the trainees to essentially "see" the otherwise invisible magnetic fields. Distribute bar magnets, sketch paper, and iron filings amongst the groups.

- Following the teacher's example, the trainees will place a bar magnet underneath a piece of sketch paper and lightly sprinkle iron filings on top.
- As the iron filings align themselves along the magnetic field lines surrounding the magnet, the trainees would use a pencil to trace these lines on the paper.
- By this, trainees can visualize the magnetic field lines and how they propagate from one pole of the magnet to the other.
- The teacher will then discuss with the trainees about their observations, thoroughly explaining the concept of how magnetic fields emanate from north to south.

Activity 4

Magnetic Levitation: This activity will develop the appreciation of trainees regarding the forces exerted by magnetic fields. Each group will need two magnets and a wooden dowel stand.

- The teacher instructs the trainees to mount one magnet to the top of the dowel stand with its north pole facing up and another magnet suspended (using thread) below it with its north pole facing down.
- The trainees will observe the second magnet levitating due to the repulsion between the like poles of the two magnets.

- This simple demonstration showcases the counter-intuitive nature of magnetic forces and feeds curiosity. A discussion can stem from this observation about the 'invisible force' the magnets exert on each other.

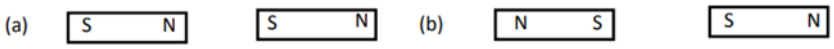
Finally, to conclude the development stage, the teacher will involve trainees in a class-wide discussion about their experiences during the activities, encouraging them to express their observations and understandings concerning magnetic fields. This will solidify their learning and allow the teacher to correct any misconceptions promptly.

Key Ideas

- Magnetic Field is the region around a magnetic material or a moving electric charge within which the force of magnetism acts. A pictorial representation of the magnetic field which describes how a magnetic force is distributed within and around a magnetic material

Assessment

1. What sort of materials when placed in a magnetic field will experience a force?
2. Draw the magnetic field patterns of the magnets shown below.



Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios like the one we used in Activity 2 so as to make the teaching and learning process more attractive and also understand the topic.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://phet.colorado.edu/sims/cheerpj/faraday/latest/faraday.html?simulation=magnets-and-electromagnets
- https://youtu.be/Va_-bNEuz84

8.9 The Earth's magnetic field and the compass (1 hr)

After this lesson, the trainee should be able to:

- devise activities and strategies to help your trainees learn the concepts related to earth’s magnet
- Explain the significance of the directions of magnetic field lines.
- Draw the shape of magnetic field lines around a permanent magnet.

In this session the trainees use a compass to visualize the magnetic field of a strong permanent magnet. The lesson begins with an analogy to a compass and the Earth's magnetic field. Since the Earth's magnetic field is the closest and strongest, the compass responds to the magnetic field of the permanent magnets, allowing trainees to map the field of that magnet in the activity.

Activity 1

- How have you been teaching the concepts of magnetic fields and share it with your friends
- What are the misconceptions associated when you teach magnetic fields.
- How can you find your way?
- Why does Earth have a magnetic field?
- Why is it important for earth to have a magnetic field.
- Why magnetic compass points to the geographic north pole ?

Compass needles line up with magnetic fields. Since Earth is a magnet, a compass will normally line up with Earth's magnetic field. Because opposite magnetic poles attract, the magnetic north pole of the compass points toward the magnetic south pole of the Earth. The following activity will help you to understand more about earth’s magnet.

Activity 2

To explore a scale model of the Earth's magnetic field. Pupils can see how a compass reacts to this field.

What to Prepare

- A small bar magnet, embedded in the middle of a foam Earth, about 15 centimeters in diameter (the magnet is placed down a hole made radially through Hudson's Bay in Canada. The south pole should be pointing towards Hudson's Bay)
- A small gim balled bar magnet, free to spin in all 3 planes (a probe)
- A bar magnet, for comparison with the model Earth

What Happens During this Activity?

Pupils explore the magnetic field, which is just like that of the Earth.

Particular points to look out for:

- The probe mostly points towards or away from the Earth, not aligned with the surface.
- The field is very like that of a bar magnet.
- The magnetic north pole and geographical North Pole are not in the same place.
- The magnetic south pole and geographical South Pole are not in the same place.
- There is a band around the Earth where the compass lies parallel to the surface: the magnetic equator.
- The effect of the field on the probe gets much weaker quite quickly as the probe moves further from the model Earth.

You might like to make the point that all this pointing up and down leads to hill-walking compasses having to be made for the Northern or Southern Hemispheres. If you take one from the UK to New Zealand, it does not work, bashing one end of the needle against the lid of the case.

Activity 3

- Open this link and answer the following assessment questions
  https://youtu.be/AW53ZP1Ry5M

Key Ideas

- A magnetic compass works because the Earth is like a very big magnet and surrounded by a huge magnetic field. The Earth has two magnetic poles near the North and South poles. This magnetic field of the Earth causes a magnetized 'needle' of iron or steel to swing freely into a north-south position.

Assessment

1. What generates Earth's magnetic field? Why is the magnetic field important?
2. What is a magnetic field flip? Roughly how often does it happen?
3. Why do scientists interested in Earth's magnetic field collect cores from rocks at the Mid-Atlantic Ridge?
4. When was the last major magnetic field flip?
5. How does ancient pottery give scientists clues about Earth's magnetic field? Why is it more precise than rocks?

6. When Earth's magnetic field strength was high and when was it lower (note that BCE means before current era and years correlate with the BC and AD system)?
7. What has happened to magnetic north since it was first located in the early 19th century? How has the field changed in the past two centuries?

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://youtu.be/Elv3WpL32UE
- https://youtu.be/AW53ZP1Ry5M
- https://phet.colorado.edu/en/simulations/magnet-and-compass
- https://youtu.be/ofRT0t9b0sg
- https://youtu.be/v3Yhf2Vy_M8

8.10 Magnetic field of a current-carrying conductor (1 hr)

At the end of the lesson the trainee will be able to

- devise activities and strategies to help your trainees learn the concepts related to magnetic field of a current- carrying conductor
- Differentiate the bar magnet and electromagnet
- List the characteristics of magnetic fields around the electromagnet

The main focus of this session will be on how magnetic fields are produced around current carrying conductors and how we can deliver this concept to trainees. The session contains activities to be completed prior to the key idea by trainees, as well as take-home resources to help trainees understand the lesson better.

Activity 1

- How have you been teaching the concepts of magnetic field around a current carrying conductor and share it with your friends
- What are the misconceptions associated when you teach magnetic fields generated from current carrying conductor

The Oersted experiment involves placing a compass needle close to a conduct carrying current. When the switch is closed, the magnetic needle deflects indicating the presence of a magnetic field around a conductor carrying current

Activity 2

Now please take a time and watch the following you tube and write briefly about what you observe and relate it what you know before**.**

https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1

Activity 3.

- Describe the activity that shows that a current-carrying conductor experiences a force perpendicular to its length and the external magnetic field. How does Fleming's left-hand rule help us to find the direction of the force acting on the current-carrying conductor?

Key Ideas

- The magnetic field produced due to a current-carrying conductor has the following characteristics: It encircles the conductor. It lies in a plane perpendicular to the conductor. Reversal in the current flow direction reverses the field's direction.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://youtu.be/S_rIy-qoofg
- https://phet.colorado.edu/en/simulations/magnets-and-electromagnets
- https://www.nagwa.com/en/playlists/135120823101/
- https://youtu.be/te8MO8jVh5k

8.11 Magnetic force on a current-carrying wire (2 hr)

At the end of this session the trainee will be able to

- devise activities and strategies to help your trainees learn the concepts related to magnetic force on a current- carrying conductor

- state the relationship between magnetic force, current and magnetic field;
- determine the direction in which a current carrying wire experiences a force in an external magnetic field
- Describe the effects of a magnetic force on a current-carrying conductor.
- Calculate the magnetic force on a current-carrying conductor.

In this lesson, trainees will learn about the magnetic force exerted on current carrying conductors due to the external magnetic field based on how the lesson is presented to them. During the session, trainees will be guided through a series of step-by-step activities and questions to help them understand key ideas. As a final step, trainees should take notes and view videos and simulations related to force on current carrying conductors from the resources they took away.

Activity 1

- How have you been teaching the concepts of magnetic force on a current carrying conductor and share it with your friends
- What are the misconceptions associated when you teach magnetic force on a current carrying conductor.

The magnetic force on a current-carrying conductor is the force experienced by the conductor when it is placed in a magnetic field. When a current flows through a conductor, it creates a magnetic field around the conductor. If this conductor is placed in an external magnetic field, the interaction between the two magnetic fields results in a force on the conductor. This phenomenon is described by the right-hand rule for the direction of the force. The magnitude and direction of the force depend on the strength and orientation of the magnetic field, the current in the conductor, and the length of the conductor in the magnetic field. If you use the following activity in your lab for your students they can simply understand how magnetic force is experienced on a current carrying conductor.

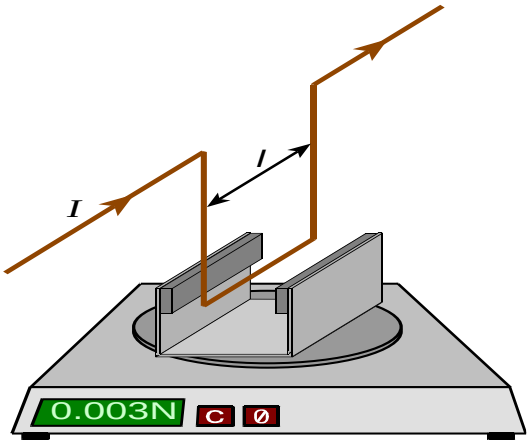
Activity 2

Here you measure the force on a current-carrying wire placed in a uniform magnetic field. This is the origin of the ‘motor force’.

You will need:

- Two mild steel yokes ,four slab magnets ,rheostat rated at least at 4 A, 6 A is better, digital millimeter, used as an ammeter ,power supply, 0–12 V ,leads, 4 mm; three are required, two need to be at least 0.5 m long ,mass balance, electronic, 0–2 kg, ± 10 mg

,two retort stands with boss and clamp, metre rule (used for holding wire in position) and shaped bare wire, six samples.



The ‘top pan balance’ is a straightforward way of investigating the factors affecting the force on a wire carrying a current in a magnetic field. The ‘wire’ is clamped so that it remains stationary and the balance measures the ‘change in weight’ of the Magnadur magnets placed on its pan.

The balance will probably be calibrated in grams and milligrams. One gram is equivalent to a weight of 0.0098 N (0.01 N will probably be accurate enough). The balance should also be capable of being ‘tared’ or zeroed with the magnets in place, so that when there is no force the reading is zero.

a. A single straight wire, connected to a dc power supply in series with an ammeter and rheostat, is taped to a meter rule and clamped horizontally at right angles to the field. Vary the current gradually up to about 5 or 6 A. (This will depend on your power supply.)
b. How does the force on the wire (or the change in weight of the magnets) depend on the current in the wire?
c. Plot a graph of force against the current in the wire.
d. To investigate how the length of wire in the field affects the force, the single wire can be replaced by wires of different length. These wires have been shaped so that a short horizontal section can be placed in the field. Investigate how changing the length affects the force on the wire. Make sure that the current is the same each time.
e. There are forces acting on the vertical sections of the wire. Why don’t these affect the reading on the balance?
f. Plot a graph of force against the length of the wire in the field.

If magnets of different strength are available, you should be able to determine how the force depends on the magnetic field strength, although a quantitative relationship may be very difficult to establish.

Outcomes

- The two graphs should show that the force is proportional both to the current in the wire and to the length of wire in the field.
- The force is also proportional to the magnetic field strength, although without Measurement you may not be convinced.

Activity 3

- Please investigate how electromagnetism can be used to communicate in the simulation below. Prompt trainees to work in pairs and create a list of observations regarding the simulation. Then, discuss these observations as a class.
- Be sure to highlight the following Big Idea in your class discussion:
  - ✓ A current-carrying wire experiences a magnetic force from a magnetic field.
  - ✓ The magnetic force on a current-carrying wire is used in a telegraph to transmit information through the Morse code.

  https://www.ck12.org/tebook/ck-12-physics-intermediate-teachers-edition/section/18.2/

Activity 4

- Discuss how you can teach your students to identify the direction of magnetic force on a current carrying conductor.

Key Ideas

A current-carrying wire in a magnetic field experiences a force that is usually referred to as a magnetic force. The magnitude and direction of this force depend on four variables: the current (I); the length of the wire (L); the magnetic field (B); and the angle between the field and the wire (θ). This magnetic force can be described mathematically by the vector cross product: $F_m = IL \times B$, or in scalar terms, $F_m = ILB \sin \theta$. In this experiment you will vary three of the variables in the equation the current, the length of the wire and the strength of the magnetic field – and measure the resulting magnetic force. By adding the Current Balance Accessory, you will also vary the angle between the wire and the magnetic field, thereby performing a complete investigation into the interaction between a current-carrying wire and a magnetic field.

Implications to teaching

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Have you been inspired to use such kinds of teaching methods in your own lesson?
- What new things have you learnt from this lesson?

Takeaway resources

- https://youtu.be/G86GPiNwkbo
    - https://phet.colorado.edu/sims/cheerpj/faraday/latest/faraday.html?simulation=generator
    - https://www.ck12.org/tebook/ck-12-physics-intermediate-teachers-edition/section/18.2/
    - https://youtu.be/2nAoOdYF4j4
    - https://spark.iop.org/force-wire-carrying-current-magnetic-field

8.12 Electromagnetic induction (2 hrs)

At the end of the lesson the trainees will be able to

- devise activities and strategies to help your trainees learn the concepts related to electromagnetic induction
- state the relationship between magnetic force, current and magnetic field;
- State Faraday's law of electromagnetic induction
- State Lenz's law in the phenomena of electromagnetic induction
- List the applications of Faraday's laws

Dear trainees, in this session we will discuss Faraday's law of electromagnetic induction getting electricity from magnetic fields. Faraday's law of electromagnetic induction is a very important principle. Most of the electrical power in the world is generated by using this principle. The session covers the concept that electric current can be produced from magnetic fields. In order to make this lesson more understandable, we will use activities, virtual lab activities, or interactive online resources. There will also be a connection between the lesson and real-life situations.

Activity 1

- How have you been teaching the concepts electromagnetic induction and share it with your friends
- What are the misconceptions associated when you teach electromagnetic induction.
- What do think the difference between the electromagnetism and electromagnetic induction

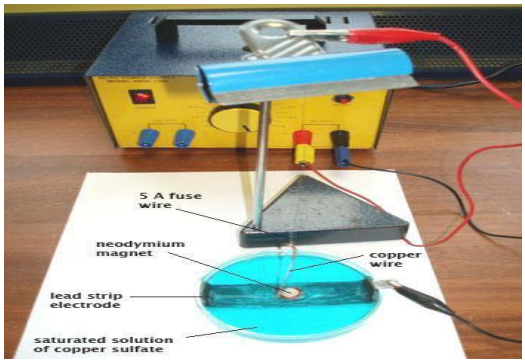
The concept of electromagnetic induction stands for getting electric current from magnetic field. There are misconceptions arise from students that collide with electromagnet. The following activities will remove the misconceptions and will help you to teach this concept.

Activity 2

To do this demonstration the following materials are needed

- Ferromagnetic cylindrical rod: diameter 10 mm, length 10 cm
- Insulated copper wire - SWG 30, 300 g
- LED
- Demountable transformer, used as a 'step-down' transformer with primary coil connected to mains, with turn's ratio to produce 6-10 V across the secondary coil.

Next follow the following steps and report qualitatively what you observe



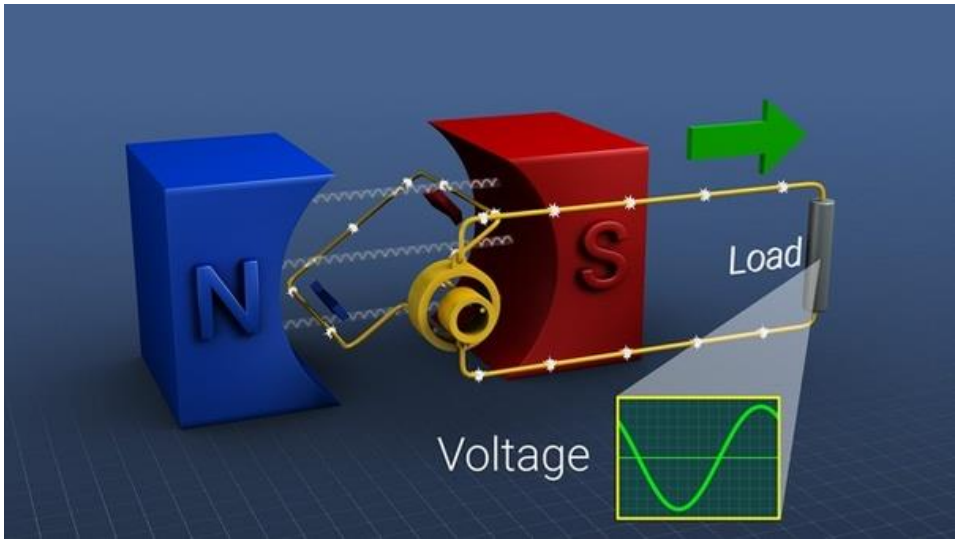
1. Wind the copper wire on the ferromagnetic rod to form a cylinder with the ferromagnetic rod as axis. Leave 0.5 cm of wire on either side of the rod. This is called the test coil.
2. Remove the insulation from the two ends of the copper wire and connect an LED in series.
3. Connect the primary coil of the demountable transformer to the AC mains.
4. Hold the test coil (ferromagnetic rod with copper wire) in your hand and move the test coil close to the secondary coil, preferably along its axis. (A circular inductor coil will have its magnetic field along its axis.) The LED glows.
5. If the primary coil is changed for a smaller one connected to the 20 V DC, the LED glows as the test coil is moved towards or away from the secondary coil.

Please report your response what you observe from the activity

Key ideas

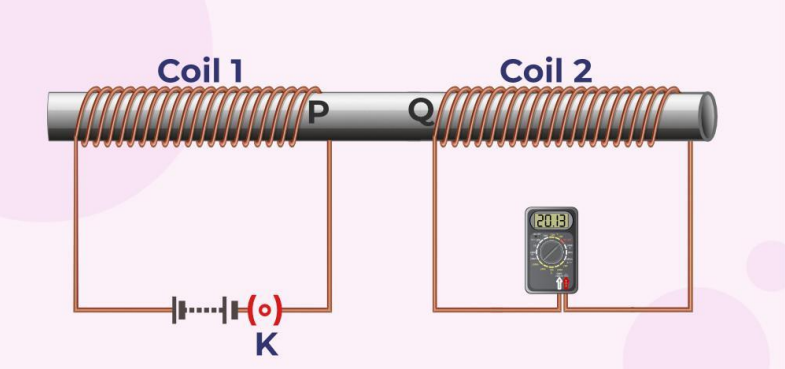
The process of electromagnetic induction can be summarized as follows:

- **Changing magnetic field:** When a magnetic field around a conductor changes, either by moving a magnet near the conductor or by changing the current in a nearby coil, it creates a changing magnetic flux.
- **Induced electromotive force (emf):** The changing magnetic field induces an electromotive force, also known as an induced emf, in the conductor. This emf causes free electrons in the conductor to move, creating an electric current.
- **Faraday's law of electromagnetic induction:** Faraday's law states that the magnitude of the induced emf is directly proportional to the rate of change of magnetic flux. The magnetic flux is determined by the strength of the magnetic field, the area of the loop or conductor, and the angle between the magnetic field and the conductor.
- **Lenz's law:** Lenz's law, another principle of electromagnetic induction, states that the induced current will flow in such a way as to oppose the change in magnetic flux that produced it. This law ensures that energy is conserved and prevents abrupt changes in current or magnetic fields.



Assessment

1. Fill the table in the right column shown below from the figure.



Position of Magnet	Position of galvanometer
When the magnet is at Rest	?
When the magnet moves toward the coil	?
When the magnet moves away from the coil	Deflection is observed in the galvanometer but in the opposite direction. (say counter-clockwise)
When the magnet is held stationary at the same position (near the coil)	?
When the magnet is held stationary at the same position (away from the coil)	?

2. What are the factors that affect the EMF produced due to electromagnetic induction?
3. Mention the main applications of Faraday's law

Implications to teaching

- Proper delivery of the lesson promotes a better understanding of transformers, both in terms of their role in electrical engineering and their description in the society.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.

Take away Resources

- https://phet.colorado.edu/en/simulations/faradays-electromagnetic-lab/about
- https://excelschools.net/en/simulation/faraday.html

8.13 Transformers (2 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to help your trainees learn the concepts related to Transformers
- to help and understand the principles and purpose of the transformer.
- Discuss how transformer is used in commonly available devices

Dear trainees, transformers facilitate the efficient transfer of energy between circuits by altering voltage levels, thereby enabling electricity to be transported over long distances with minimal loss. In this lesson you are going to learn about transformers. Diagrams, animations, or models will be used to illustrate the structure and working principle of the transformers. Virtual lab activities or interactive online resources will also be employed to make it more understandable. The lesson will also be linked to real life situations.

Activity 1

- How have you been teaching the concepts transformer and share it with your friends
- What are the misconceptions associated when you teach transformer.
- Discuss in groups how electricity is transported over long distances from power stations to homes and businesses with minimal loss.

Recap on any previous learning on electromagnetic induction. Introduce subject area and refer students to the Transformers Student Revision Notes in the 'Education' section *www.twothirtyvolts.org* .

Allow time for students to review these. Explain experiment and learning objectives. The following activity is an interactive teacher demonstration that can be used to explore and to get students talking about various aspects of electromagnetic induction in the context of a simple transformer.

Activity 2

This activity will help you when you teach about transformer

The following material are required to demonstrate about the concept of transformer

- A mounted 2.5 V filament bulb, a low-voltage AC power supply, 0–12 volt,2 (120 + 120)-turn coils.an iron retort stand and connecting wires

What Happens During this Activity?

This demonstration might be carried out after electromagnetic induction has been introduced. It then provides a way into thinking and talking about transformers. The main aim is to get students talking about what they can see happening. The demonstration can be carried out in a series of steps.

Start simple – with a single glowing bulb (we used a 2.5 volt bulb) connected to the AC low-voltage output of a power supply. Switch on to about 3.0 volt and the bulb lights nice and bright. No surprise there!

Now set the challenge:

YOU: How can we light the bulb without connecting it up to this kind of power supply or to a battery?

- Using coils to make a link connect the bulb to a 240-turn coil of wire.

YOU: How might connecting the bulb to a coil of wire help in making it light up?

- Place the second 240-turn coil at the bottom of an iron retort stand and connect it to the alternating supply still set at about 3.0 volt. Now place the coil connected to the bulb over the retort stand. Nothing happens… until the second coil (with bulb) is slid down the vertical stand.

Concluding the demonstration

- The bulb lights, getting brighter the further the secondary coil is moved down the iron rod.
- This simple demonstration is based on some fascinating physics and provides an excellent opportunity for students to talk through quite a complicated, multi–step explanation based on electromagnetic induction. The first point you might make:

YOU: Look! The bulb is not connected to the supply and yet it lights! The first coil is connected to the supply but there's no connection to the second coil. What on Earth's going on here? Who can explain?

The explanation to move towards is as follows:

- The changing potential difference from the supply drives a changing electric current round the lower coil or primary.
- The changing electric current in the lower coil produces a changing magnetic field. When the current is zero, the field is zero; when the current is a maximum, the magnetic field is at maximum strength.
- The changing magnetic field is carried by the retort stand core and links the secondary (upper) coil to the primary (lower) coil.
- The changing magnetic field linking the upper coil induces a changing voltage across this secondary coil.
- The changing voltage across the upper coil drives a changing current in that coil and in the bulb, making it light.

Further questions to ask, and some (smart) students' answers:

YOU: So why does the bulb get dimmer as the upper coil is moved up the retort stand?

Student 1: There must be a weakening of the magnetic field as you go higher.

YOU: What happens if the bulb is connected to 120 turns rather than across all 240? Try it!

Student 2: The bulb goes dimmer. This is because a smaller voltage is induced across the secondary coil as there are a smaller number of terms. We have a simple step–down transformer!

Activity 3

Based on your interactions with the students, you might have identified the most common misconceptions related to transformers.

There are several misconceptions related to transformers. Some of them are:

- **Transformers are all the same**: Some people mistakenly believe that all transformers are identical and serve the same purpose. In reality, transformers come in various types, sizes, and configurations, each designed for specific applications. For example, there are power transformers used in electrical grids, distribution transformers in neighborhoods, and even small transformers in electronic devices like cell phone chargers.
- **Transformers are perfectly efficient**: While transformers are highly efficient devices, they are not 100% efficient. Some energy is lost as heat during the transformation process due to factors such as resistance in the transformer windings and magnetic core losses. Minimizing these losses is a key consideration in transformer design and operation.
- **Transformers are only for power distribution**: While transformers are commonly associated with power distribution, they have other applications as well. For example, transformers are used in various electronic devices to step up or step down voltage levels, isolate circuits, and provide impedance matching

Did you change your mind after reading the text? If you did, explain your views again in the light of the text and give relevant examples.

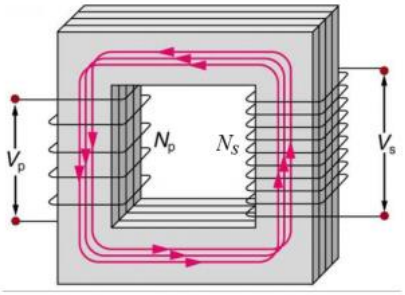
……

Key Ideas

- A transformer is an electrical device that transfers electrical energy from one circuit to another through the process of electromagnetic induction. It is most commonly used

to increase (’step up’) or decrease (’step down’) voltage levels between circuits without altering the frequency.

- A Step-up Transformer converts the low primary voltage to a high secondary voltage and steps up the input voltage. On the other hand, a step-down transformer steps down the input voltage.
- A transformer is simply a pair of coils wound on the same core. The core is often shaped as a square loop with primary and secondary coils wound on opposite sides.
- The construction of a transformer allows the magnetic flux generated by a current changing in one coil to induce a current in the neighboring coil.



Assessment

1. Design your own transformer.
2. If possible, investigate the types of transformers in your locality. You may need to consult electric power operators.
3. Identify the type of transformers in electronic devices like cell phone chargers and others.
4. What is a transformer? Explain its working principle
5. Explain how transformer is used in commonly available devices

Implications to teaching

- Proper delivery of the lesson promotes a better understanding of transformers, both in terms of their role in electrical engineering and their description in the society.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.

Takeaway resources

- To know more about transformers, read grade 12 physics textbook.

- Perform force PHET experiment simulation using the following link so as to understand transformers in a better way.
- https://phet.colorado.edu/sims/cheerpj/faraday/latest/faraday.html?simulation=faraday
- https://www.twothirtyvolts.org.uk/pdfs/education/lesson-plans/Transformers_14to16_Lesson-Plan.pdf

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of electricity and magnetism. Specifically, we have considered the following aspects:

- Explanation of Methods of charging a body, coulomb's ;law, the electric field , electric circuits and concepts associated with electric current and devices such as Ammeter and voltmeter are discussed
- The concept of magnetism associated with bar magnets and electromagnets are discussed
- The electromagnetic force exerted on a current carrying conductor is discussed with different activates
- A current-carrying conductor produces a magnetic field around it. The right-hand rule is used to determine the direction of the magnetic field.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*
- *Raymond A. Serway, Physics for Scientist and Engineers*
- *Douhlas C. GianColi, Physics for Scientist and Engineers*
- *Robert Resnick and David Halliday, Fundamentals of Physics*

Chapter 9

Basics of Electronics

Introduction

Dear Trainee, there are a number of basic concepts that form the foundations of today's electrical, electronics and radio technology. Electrical current, voltage, resistance, capacitance, and inductance are a few of the basic elements of electronics and radio. Apart from current, voltage, resistance, capacitance, and inductance, there are many other interesting elements to basic electronics technology. While some can become quite complicated, it is nevertheless possible to gain a good understanding of them without delving into the complicated depths of these topics.

Therefore, in this chapter, you will learn how to teach the basic concepts related to Basic electronics. You have 3 hours at your disposal for teaching the chapter.

9.1 Semiconductors (1 hr)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to semiconductor.
- Understand why doping of semiconductors is useful;
- Be familiar with basic electronic devices made using semiconductors and how these devices operate.
- Differentiate the difference between intrinsic and extrinsic semiconductors
- Appreciate the applications of P-type and N-Type semiconductors

In this session, we introduce the basic teaching methodology for teaching secondary school trainees about semiconductors. There will be activities for trainees and key ideas as well as takeaway resources in this session.

Activity 1.

- How have you been teaching the concepts of semiconductor? Please, take a moment and share your experience to the whole class.
- Could you start your teaching through describing the materials applicable in your surrounding?

- What were the common misconceptions held by your students in relation to this topic?

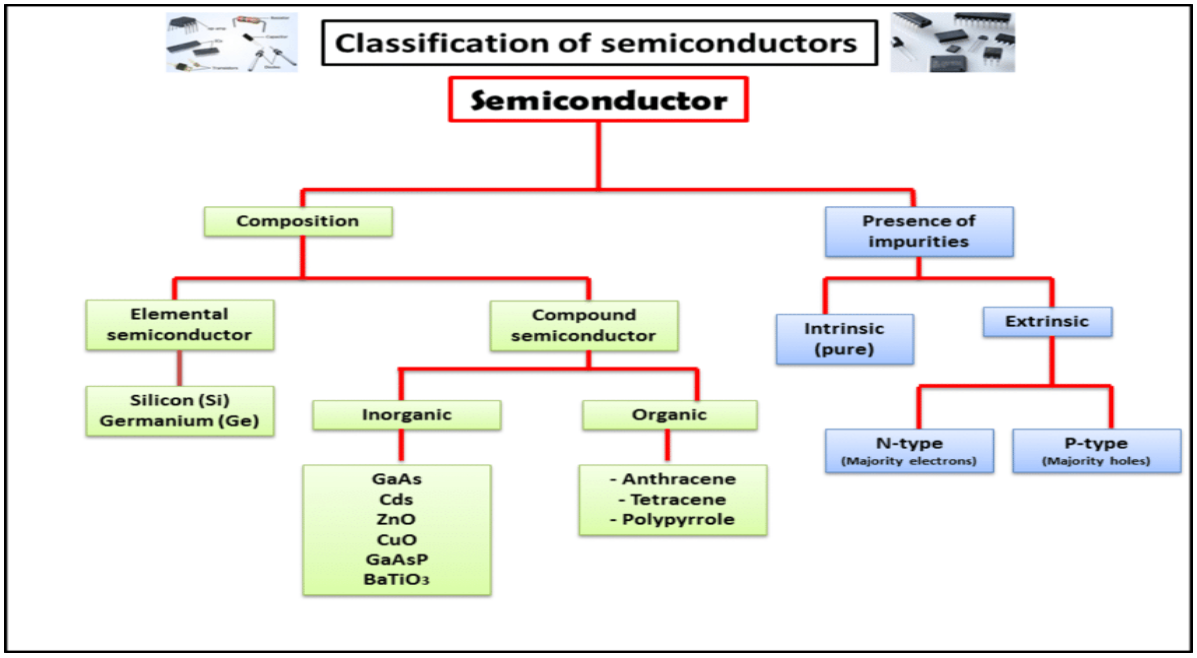
Dear trainee to correct the misconceptions associated with semiconductor please read the following articles that deals the detail of misconceptions seen around the student.

- "Students 'Misconceptions about Semiconductors and Use of Knowledge in Simulations"
- "Students' Misconceptions about Semiconductors and Use of Knowledge in Simulations"

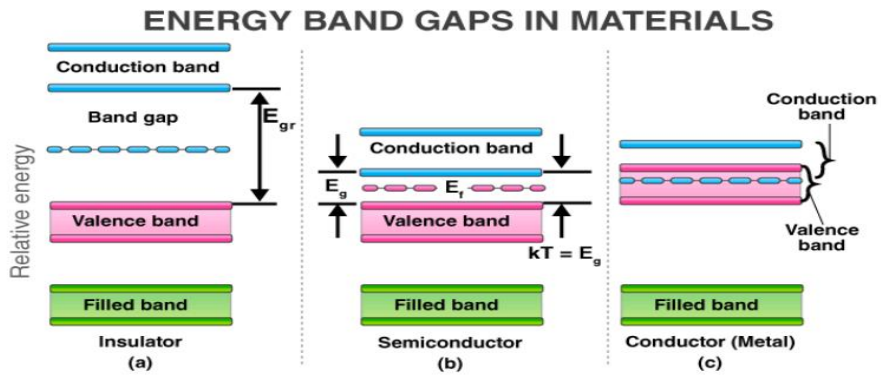
Activity 2

a. What are basic difference b/n Conductors, Insulators and Semiconductors?
b. What are the difference b/n intrinsic and extrinsic semiconductors, List as much as possible in the following table
c. Discuss the difference b/n N-type and P-Type materials.

Key Ideas



- **Semiconductors** are materials which have a **conductivity between conductors** (generally metals) and non-conductors or **insulators** (such as ceramics). Semiconductors can be compounds, such as gallium arsenide, or pure elements, such as germanium or silicon. Physics explains the theories, properties and mathematical approach related to semiconductors.



Implications to teaching

- Proper delivery of the session promotes a better understanding of transformers, both in terms of their role in electrical engineering and their description in the society.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.

Takeaway resources

- https://www.doitpoms.ac.uk/tlplib/semiconductors/charge_carriers.php\
- https://phet.colorado.edu/en/simulations/semiconductor
- https://www.youtube.com/watch?v=5zz6LlDVRl0

9.2 Logic gates and logic circuits (2hr)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to logic gate circuits
- apply the different types of logic gates
- Identify logic gate symbols
- Analyze truth tables

Dear trainees, logic gates are fundamental building blocks of digital circuits, performing logical operations on one or more binary inputs to produce a single binary output. There are several types of logic gates, each with its unique behavior based on Boolean algebra principles. In this session you are going to learn about logic gates. Diagrams, animations, or models will be used to illustrate the structure and working principle of logic gates. Virtual lab activities or interactive online resources will also be employed to make it more understandable. The session will also be linked to real life situations.

Activity 1

- Have you ever thought how traffic lights and control systems work to determine when to change signals? How a security alarm is activated if either motion sensors or door sensors detect activity? Discuss in groups and report to the class.

After completing the above activity and analyzing the trainees' report, you may know whether they have good concept of logic gates or not. Now, elaborate the concept using the following key ideas.

Part 1

In groups, explore the role of logic gates for the following cases and report to the class through your group representatives.

- Manufacturing processes
- Biological systems
- Financial decision making
- Medical diagnostics

Part 2

Based on your interactions with the trainees, you might have identified the most common misconceptions related to logic gates.

Part 3

There are several misconceptions related to logic gates. Some of them are:

- **Logic gates are physical gates**: One common misconception is that logic gates are physical gates or barriers that control the flow of information. In reality, logic gates are abstract representations of digital circuits that perform logical operations on binary inputs to produce binary outputs.
- **Logic gates operate instantaneously**: There's a misconception that logic gates operate instantaneously, with outputs changing immediately in response to input changes. In reality, logic gates have propagation delays, and the time taken for an output to change after an input changes can vary depending on factors such as gate type, circuit complexity, and environmental conditions.
- **Logic gates are relevant only to electronics**: While logic gates are commonly associated with digital electronics, there's a misconception that they have no relevance outside of this domain. In truth, logic gates can be applied to various fields, including computer science, mathematics, biology, and decision-making processes in everyday life.

Part 4

Did you change your mind after reading the text? If you did, explain your views again in the light of the text and give relevant examples.

……

…..……

Part 5

Answer the following questions.

- List the different types of logic gates with their symbols.

Activity 2

- Sami creates a logic circuit. He uses three different logic gates in his circuit. Each logic gate has a maximum of two inputs.

He describes the logic of each gate

(a) “The only time the output will be 1 is when both inputs are 1.”

State the single logic gate: .....

Draw the single logic gate:

(b) “The only time the output will be 1 is when both inputs are 0.”

State the single logic gate.....

Draw the single logic gate:

(c) “The only time the output will be 0 is when both inputs are 1.”

State the single logic gate.....

Draw the single logic gate:

(c)”The only one input and one output. Output is opposite of input”

State the single logic gate.....

Draw the single logic gate:

Activity 3

Download the lab manual from file:///C:/Users/hp/Downloads/EXP1SEM2.pdf

And do the virtual lab. Finally summarize the lesson

Key Ideas

- Logic gates are the switches that turn ON or OFF depending on what the user is doing.

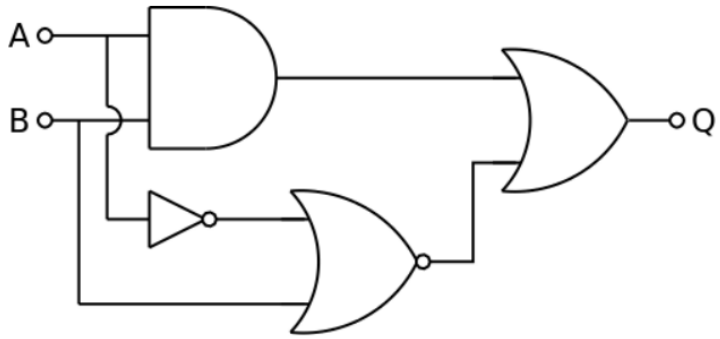
- They are the building blocks for how computers work.
- Logic gates turn ON when a certain condition is true, and OFF when the condition is false.
- They either display the answer true (ON) or false (OFF).
- Major logic gates are NOT, AND, OR, and XOR.
- There are also other ones, such as NAND, NOR, and XNOR.

You may introduce logic gates by comparing it to decision-making processes in everyday life. For instance, an AND gate represents a scenario where multiple conditions must be met for a certain outcome to occur. This could be analogous to conditions that must be satisfied before making a significant decision, such as joining private school (e.g., affordability, location, and condition). OR gate may represent a scenario where you are requested to bring one of your parents (your mother, father) to school.

In activity 1, traffic lights and control systems often employ logic gates to determine when to change signals. By using logic gates to process inputs such as vehicle presence and traffic flow, these systems can efficiently manage traffic flow and ensure safety on roads. Moreover, logic gates are integral to home automation systems, where they can be used to control various appliances and devices based on specific conditions. For example, an OR gate might be employed to activate a security alarm if either motion sensors or door sensors detect activity.

Assessment Questions

1. Draw the correct symbol and truth table for each of the following logic gates
    i. NOT gate b) AND gate c) OR gate d) NAND gate e) NOR gate
2. Simplify the following circuit using only NAND gates by (a) replacing each logic gate with the correct NAND equivalent circuit and (b) removing any redundant logic gates



Implications to teaching

- By highlighting these real-life applications, trainees can gain a deeper appreciation for the relevance and importance of logic gates beyond their traditional use in digital electronics.

Moreover, understanding how logic gates are utilized in various contexts can foster critical thinking skills and encourage interdisciplinary thinking across different fields.

- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.

Takeaway resources

- To know more about transformers, read grade 12 physics textbook.
- Use the following link for online simulation of logic gates. .
- https://app.logic-gate.online/

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of basic electronics. Specifically, we have considered the following aspects:

- Explanation of semiconductors associated with energy band diagram and the conductivity properties are discussed with activities.
- Discussion of the concept of logic gates

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*
- *Tayal D.C. Basic Electronics. 2nd ed. Himalaya Publishing House Mumbai, (1998).*
- *Theraja B.L., R.S. Sedha. Principles of Electronic Devices and Circuits, S.Chand and Company Ltd, New Delhi, (2004).*
- *Serway, R. A. and Vuille, C., 2018, College Physics, 11th ed., Cengage Learning, Boston,USA*

Chapter 10

EM Wave and Geometrical Optics

Introduction

Dear trainee, light is one form of electromagnetic wave. Light lets us see things and is responsible for our visual contact with our immediate environment. It enables us to admire and adore various beautiful manifestations of nature. You can use light rays to model mirrors, lenses, telescopes, microscopes, and prisms. The study of how light interacts with materials is called optics. When dealing with light rays, you are usually interested in the shape of a material and the angles at which light rays hit it. This kind of optics is referred to as geometrical optics.

In this chapter, you will learn more about how to teach these concepts using constructive approaches. Topics in EM spectrum and geometrical optics are focus of this unit. You have 8 hours at your disposal for teaching the section.

10.1 EM spectrum (1 hr)

At the end of this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to EM spectrum,
- Describe the importance of the EM spectrum in every life situation,
- Appreciate real applications of the EM spectrum.

Dear trainees, in this session you are going to learn about the concept of EM spectrum. Practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the concepts of EM waves? Please, take a moment and share your experience to the whole class.
- What kind of misconceptions have you identified in relation to this topic?

Now let us explore how to teach this topic using the 5E learning method.

Activity 2 (Excite/engage)

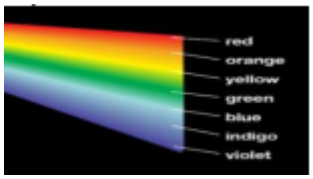
In pairs, read and discuss the scenario provided below and come up with the answer related to the scenario.

- I am a multi-colored circular arc, and I get my origin due to reflection, refraction, and dispersion phenomena when sunlight interacts with water droplets; I always appear in the section of the sky directly opposed to the sun. Guess who I am?

Have you guessed the correct answer? In order for you to understand this concept, perform the following experiment.

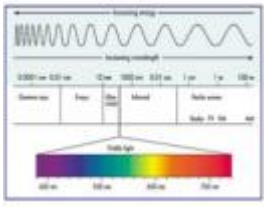
Activity 3

Perform an experiment by using the beaker containing water and the source of light. By sending light through that beaker, try to investigate the different colors formed on the screen. What do you think about the stratified formed colors? Discuss in pairs, and answer the asked questions and write your answers on the blackboard.



Activity 4

- In your group, discuss on the diagram of the spectrum given by your trainer. Try to enumerate the different radiations that appeared in the EM spectrum, and how they are different? Present your work to the whole class. You can watch videos to enhance your understanding.

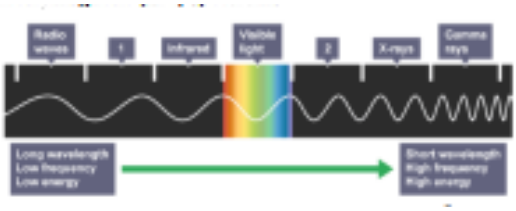


Activity 5 (Elaborate)

- Discuss about a scientific explanation of concepts related to the EM spectrum
- Watch a video about the application of EM spectrum and write a summary on the applications of the electromagnetic spectrum

Assessment (Evaluate)

This diagram shows the different regions of the EM spectrum.



a) Identify regions 1 and 2 from the diagram above.

b) Choose the correct phrase in each bracket below:

- Visible light travels *[f*aster than/at the same speed as / slower than] radio waves.
- The frequency of visible light is [higher than/the same as/lower than] the frequency of X-rays.
- The wavelength of visible light is [longer than/the same as/shorter than*]* the wavelength of radio waves

Key ideas

- A spectrum is dark when it is absorbed by a material, while a spectrum is bright when it is emitted.
- Spectra differ due to their difference in wavelength and in their frequency.

Implications to teaching

- Literature support the importance of teaching trainees using active learning strategies like 5E so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway Resources

In addition, further reading, listening or viewing activities related to this sub-topic are available through the following web links:

- https://scied.ucar.edu/learning-zone/earth-system/electromagnetic-spectrum
- https://byjus.com/jee/electromagnetic-spectrum-and-electromagnetic-waves/
- https://www.youtube.com/watch?v=FrfcjNTapCU
- https://youtu.be/7F6fT5p5oFk

10.2 Image formation by mirrors (2 hrs)

After the end of this session, trainees will be able to:

- apply the understanding of reflection in image formation by mirrors,
- plan innovative teaching strategies for effective teaching and learning of the topic in specific situations.

Dear trainees, in this session you are going to learn about the concept of image formation by mirrors. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the image formation by mirrors? Please, take a moment and share your experience to the whole class.
- Have you started your teaching through describing the things that are happening around them?

Before discussing about the image formed by mirrors, let us recap your knowledge about mirrors through the following activity.

Activity 2

The three types of mirrors that you come across are plane mirrors, concave mirrors and convex mirrors. Discuss your observations.

- What differences do you observe? Can you identify them by touching?
- Do you know that concave mirrors also known as shaving mirrors? What type of mirrors a dental surgeon uses for focusing the light'?

The other important point about mirrors is their focal point. Do you know how to locate the focal length of mirrors? To help you understand this concept, let's do the following activity.

Activity 3

1. Take a concave mirror. Let light fall on the mirror. The light converges at one point. Move the mirror so that you get a sharp image on the wall or the screen, as the case may be. Measure the distance between the mirror and sharp point so as to determine the focal length of the mirror.
2. Taking a convex mirror the activity is repeated. Let the light fall on convex mirror. What happens? The light diverges in different directions and does not concentrate at one point.

Try to also discuss about the other important terms that are used to describe spherical mirrors and rays used to form images. You can use a power point. Now discuss about the two laws of reflection with your colleagues before moving you move to the discussion of image formation by these mirrors.

Activity 4

1. Stand one step away from a large mirror.
2. What do you observe in the mirror? This is called your image.
3. What size is your image? Bigger, smaller or the same size as your actual size?
4. How far is your image from you? How far is your image from the mirror?
5. Is your image upright or upside down?
6. Take one step backwards. What does your image do? How far are you from your image?
7. Lift your left arm. Which arm does your image lift?

What did you notice from the above activity? The formation of an image by a plane mirror is illustrated in the following simulation software.

- https://ophysics.com/l9.html

Activity 5

- If two different plane mirrors are placed at an angle, how many mirrors are formed?

Now let us discuss about the image formation by spherical mirrors.

Activity 6

- How can you locate the image formed by a concave mirror for different positions of the object? Are the images real or virtual? Are they enlarged, diminished or have the same size?

Use the following simulation software to demonstrate about how an image is formed in spherical mirrors.

- *oPhysics: Interactive Physics Simulations* https://ophysics.com/l10.html
- Geometric Optics: Basics https://phet.colorado.edu/sims/html/geometric-optics-basics/latest/geometric-optics-basics_all.html

Discuss your observation with your colleagues and how it relates to the principles of optics you know.

Activity 7

- Draw neat ray diagrams for locating the image formed by a concave mirror for each position of the object and describe the nature, position, and relative size of the image formed in each case.
- Repeat the same procedures for a convex mirror.

As a final note, let us do the following activity.

Activity 8

- Discuss in groups about the real life applications of mirrors.

The teacher will also highlight how our everyday experiences, such as using a magnifying glass, are based on these principles.

Key ideas

- The image of an object in a plane mirror appears to be behind the mirror. You also find that the virtual image is located at the same distance behind the mirror as the object distance. Also the height of the image is identical to the height of the object and is upright. The image size is the same as the object size and is upright. Although mirrors do not produce an inverted image, left and right are inverted. The image of a right hand is a left hand
- The properties of the image produced by a concave mirror depend on the location of the object. This is not the case for a convex mirror.

Implications to teaching

- Literature support the importance of inquiry based teaching so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session? Allow trainees to describe verbally what they have understood from this simple electrical project.
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway Resources

In addition, further reading, listening or viewing activities related to this sub-topic are available through the following web links:

- https://byjus.com/physics/plane-mirrors/
- https://byjus.com/jee/concave-mirror-image-formation/

- https://byjus.com/jee/image-formation-in-convex-mirror/

10.3 Image formation by lenses (2 hrs)

After going through this unit, you will be able to :

- explain refraction by spherical lenses,
- apply the understanding of refraction to learn the image formation in lenses,
- comprehend the structure and functions of lenses,
- plan innovative teaching strategies for effective teaching and learning of the topic in specific situations.

Dear trainees, in this session you are going to learn about the concept of image formation by lenses. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching about the concept of image formation by lenses? Please, take a moment and share your experience to the whole class.
- Have you started your teaching through describing the things that are happening around them?

Now, workout on the following problem situations:

Activity 2

Think about these two situations and try to explain them based on your previous knowledge.

a) How can people see his/her reflection in a spoon?
b) How can a magnifying glass make an object appear larger?
c) How the human eye itself works like a lens, focusing the light on the retina to form an image, and this is why we are able to see.
d) The second fact could be about the Hubble Space Telescope, which uses multiple lenses and mirrors to capture images of distant galaxies, demonstrating the practical application of these principles in astronomy.

This will serve as a segue into the new topic of lenses. Then after move to discussing about the important terms that are used to describe spherical mirrors and rays used to form images.

Activity 3

- How can you locate the image formed by a convex lens for different positions of the object? Are the images real or virtual? Are they enlarged, diminished or have the same size?

For further clarification, try to do the following hands on activity.

Activity 4

Use a convex lens to project an image of a candle on a screen. Working together in pairs answer the following questions about the image formed.

a) Explain in your own words why the lens forms an image on the screen. If necessary, illustrate your explanation with a ray diagram.
b) What will happen to the image if the screen is moved slightly closer to and further away from the convex lens? Explain.
c) What will happen to the image on the screen if half of the convex lens is covered with a piece of card? Explain.
d) Can we see the image if the screen is removed? Explain your answer.

Support the above activity with following simulation software to demonstrate about how an image is formed in convex lens.

- *oPhysics: Interactive Physics Simulations* https://ophysics.com/l10.html
- Geometric Optics: Basics https://phet.colorado.edu/sims/html/geometric-optics-basics/latest/geometric-optics-basics_all.html

Dear trainees, have you understand how the position of an object affects the image formation in a convex lens. To further enhance your understanding, perform the following activity.

Activity 7

- Draw neat ray diagrams for locating the image formed by a concave mirror for each position of the object and describe the nature, position, and relative size of the image formed in each case.
- Repeat the same procedures for a convex mirror.

As a final note, let us do the following activity so as to look at the applications of this principle in your everyday experiences.

Activity 8

- Discuss in groups about the real life applications of lenses and share your findings with the whole class.

Key ideas

The properties of the image produced by a convex lens depend on the location of the object. This is not the case for a concave lens.

Implications to teaching

- Literature support the importance of practice based teaching so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session? Allow trainees to describe verbally what they have understood from this simple electrical project.
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway Resources

In addition, further reading, listening or viewing activities related to this sub-topic are available through the following web links:

- https://byjus.com/physics/concave-convex-lenses/

10.4 Human Eye and Optical Instruments (2 hrs)

After going through this session, trainees will be able to:

- devise activities and strategies that help them to teach the concepts related to human eye and optical instruments,
- describe the image formation by the eye,
- explain the physics behind the operation of optical instruments.

Dear trainees, in this session you are going to learn about the concept of human eye and optical instruments. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the human eye and optical instruments? Please, take a moment and share your experience to the whole class.

- Have you started your teaching through describing the things that are happening around them?

Once the rules for predicting how rays travel through lenses have been discussed; a fantastic range of practical devices began to appear which aided the development of the modern world. Let us start our discussion with a human eye.

Activity 2

- In groups of two, look at one another's eye. Observe critically its external shape. Observe it carefully and note its behavior as one tries to see some objects in class. Then discuss about the functions of the eye.

Notice that the eye ball is round and fleshy.

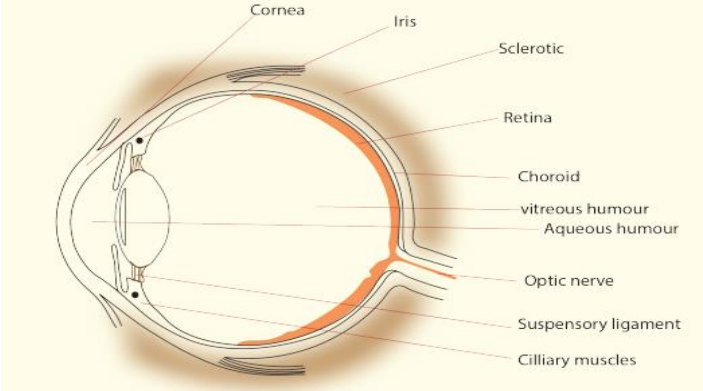


Figure 2.1: Anatomy of an eye

Activity 3

- Hold a book at an arm's length and move it closer to find the nearest distance that you can focus the words clearly without straining your eyes. Approximate the distance between your eyes and the book. What does this distance represent?

Have you understand that the near point of a normal eye is 25 cm?

Activity 4

- Look at the trees around your school. Now, try to look at objects far from the school. Are you able to focus the distant objects? Measure this distance from the object to your eye. Write down your observation in the notebook.
- Hold a book at an arm's length and move the lens so that the prints are read without the eye getting strained. Now, try to read the words on a chalkboard a distance from the book. Are you able to focus both near and distant objects?

People with normal vision can focus clearly near and distant objects. Those who only focus near objects are said to be short-sighted and those who only focus on far objects are long-sighted.

You know that people put on eye glasses for different reasons.

Activity 5

- Have you seen before some people putting on eye glasses? What do you think these glasses (spectacles) are used for.
- What kinds of lenses are used to correct eye defect problems?

Activity 6

- How many of you still have their grandparents? Have you ever tried to observe how grandparents observe objects? Discuss with your neighbor and write in your notebook results of your discussion.

When people grow older, their eye lens becomes stiff and it becomes hard for the cilliary muscles to adjust it. Such people have a defect called Presbyopia.

You use your eyes to see and view different objects. The eye cannot be used to view clearly these objects at night, and some distant objects or hidden objects. Objects which cannot be viewed by the eye can be focused using other instruments. All the instruments used to aid vision are called Optical instruments.

Activity 7

In our daily activities and development, we observe different things in environment or in universe. Sometimes, some objects cannot be easily observed using our naked eyes. We need to see these very small things at big distance.

i. What do you think we use to observe those distant or very small bodies?
ii. Discuss the properties used by those instruments?
iii. Name at least four instruments that people use to observe distant or very small objects.

Activity 8

When a patient goes to hospital having a headache and fever, a doctor may require a blood test for malaria. When a sample of blood is taken, it is not possible to check whether a patient has malaria or not. But a laboratory technician may need to test the blood using some instrument and decide whether the patient has malaria or not.

i. Which instrument do you think may be used to test malaria from blood sample?

ii. Discuss how that instrument function.

iii. What other instrument do you think can be used for such purpose?

Key ideas

- The eye is a biological instrument used to see objects at different distances. It uses a convex lens system to form a small, inverted, real image of an object in front of it.

Assessment questions

1. Name the part of the eye
    a. which controls how much light enters it,
    b. on which the image is formed,
    c. which changes the focal length of the crystalline lens.
2. A farsighted person has a near point of 100 cm. Reading glasses must have what lens power so that this person can read a newspaper at distance of 25 cm? Assume the lens is very close to the eye

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway Resources

In addition, further reading related to this sub-topic is available through the following web links:

- https://elearning.reb.rw/course/view.php?id=1259&section=3
- https://ncert.nic.in/ncerts/l/leph201.pdf

10.5 Color Addition and subtraction (1 hr)

At the end of this session, trainees will be to:

- devise activities and strategies that help them to teach the concepts related to color addition and subtraction,

- describe the additive primary colors of light (red, blue, green) and the subtractive primary colors of pigments (cyan, magenta, yellow).

Dear trainees, in this session you are going to learn about the concept of color addition and subtraction. Daily life and practical activities are included to make it more understandable. Let us start the session with your teaching experience.

Activity 1

- Have you got the opportunity to teach about the concept of color addition and subtraction? Please, take a moment and share your experience to the whole class.
- Have you started your teaching through describing the things that are happening around them?

Materials:

- ✓ slide projector, white screen, prism, 6 flashlights with batteries, scissors, pencils, colored filters (red, blue, green, cyan, magenta, and yellow)

Now let us explore the additive and subtractive primaries using colored lights using the following activity.

Activity 2

- For this activity, prepare 6 flashlights and 6 colored filters (red, green, blue, magenta, cyan, and yellow). You need to also cut out circles that will cover the flashlight's light with each different colored filter. The flashlights can be taken apart, and the clear plastic cover traced. The filter should be placed on top of the clear plastic cover when then flashlight is put together. You need to also a space in the room with a large white piece of paper hung on which you can shine the flashlights.
- Place a slide projector in front of a white screen. Turn on the projector. Position a prism in front of the light. Place the screen at a shallow angle intercepting the light, so that the rainbow is spread over a greater distance. This makes it easy to see the colors. As a result, the narrow ray of white light which strikes the prism is broadened out in space according to the different frequencies contained within the white light (red, orange, yellow, green, blue, indigo, and violet), and we see the familiar rainbow.
- Now place a colored filter, one at a time, between the slide projector and the prism. The prism will display the frequencies of light which are able to pass through the filter; observe the gaps in the rainbow for those frequencies which were not able to pass

through the filter. Now trainees should be able to see that red passes through a red filter, blue passes through a blue filter, and green passes through a green filter. (Make a chart if it helps.)

If you don't find such equipments, try to perform the following simulation experiment.

1. Open the Color Vision sim and click the single bulb and make sure they've set the filter color to white. Now play with the controls associated with this part of the sim for 2-3 minutes to gain familiarity with how things work.
2. Now investigate how our eyes see color when using lighting filters. Click the reset button on the bottom right corner. Using the colored (yellow) bulb, switch the beam representation to photon particle mode. Then answer the following questions:
    - What color light is coming from the flashlight?
    - What color does the person see?
3. Now try each of these combinations, and note their observations for each. You can prepare this table in your notebooks:

Color of Light	Color of Filter	Observation
red	yellow	
red	magenta	
blue	blue	
blue	cyan	
blue	red	
yellow	red	
yellow	blue	

4. Why we call the use of filters and dyes subtractive coloring? Have a class discussion.
5. Now switch to the white light bulb and answer the following:
    - What colors do you see coming from the flashlight?
    - Do the filters affect the white light differently than they affect the yellow light? If so, what difference do you observe?
6. Next, click the RGB bulbs icon at the bottom of the screen and answer the following questions:

- What are the primary colors of light?
- What color does the person see when all of the sliders are all the way up?

Now leave the red and green sliders up and turn off the blue and record the color you see now. Then turn the green and blue back to max power and record the colors you see. Finally, turn off the red flashlight and turn the green to max power. Now record the color you see?

7. Have you noticed that the colors they just made are complimentary colors to the primary ones, meaning they are blends? Now try to make the following colors based on sliding the power levels of each color to the correct position. Record your results in the table. You can use percentages or fractions to estimate the power level. When you finish, think of why we call coloring from light emitted by the flashlights additive color. Then explore the color light you observed when you subtract each color one at a time from the white light you created.
8. Finally share and compare your results and observations with other groups.

From the above experiment, have you noticed that ADDITIVE primary colors (red, green, and blue light) combine to make white light? Subtracting a primary color from white light, you can obtain SUBTRACTIVE primary colors (yellow, magenta, or cyan).

Key ideas

The additive primaries, or the primary colors of light, are red, blue and green. These combine to form white light. If we subtract each of these colors, one at a time, from the white light, we end up with the subtractive primary colors, or the primary pigments-cyan, magenta, and yellow:

- red light + green light + blue light = white light
- white light – red light = cyan light
- white light – green light = magenta light
- white light – blue light = yellow light

Assessment:

- Do lighting filters use additive or subtractive properties to bring light of a certain color to our eyes? Explain.
- Do different color lights (RBG) use additive or subtractive properties to bring light of a certain color to our eyes? Explain using evidence from your lab

- What are the primary colors of light?

Implications to teaching

- Literature support the importance of linking the concept you teach to trainees real life scenarios so as to make the teaching and learning process more attractive and also understand the topic. Have you been inspired to use such kinds of teaching methods in your own session?
- What new things have you learnt from this session?
- Do you have any other strategy that you suggest for teaching this topic? If so, please share it to your colleagues.

Takeaway Resources

In addition, further reading related to this sub-topic is available through the following web links:

- Primary Colors of Paint, Ink, and Dyes http://home.att.net/~jpzenger/RYBORCMY.htm
- Indiana Academic Standards http://ideanet.doe.state.in.us/standards/welcome2.html
- Edmund Scientifics http://www.scientificsonline.com/

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of EM spectrum and geometrical optics. Specifically, we have considered the following aspects:

- Discussion of how electromagnetic spectrum are classified into categories such as radio, infrared, ultraviolet, and so on.
- Explanation of the dependence of the image formed by a concave mirror and convex lens on the position of the object.
- Explanation of the working principles of the human eye and optical instruments
- Discussion of the color addition and subtraction.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At

the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Chapter 11

Nuclear Physics

Introduction

Dear trainee, Nuclear physics plays a pivotal role in numerous fields. It is the driving force behind the energy production in stars, including our own sun. On Earth, nuclear reactions fuel power plants, provide medical treatments such as radiation therapy, and enable imaging techniques. Moreover, nuclear physics continues to push the boundaries of scientific exploration, unlocking mysteries of the universe.

In this chapter, we will learn how teach key concepts such as the nucleus, radioactive decay, nuclear reactions, and the principles of nuclear fission and fusion. These concepts not only form the basis of nuclear physics but also underpin technological advancements and scientific breakthroughs. You have 5 hours at your disposal for covering this chapter.

11.1 The nucleus (1 hr)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach about the nucleus,
- identify some misconceptions related nucleus and take corrective measures.

Dear trainees, atoms are the basic building blocks of matter. An atom consists of a positively charged central nucleus that is surrounded by one or more negatively charged electrons. In this lesson you are going to learn about the atomic nucleus. Diagrams, animations, or models will be used to illustrate the structure of the nucleus. Virtual lab activities or interactive online resources will also be employed to make it more understandable. The lesson will also be linked to real life situations. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching the nucleus?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to the nucleus. Some of them reported in literature are listed below.

- Nucleus is relatively large compared to the rest of the atom
- misconceptions about the composition of the nucleus

- Confusing the nucleus with the solar system model

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Let the trainees use the diagram or video of the solar system. Use the analogy of the solar system to understand about the atomic nucleus. It is a popular method, especially for visualizing the structure of an atom and understanding the arrangement of particles within the nucleus. Just like the sun is at the center of the solar system, the nucleus is at the center of an atom. Emphasize that the nucleus contains most of the atomic mass, similar to how the sun contains most of the mass in our solar system. The solar system model suggests that electrons orbit the nucleus in fixed, circular paths, similar to planets orbiting the sun.

Activity 3

Watch the following video and discuss in groups what you understood from it about the atomic nucleus.

https://www.youtube.com/watch?v=oW7USk5x4do

Have you properly understood the nucleus?

Key Ideas

- In reality, the nucleus is incredibly small compared to the overall size of the atom. If an atom were the size of a football field, the nucleus would be about the size of a pea in the center.
- There can be misconceptions about the composition of the nucleus, such as the idea that neutrons are positively charged or that protons and electrons exist within the nucleus. In reality, protons and neutrons are the primary constituents of the nucleus, and neutrons have no charge.
- The solar system model suggests that electrons orbit the nucleus in fixed, circular paths, similar to planets orbiting the sun. However, in reality, electrons exist in electron clouds or orbitals, which are not fixed paths but rather areas where the electrons are likely to be found.
- Additionally, the solar system model doesn't accurately represent the behavior of electrons.

Assessment

- What determines the stability of the atomic nucleus?

Implications to teaching

- By using this analogy, trainees can visualize the atomic structure more easily and understand the arrangement of particles within the nucleus in relation to the overall structure of an atom. It provides a relatable framework for exploring complex atomic concepts.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the nucleus, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the nucleus in a better way.
    - https://phet.colorado.edu/en/simulations/build-a-nucleus

11.2 Radioactivity and uses of nuclear radiation (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach radioactivity and uses of nuclear radiation,
- identify some misconceptions related to radioactivity and nuclear radiation and take corrective measures,
- discuss dangers of ionizing radiation,
- list protective measures against dangers of nuclear radiation.

In this lesson, you are going to learn about radioactivity and nuclear radiation along with safety rules against hazards of nuclear radiation. Diagrams, animations, or models will be used to illustrate radioactivity and nuclear radiation. Virtual lab activities or interactive online resources will also be employed to make it more understandable. The lesson will also be linked to real life situations. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching radioactivity and uses of nuclear radiation?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to radioactivity and uses of nuclear radiation. Some of them reported in literature are listed below.

- All radiation is harmful
- Radioactivity lasts forever
- Low level radiation exposure is not a concern
- Radiation exposure is only a concern near nuclear facilities

Are the misconceptions that you identified match with those reported in literature?

Activity 2

List the possible radioactive sources in your locality and list safety rules that should be implemented against the radiation hazards.

Activity 3

Have you ever seen the above symbols posted in laboratories or hospitals? What is the purpose of posting such symbols? Discuss in groups and report to the class.

Activity 4

Discuss in groups about the uses of nuclear radiation for humankind and report to the class via your group representative.

The most common method of teaching radioactivity is using the analogy pot of water on stove.

Pot of water: Represents a radioactive substance. Just as the water contains energy that causes it to boil and release steam, radioactive materials contain unstable nuclei that undergo radioactive decay, emitting radiation in the process.

Boiling water: Represents the radioactive decay process. As the water boils, bubbles of steam are released from the surface and escape into the surrounding environment. Similarly, radioactive decay involves the spontaneous emission of radiation (such as alpha particles, beta particles, or gamma rays) from the nucleus of unstable atoms, which then propagate outward

Steam: Represents the radiation emitted during radioactive decay. In the analogy, steam represents the various types of radiation emitted by radioactive materials. This radiation can interact with surrounding objects or materials, potentially causing ionization and other effects.

Stove (Heat source): Represents the energy that drives the radioactive decay process. Just as the heat from the stove provides the energy needed to heat the water and cause it to boil, external factors (such as the decay of radioactive isotopes or external radiation sources) provide the energy necessary for radioactive decay to occur.

Safety precautions: Just as you would take precautions to avoid burns from the hot steam or direct contact with the boiling water, it's essential to take appropriate safety measures to minimize exposure to radiation from radioactive materials. This may include using shielding, maintaining a safe distance, and following safety protocols in environments where radioactive materials are present.

Have you properly understood radioactivity and the uses of nuclear radiation?

Key Ideas

- Some students may have misconceptions about the health effects of radiation exposure, such as believing that all forms of radiation are inherently harmful or that radiation exposure always leads to immediate sickness or death. In reality, the health effects of radiation exposure depend on factors such as dose, duration, and type of radiation.
- Many students believe that radioactive materials remain hazardous indefinitely. While some radioactive isotopes have long half-lives and can persist for thousands or even millions of years, others decay relatively quickly and become harmless in a short period.
- Some students underestimate the risks associated with low-level radiation exposure. Even though the immediate health effects may be minimal, prolonged exposure to low doses of radiation can increase the risk of cancer and other health problems over time.
- While nuclear power plants and other nuclear facilities are sources of radiation exposure, radioactive materials can also be found in various industries, medical settings, and natural environments. Individuals may be exposed to radiation through everyday activities such as medical imaging procedures, air travel, and the use of consumer products.
- Many mining operations involve extracting minerals and ores that contain naturally occurring radioactive materials such as uranium, thorium, and radium. When these materials are excavated and processed, radioactive dust and gases can be released into

the environment, leading to increased radiation levels in the surrounding air, water, and soil putting people around the area at risk. People who consume contaminated water or use it for irrigation may be exposed to radiation through ingestion and skin contact. Inhalation of radioactive dust particles can lead to internal radiation exposure and increase the risk of respiratory diseases and lung cancer. In fact radiation can also affect people from a distance. Most importantly, in medicine, radiation is used to see how organs or tissue are functioning (for diagnosis) or to target and destroy damaged or diseased organs or tissue (for treatment).

Assessment

- Discuss about the different types of nuclear radiation and their uses in medicine, energy production, agriculture etc.,

Implications to teaching

- By addressing these misconceptions and following safety rules and guidelines, individuals can effectively mitigate the risks associated with nuclear radiation exposure and ensure a safe working environment in settings where radioactive materials are present.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about the radioactivity and safety rules against hazards of nuclear radiation, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the nucleus in a better way.
  https://phet.colorado.edu/en/simulations/alpha-decay

11.3 Nuclear reaction and energy production (2 hrs)

At the end of this lesson, trainees will be able to:

- devise activities and strategies to teach nuclear reaction and energy production,
- identify some misconceptions related to nuclear reaction and take corrective measures.

In this lesson, you are going to learn about nuclear reaction and energy production. Diagrams, animations, or models will be used to illustrate the lesson. Virtual lab activities or interactive online resources will also be employed to make it more understandable. The lesson will also be linked to real life situations. Let us start the session with your teaching experience.

Activity 1

- How have you been teaching nuclear reaction and energy production?
- What kind of misconceptions have you identified in relation to this topic?

There are several common misconceptions related to radioactivity and uses of nuclear radiation. Some of them reported in literature are listed below.

- All nuclear reactions lead to explosions
- Nuclear reactions always produce radioactive waste
- Nuclear energy is highly unsafe
- Nuclear energy equals nuclear weapons:

Are the misconceptions that you identified match with those reported in literature? Now let us do some activities in relation to this topic.

Activity 2

Organize a discussion forum

1. on how nuclear fusion acts as a source energy in the sun.
2. nuclear reactions are employed in food safety and preservation.

Activity 3

Watch the following video in groups. Each group member should reflect what he/she understood from it.

https://www.youtube.com/watch?v=mBdVK4cqiFs

Have you properly understood radioactivity and the uses of nuclear radiation?

Key Ideas

- While some nuclear reactions, such as nuclear fission in atomic bombs or nuclear fusion in thermonuclear weapons, can indeed result in explosions, not all nuclear reactions have explosive outcomes. Many nuclear reactions, such as those used in nuclear power plants or medical applications, are carefully controlled and do not lead to explosions.

- While nuclear reactions can indeed produce radioactive byproducts, not all nuclear reactions result in long-lived radioactive waste. Some nuclear reactions produce short-lived isotopes that decay relatively quickly, while others produce stable or non-radioactive isotopes. Additionally, advancements in nuclear technology and waste management techniques aim to minimize the generation and impact of radioactive waste.
- There is a prevalent misconception that nuclear energy is extremely hazardous and catastrophic. Modern nuclear power plants incorporate advanced safety features and tight regulations to minimize risks. Statistically, nuclear energy has one of the lowest rates of accidents and fatalities compared to other energy sources like coal or oil.
- Some people assume that all nuclear facilities contribute to rapid increase in nuclear weapons. In reality, nuclear power plants generate electricity for civilian use and are subject to international laws to prevent the diversion of nuclear materials for military purposes.

Assessment

- How nuclear power plants provide a significant portion of the world's electricity supply, contributing to the operation of homes, businesses, and industries?

Implications to teaching

- Addressing these misconceptions requires clear communication, public education, and evidence-based discourse to foster informed decision-making and policy development regarding nuclear energy and its role in the transition to a sustainable energy future.
- Literatures support the importance of linking the concept you teach to trainees real life scenarios like the one we used in the above activities so as to make the teaching and learning process more attractive and understandable.
- Do you have any other teaching strategy that you suggest for teaching this topic? If yes, please share it to your colleagues.

Takeaway resources

- To know more about nuclear reaction and energy production, read grade 11 physics textbook.
- Perform force PHET experiment simulation using the following link so as to understand the nucleus in a better way.
    - https://phet.colorado.edu/en/simulations/nuclear-fission

Chapter Summary

In this chapter, we have dealt with the teaching-learning of the physics of nuclear physics. Specifically, we have considered the following aspects:

- Explanation of nuclear physics as the field of science concerned with the behavior and properties of atomic nuclei. It explores the structure, interactions, and transformations of atomic nuclei, which are composed of protons and neutron.
- Explanation of radioactivity as a spontaneous emission of particles or radiation from unstable atomic nuclei, often resulting in the transformation of one element into another.
- Explanation of nuclear fission as the splitting of a heavy nucleus into lighter nuclei, releasing a large amount of energy. It is applicable in nuclear power plants and nuclear weapons.
- Explanation of nuclear fusion as the combining of light nuclei to form a heavier nucleus, releasing a tremendous amount of energy.

In discussing these concepts, we have primarily dwelt upon how to make their learning interesting and how to resolve the difficulties faced by trainees. We have shared our experiences and suggestions for using a variety of strategies, activities and methods aimed at involving trainees actively in the learning process, encouraging them to think on their own and work out the connections between physical phenomena and their conceptual understanding. At the same time, we have also emphasized the importance of teaching the language of physics with the required precision.

We have also suggested some ideas for assessing whether trainees have been able to learn the concepts better by following these methods.

References

- *Physics Textbook (2015). Austin, Tex. :Texas Education Agency*
- *Ethiopian secondary schools Physics Textbooks*

Part II – Educational Technology

Part II – Educational Technology

Introduction

This Educational Technology training manual is developed by EdTech Hub ET in collaboration with the Ministry of Education (MOE) to empower general education teachers to leverage technology effectively in their teaching and learning practices. Built upon the UNESCO ICT Competency Framework for Teachers (2018), MoE Digital Competency Framework and the TPACK model of technology integration as its conceptual framework, the manual provides practical guide on how to integrate technology in secondary school teachings. Further contextual factors have been considered, and several consultative workshops were conducted to develop the material.

This professional development resource aims at entrenching digital literacy in teaching and learning, equipping teachers, and learners with ICT skills, and enhancing their capacity to use technology in their day-to-day activities. Above all, it helps teachers to consider and use any locally available technologies for teaching and learning purposes.

The manual helps teachers and practitioners in secondary schools to practice creative use of technology in their classrooms. However, the material is not a comprehensive how-to guide, rather it provides initial possible strategies and practical exercises for schools to consider integrating technology in their lessons. Teachers are encouraged to further explore on EdTech subjects to have a detailed knowledge and skills in their efforts to leverage technology in their lessons through participating in continuous professional development activities.

The first unit of the material details educational technology related concepts, locally available digital resources and their practical implication at the school level. The second unit looks at the basic digital skills needed in our daily life which encompasses through navigating computer and smartphones, connecting to the internet, using the worldwide and web and google educational apps. The subsequent units' contents (units three through five) are intended to help teachers explore various digital tools and resources that will assist them in incorporating technology into their lessons. The emphasis has been on how to help teachers improve both subject knowledge and digital literacy simultaneously. Each unit's sessions feature practical suggestions for the classroom and out-of-school practices, as well as explorations of free web-based resources and activities for preparing. The final unit focuses on the safety and security procedures that should be implemented when using digital resources and working online to preserve teacher data and safety.

The module is suitable for both new and experienced general education teachers, offering comprehensive coverage of essential topics such as an introduction to educational technology, digital technology tools, open educational resources, and digital citizenship. To fully grasp the material, participants can expect to invest approximately two full days in face-to-face setting or two weeks of online teaching in completing the course.

Pedagogical Approach

The pedagogical approach employed in developing this module aligns with the experiential learning model**.** Learners actively engage with new information through a variety of interactive methods, including discussions, demonstrations, question-and-answer sessions, and other activities. These experiences serve as the foundation for their learning journey, providing concrete encounters that facilitate understanding.

After these initial experiences, learners enter a reflective phase. During this stage, they contemplate their encounters, draw connections to existing knowledge, and conceptualize the newly acquired concepts. Often, this reflective process leads to the understanding of the educational implication and development of novel ideas based on their experiences. Finally, learners are encouraged to engage in a self-assessment to measure and test their understanding and skills within their own context, reinforcing the learning process.

The sessions within this module are thoughtfully organized. They include a brief introduction to the topic, expected learning outcomes, specific activities, key ideas, implications for learning, and takeaways. Teachers are prompted to respond to key questions and note down activity points for future reference. Consider recording these insights in your portfolio using the provided handout. This structured approach serves as a quick reference for understanding digital literacy and its practical application in teaching and learning. The key ideas highlight essential information related to the topic, enabling educators to apply their learning effectively. Additionally, supplementary reading resources are provided for offline activities and further practice. Overall, this process reflects the experiential model of learning.

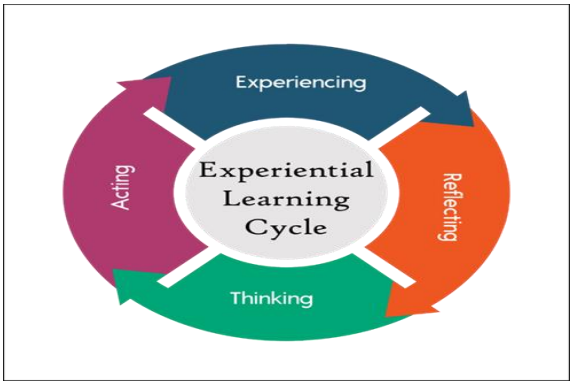


Figure 1: Experiential Learning Cycle; Source: Bing

Training Delivery Methods

In this digital skills training, we leverage a variety of online platforms to facilitate our sessions. Engaging in numerous activities across these platforms offers dual advantages. Firstly, it enhances the interactivity and user-friendliness of our training sessions. Secondly, it grants participants hands-on experience with diverse educational tools, which they can then seamlessly integrate into their teaching practices upon returning to their respective schools. Facilitators are advised to familiarize themselves with these digital tools in advance, ensuring a smooth guidance process for the participants. Facilitators are also required to complete the online EdTech course in advance as it enables them practice with different online training tools and the content of the training. A link to the online training is provided in unit five of this material.

Materials needed to during the Training

As a trainee, you'll require a copy of the trainees' guide (this document), a general lesson plan for each day and an accompanying PowerPoint slideshow to deliver this course. During the training, refer to the relevant slides in the manual. Many of the notes from the manual are also included directly in the slides. Ensure that participants have access to an internet connection for optimal course delivery. Some parts of the course will require participants to use a computer (PC or laptop) with a slideshow program and internet access. Encourage participants to bring tablets or smartphones. Ideally, all participants should have smartphones, but if not, at least one internet-connected tablet or smartphone should be available in each group setting, as practical exercises are an integral part of the course.

Before starting the course, create a working Telegram Group among participants. The group page will serve as our online dashboard for sharing documents and information. We strongly recommend utilizing all available digital resources during course delivery and minimizing paper use.

Learning Outcomes

After completing this module, you will be able to:

- Explain importance of educational technology and its applications their subjects.
- Design technology enhanced lesson plans that can address specific learning objectives.
- Take advantage of locally available digital tools to increase student engagement and active participation.

- Engage in different online and offline educational tools to enhance students' learning outcomes and professional development.
- Use digital resources safely and securely to ensure operational efficiency and data security.

Total Allotted Time to Each Unit (Face-to-Face)

S/N	Unit	Content	Number of Sessions	Allotted Time	Remark
1	One	Understanding Educational Technology	Two	1hr 5'	
2	Two	Basic Digital Skills	Two	1hr 10'	
3	Three	The use of social media for Education Purpose	One	1hr 25'	With practice
4	Four	Online Educational Tools	Three	3hr 20'	With practice
5	Five	Accessing and Creating Digital Content	Three	3hr 50'	With Practice
6	Six	Digital Citizenship	Two	1hr 10'	

UNIT ONE: UNDERSTANDING EDUCATIONAL TECHNOLOGY

Introduction

This unit provides you with a set of activities designed to explore the concept of educational technologies and digital literacy. It supports you to understand digital literacy in light of its implications for classroom teaching and learning. You will delve into the concept of educational technology and discuss its impact on how students learn and how you can teach. In addition, you will also explore any possible technologies available in their local areas. Further, it will enable you to explore the concept of Teaching and Larning Using Locally Available Resource (TALULAR) as a framework for identifying technology-based learning resources. This includes digital resources within your schools and towns, tech-savvy colleagues, and even relevant institutions. Think of this session as a springboard for seamlessly integrating technology into your learning environments.

Learning Objectives

At the end of this unit, you will be able to:

- Explore digital resources in your school and consider their use for teaching and learning activities.
- Explain the concept of educational technology and its application in teaching and learning practices.
- Identify key digital literacy skills and its implication for teaching and learning.

Key Topics

Session One: Locally available digital resources and their function

Session Two: The concept of educational technology and digital literacy

Session One: Locally available digital resources and their function.

Introduction

This session contains activities that are designed to provide you with an opportunity to explore any possible technologies available in your school and local areas. It will provide a useful starting point to think of using locally available digital resources in your classroom instruction and professional development. They will further explore the concept of TALULAR for technology-related learning resources. TALULAR is an acronym that stands for Teaching and

Learning Using Locally Available Resources. There are different technological resources available in your local context that can be used for teaching and learning. These resources might include any digital resource in your schools.

Activity 1.1. Individual Task (10 minutes)

Individually, list down all digital resources you might know and their possible uses in our daily lives. Consider how technologies are being used in your town, country, and the world at large.

NB: Use Slido/Menti.com to respond (your facilitator will give you a link to Slido.com or Menti.com). After all your peers share their answers on a link shared by your trainer a word cloud will be created as shown figure 1.

Facilitator Notes

Generate a link to https://www.slido.com/ or https://www.mentimeter.com/ and distribute it to participants. Then direct them to submit their responses via the chosen platform. They will also learn how to create word clouds and use the platforms by doing so. In the event of offline sessions or connectivity issues, provide participants with sticky notes to jot down their responses.

You can create a word cloud like the below one through different online tools like menti.com, kahoot.it, and other related apps. Step-by-step guidelines have been provided in the digital tools' session.

Figure 2: Word Cloud

Activity 1.2. Group Discussion on your digital experience (15 minutes)

In groups of four to six, share your experience of using digital content or resource in your classroom or elsewhere for teaching and learning purpose.

- What was the topic of your lesson?
- How you use digital content or digital resource?
- How do you prepare or from where did you get the content or the resource?

NB: Share your response to the wider team (whole class) through one of the interactive online tools or use a flipchart to share your group discussion.

Facilitator Notes

Provide participants with a link to an online collaboration dashboard, such as Padlet or Jamboard, and instruct them to post their group discussions on the platform. In cases of connectivity issues, participants may use a flipchart to present their discussions. However, they are encouraged to utilize digital platforms for their presentations to foster creativity. Emphasizing the educational benefits of technology, such as reducing paper usage, encourages participants to employ all available digital resources to disseminate their discussion outcomes. For instance, they could photograph their discussion and upload it to the Telegram group page. The facilitator can then display these images via a projector for the entire class to view.

Activity 1.3. Explore Digital Experience of a Teacher (15 minutes)

Case Story 1

At Sendafa Secondary School, Mr. Menberu, a dedicated physics teacher, sought to enhance student engagement through interactive learning. Despite resource constraints, his ambition to incorporate technology into his teaching led him to utilize locally available digital tools. Mr. Menberu identified several underused assets within the school, including desktop computers, plasma TVs, tablets, and his personal smartphone. Conversations with the school principal, Mr. Aman, and the ICT teacher, Mr. Naol, revealed that these tools could be effectively employed for educational purposes with minimal maintenance. Recognizing Mr. Menberu's enthusiasm, the school also provided him with complimentary Wi-Fi access to facilitate the use of online educational resources. To Mr. Menberu's surprise, he discovered that many students had access to smartphones and TVs at home. After assessing all available digital resources, he collaborated with Mr. Naol and his department colleagues to devise strategies for leveraging these technologies to make physics more engaging and understandable. Mr. Menberu's initiatives included:

- ✓ ***Establishing a Telegram group for his class to distribute educational content and maintain communication with students and parents.***
- ✓ ***Offering downloadable video lectures for students to view on any accessible device.***
- ✓ ***Encouraging students to engage with educational TV programs, providing them with specific channel recommendations.***
- ✓ ***Introducing students to physics simulations via the PhET app in the school's digital hub.***
- ✓ ***Utilizing the classroom's plasma TVs to display images and videos that complemented his lessons.***
- ✓ ***Creating PowerPoint presentations to further enrich his teaching materials.***

Mr. Menberu's Educational Technology use not only revitalized his physics lessons but also ignited a newfound appreciation for the subject among his students. The positive shift in student performance was evident, and his classroom soon became an exemplar for

fellow educators, inspiring them to harness the power of technology in their teaching practices.

Read case story 1 and reflect on the following questions based on Mr. Menberu's experiences:

- What did you learn from his approach to digital integration in his teaching?
- Identify the types of digital content/tools he discovered to aid his students' learning?
- What are the effects of Mr. Memberu's using of digital resources in his classroom?
- How can you apply his experience to your own teaching and learning context within your subject areas?

Session Two: The Concept of Educational Technology

Introduction

In this session, you will investigate various definitions of educational technology and interpret the concept through practices. You will also explore what does not constitute Educational Technology and address common misconceptions within the educational context. They will formulate their personalized definition of educational technology, having examined different concepts in the area. Finally, they will explore key concepts of digital literacy and their implication for teaching and learning.

Activity 2.1. Individual activity on myths about Educational Technology (10 minutes)

This activity helps trainees to identify and explore what is commonly referred to as digital literacy or educational technology but in actual teaching and learning, they are not. Post agree and disagree signs on the wall and read aloud the below sentences then ask participants whether they agree or not. Then, ask them why they agree or disagree.

Facilitator Notes

Read out the below statements one at a time and ask participants to agree or disagree giving reason for their choice. Alternatively, you can attach 'agree' and 'disagree' signs on the opposite walls and conduct the activity in groups. Participants need to have a clear understanding of the various concepts of educational technology particularly as they relate to teaching and learning practices.

Educational Technology

- Educational Technology is merely the ability to use digital technologies (disagree)

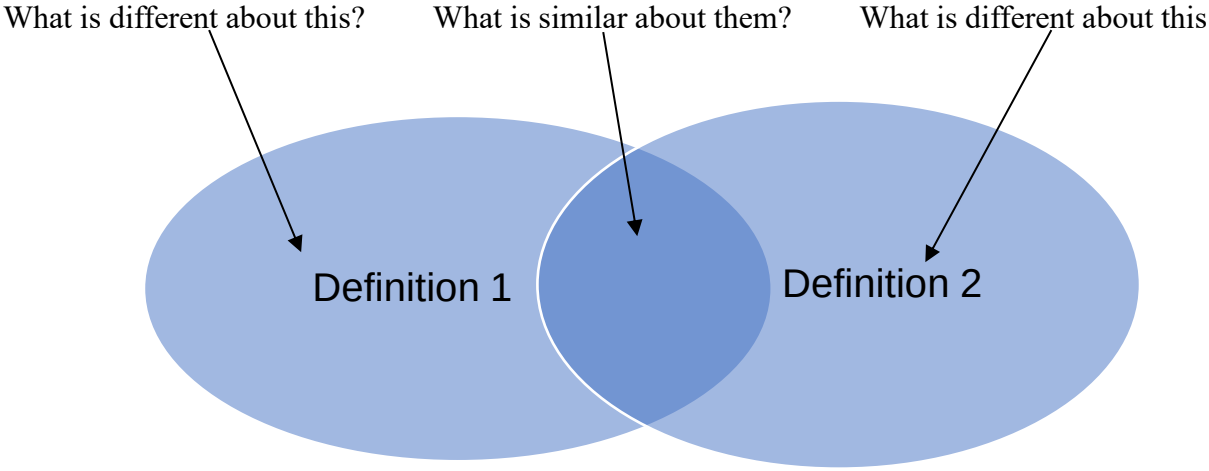
- Being able to understand how a tool works do not tell us how effect it is being used, or the value or purpose for which it is being used.

- Educational Technology is just a set of basic computer skills related to the use of hardware, software, and online resources (disagree). EdTech is the use of hardware, software, and online resources to improve students learning outcomes.
- Digital literacy includes the ability to use digital technology safely and securely (agree). But, while e-safety and security are essential aspects of digital literacy, this is far from the whole picture; it also encompasses the use of technology as methodology, assessment tools, classroom management and to access to digital contents.

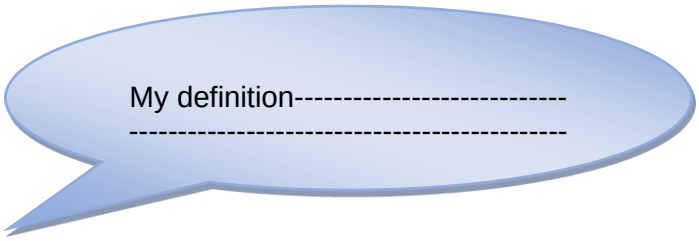
- The ultimate purpose of Educational Technology practices is to use different online and offline educational resources (disagree). The ultimate purpose of EdTech is to improve students' learning outcomes through using any available technology. We use technology not for the sake of using it, but only to improve learning outcomes.

Activity 2.2. Define Educational Technology (**Individual task 10 minutes)**

Individually go to the list of definitions in the 'key ideas' below, then choose two of the definitions provided, the one you are most drawn to and the one which you think is more related to teaching and learning. Then, compare the two definitions. Take the parts of each definition that make the most sense to you and write your definition of educational technology. Share your definition on https://jamboard.google.com/. A specific link to Jamboard will be provided by the facilitator. You might also share your definitions on Telegram group page.



Take the parts of each definition that make the most sense to you and write your own definition of educational technology.



Facilitator Notes

This activity provides practitioners with several definitions of educational technology and supports them to identify common futures among the definitions. They will review the definitions considering their usefulness in teaching and learning. Finally, they will develop their definition of digital literacy.

Key Ideas

In today's digital age, educators have access to a variety of resources, but it's essential to recognize that not all schools or educational settings have equal access to high-tech gadgets or sophisticated digital tools. In many cases, locally available resources play a crucial role in enhancing the teaching and learning experience. Traditional media such as television and radio remain relevant even in the digital era. For instance, Plazma TVs allow teachers to display visual content by project educational videos, animations, or slideshows to enhance explanations and engage students. Again, almost every teacher carries a smartphone these days, even including students. Teachers can use their phones to look up information on the spot, for capturing photos or videos during field trips or experiments and other activities as well. Besides, teachers might also consider using radios for audio-based learning and access to educational broadcast programmes. Similarly, teachers might consider using other digital resources to improve their teaching and learning practices. let's not overlook the value of familiar tools like TVs, radios, and mobile devices. By thoughtfully harnessing these resources, teachers can create dynamic and engaging learning environments that benefit all students.

Definitions of Educational Technologies

- Educational Technology is the use of technology in the instructional processes to enhance both teaching and learning.
- Educational Technology is the use of multimedia to create engaging, effective learning experiences.

- Educational technology is the use of available technological tools for pedagogical purposes and motivation.
- Educational technology is the l use of technology, such as computers, digital technology, and networked digital devices as well as theories for educational purpose in ethical way.
- Educational technology is the use of digital technology in teaching and learning as methodologies, classroom management, formative assessments, teachers' training, etc tools.

Implication to Teaching

Record your responses to the following questions as your key learning areas and future consideration on your handout.

- What did you learn about Educational Technology and how are you going to apply it in your practice?
- What digital resources are easily available in your school and how are you going to use them next year?
- What adjustment you would do to your practice to integrate technology into your lesson based on the above activities?

Self-Assessment (Unit One)

1. What is the acronym TALULAR and how does it relate to technology-based learning resources?
   A. Teaching And Learning Using Locally Available Resources; it helps identify technology-based learning resources
   B. Technology And Learning Using Local Applications; it focuses on digital literacy skills
   C. Teaching And Learning Using Advanced Resources; it emphasizes online educational resources
   D. Technology And Learning Using Global Tools; it highlights the use of international digital resources

2. What is the importance of digital literacy in navigating the digital landscape?
   A. It equips individuals to evaluate information critically
   B. It focuses on technical proficiency only
   C. It enhances personal and professional development
   D. It is a luxury rather than a necessity

3. How can teachers leverage digital literacy skills to enhance their teaching and learning activities?
   A. By accessing a vast library of online content

B. By collaborating with students on digital platforms
C. By sharing engaging resources
D. All of the above

4. What is the role of technology in our daily life?
   A. Technology is irrelevant in our daily routines
   B. Technology enhances connectivity and productivity
   C. We can live without technology
   D. Technology benefits only specific group of people

5. One of the following is very important to integrate technology into lesson?
   A. Level of advance of technology
   B. Availability of online resources
   C. Learning outcomes
   D. None of the above

Reference Materials

Type	Resources
Read	Making Teaching from Locally available resources
Read	We are Teachers online Resources
Read	Definition of Educational Technology
Watch	What is Digital Literacy?
Watch	Why Digital Literacy matters?

UNIT TWO: BASIC DIGITAL SKILLS

Introduction

This unit delves into basic digital skills such as basic organisation of computers, connecting to the intermate, using search engines, and email account creation. The sessions in this unit provides you an overview of the fundamental components of a computer followed by bridging the gap between your computer and the vast world of information. Mastering internet connectivity helps you to access a universe of resources at your fingertips. No exploration of the digital world is complete without harnessing the power of search engines. Here, you'll gain the expertise to navigate these powerful tools effectively, allowing you to locate information with precision and efficiency.

Finally, you will build the skills to create and manage email accounts, transforming them into valuable tools for communication with students, colleagues, and anyone in your professional network. You will also explore the role of email as a tool for teaching and learning.

Learning Objectives

At the end of this chapter, you will be able to:

- Identify different parts of computers and their functions.
- Use the Internet, the World Wide Web, and search engines.
- Create your own personal email account and start using it to improve your teaching and learning practices.
- Exercise using Google Educational Apps for classroom instruction.

Key Topics

Session One: Computers and Smartphones

Session two: Using Web Browser and Email

Session Three: Google Educational Apps

Session One: Computers and Smartphones

Both computers and smartphones are powerful tools that have revolutionized the way we live, work, and communicate. However, they have distinct differences in terms of functionality, portability, and

processing power. In this session, you will explore different parts of a computer and its function. Computers, including desktops and laptops, offer greater processing power and storage capacity compared to smartphones. They are ideal for demanding tasks like video editing, gaming, and running complex software.

Smartphones on the other hand, are small, portable devices that offer a wide range of features, including communication, entertainment, and productivity tools. They are powered by mobile operating systems like Android and iOS, and their processing power has significantly increased in recent years.

Activity 1. 1. Navigating Computer (Peer work – 15 minutes)

Take a moment to observe the computer or laptop you are currently using at school or plan to use in the future. Answer the following questions by discussing with your peer.

- What are the different parts of your computer/laptop/desktop? Categorize the hardware parts of the computer into input, process, and output devices.
- What do you do with your computer (Desktop or laptop) you bring with you or find at your schools?
- Are you using computers as teaching and learning tools in your teaching and learning? For what purpose did you use them in teaching and learning?

Activity 1.2. Navigating your phone (Think Pair Share – 10 minutes)

Mobile phones are emerging to be strong learning tools if used appropriately. Still, some educators believe that using cell phones might be a distraction in schools and classrooms as students might use them inappropriately. While still, this remains true, educators and teachers found that phones can be turned into learning tools by putting in place good school rules and policies. Phones have evolved over the years into powerful teaching aids that, when used appropriately, can improve learning outcomes.

Take a time to observe your phone's functions. Consider how you could use your cell phone to assist your students learn better in class. (Consider your local environment) What types of tasks can you complete with your phone as a teacher? Pair your answer with your peer sitting next to you, then share with the whole class what you both have discussed and matched.

Session Two: Using Web Browsers

In this session, you will explore the internet and its use to connect you with a global network which allows for communication and resource sharing across the world. World Wide Web, also known as the web, is a system which contains resources that are accessed through the internet.

The World Wide Web uses website sites to create virtual spaces on the internet where videos, files, images, and other digital resources are stored so that you can view, store and retrieve them.

Activity 2.1. Connecting to the Internet (Individual Practice – 5 minutes)

- How would you connect to the internet through your phone or computer?
- Using any digital device you have on your hand, please connect to the internet, and do something. And then show it to your friend or Facilitator?

Facilitator Note:

Conclude the discussion by mentioning that we can connect to the internet in different ways including through data on your phone, WIFI or cables. Wi-Fi is a wireless technology that enables electronic devices with wireless adapters such as laptops, mobile phones, TVs, and tablets to connect to the internet.

Activity 2.2. Using a Web Browser (Group discussion – 15 minutes)

In a group of four to six, engage in a discussion about the following questions:

Figure 3: Different Browsers

- What is a web browser?
- Which web browsers do you typically use?
- How have you utilized web browsers to enhance your teaching and learning processes?

NB: Share your response to the wider team (whole class) through one of the interactive online tools or use a flipchart to share your group discussion.

Activity 2.3. Use of Emails (Group Discussion – 10 minutes)

This activity introduces participants to email ultimately aiming at helping them use email as a communication tool.

Group Discussion (10 minutes)

In groups of four to six, discuss the following questions.

- What is email and how does it function?
- What are the benefits of using email in educational settings?

Figure 4:Email; Source@pixabay

- What are your current email habits and challenges? How often do you check your emails?
- With whom do you usually use emails and for what purposes?
- How can teachers use email for teaching and learning?

Activity 2.4. Create your email (Demonstration - 25 minutes)

Click on this (How to create a gmail account) and watch the video about email creation and then create your email. You can also follow the steps provided in the box below as you create your email. Once, you watch the demonstration, create at least two email accounts on Gmail and Outlook email platforms.

What to do:
To create gmail account follow the following steps.

- **Go to the Google Account sign in page.**
- **Click Create account.**
- **Enter your name.**
- **In the "Username" field, enter a username.**
- **Enter a secured password and confirm your password.**

What to do:
To create an Outlook email account, you need to follow these steps.

- Go to the Microsoft Outlook website and select Create free account.
- Click Get a new email address. You can choose between @outlook.com or @hotmail.com as your domain name.
- Choose a username that is unique and easy to remember. If your username is already taken, you will need to pick another one.
- Create a password that is strong and secure. You can use a combination of letters, numbers, and symbols.
- Enter your personal information, such as your name, birthdate, and country or region.

- Verify your account by entering the code that is sent to your phone number or alternate email address.

Activity 2.5. Send email messages (Individual Task - 15 minutes)

Now you have already created an email account, please send a message to at least five participants including your facilitator. Then in a group, reflect on the following questions:

- How do you find your experience? Was it difficult or easy?
- What are the common features you saw on the email page? List down all the features on the email page?

Facilitator Notes

Following participants reflection, please show them the main features on email page such as new email (compose new email), inbox, outbox, sent items, delete, etc.

Activity 2.6. Accessing and Navigating Google workspace

Google Workspace for Education provides free educational apps for students and educators. These tools cover various learning needs and include popular options like Google Docs, Sheets, and Slides for collaborative document creation; Google Classroom for managing online classes, Google Search for finding information, and Google Scholar for academic resources. In this activity, you'll learn how to access these tools easily. Later, we'll explore the use of some of these tools in more detail.

Figure 5: Google Apps

Open the Google Chrome website (Google website) and explore the page. Specifically, open the nine dots you see in the top right corner of the Google Chrome browser which represent the app launcher or app grid. When you click on these dots, it opens a menu that provides access to various Google apps. You can find shortcuts

to apps like Gmail, Google Drive, Google Form, and more. This is a convenient way to quickly access your favourite Google tools.

Demonstration- 20 Minutes

Use the following what to instruction and access different google apps using the app grid, Navigate the app, list different apps you accessed and state their function. Practice adding and removing different apps into the app launcher.

What to do:

Follow the below guide to access different Google apps either on your computer or phone.

- **Make sure you have a Google account: If you use Gmail, YouTube, or other Google services, you already have one.**
- **Open Chrome browser and go to a Google website.**
- **Log in to your Google account (if not already signed in)**
- **Look for the App Launcher icon: It's a grid of nine small squares, usually located in the top right corner of the webpage.**
- **Click on the App Launcher icon. This will display a list of various Google Apps you can access.**
- **Choose the Google App you want to use: Click on the icon for the desired app (like Docs, Sheets, Slides, Classroom, etc.) to launch it within the Chrome browser window.**

Facilitator Note (Optional): *Show participants a five-minute video taken from the reference section. Then ask participants to access google apps through app launcher or app grid on chrome/google website either through their phone or laptop. Give them some time (10 minutes) to do this.*

Key Ideas

Computers

Figure 6; Source @Google Image

A computer, typically positioned on a desk, is specifically crafted for individual use. It comprises various interconnected components, functioning as a cohesive unit. Computer hardware parts are categorised into three parts:

- Input Devices: These are the tools that allow you to interact with your computer. Think keyboards, mice, touchscreens, webcams, and microphones. How do you use these to provide instructions and information to your computer?
- Processing Unit: Imagine this as the brain of your computer. It receives your instructions from the input devices, processes them, and generates the desired results.
- Output Devices: These are the components that display the results of your computer's work. Monitors, printers, and speakers fall into this category. How do they translate the computer's calculations into a form you can understand and interact with?

Computers can be powerful tools that can revolutionize teaching and learning, offering a range of benefits for both students and educators. From providing access to information to fostering collaboration and developing digital skills, computers have become an integral part of the modern educational landscape.

Smartphones

Smartphones serve as powerful educational tools, providing a portable repository of information and interactive learning possibilities. Smartphones can be utilized both in the classroom and for personal learning for the following activities:

- Access to Information: Students and teachers can instantly tap into the vast internet resources for research, answering questions, and exploring new topics.
- Educational Apps: Numerous subject-specific apps cater to various age groups and learning styles. These apps offer interactive exercises, simulations, and engaging games.
- Collaboration Tools: Communication apps allow students to form study groups, collaborate on projects, and share ideas beyond the classroom.
- Creative Learning: Teachers can use smartphones to create educational videos, presentations, or podcasts, reinforcing their understanding and showcasing their learning.

World Wide Web and Browsers

The World Wide Web, commonly known as the web, is a vast system that houses resources accessible through the internet. Websites create virtual spaces on the web where videos, files, images, and other digital content are stored. As users, we can view, store, and retrieve these resources. Connecting to the internet via Wi-Fi, data, or cable allows our electronic devices such as laptops, mobile phones, TVs, and tablets to access this wealth of information.

As educators, the internet provides us access to information on nearly any subject matter. Whether you're researching, learning, or exploring, the web is a treasure trove of knowledge. Beyond information, the internet enhances our ability to communicate and collaborate with people worldwide.

Web Browsers

A web browser is application software that enables you to access resources and websites on the World Wide Web. Several popular browsers include Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Edge. These browsers operate similarly and share common controls. Once you master one browser, you'll find it easier to navigate others as well.

Email

Email (electronic mail) is the exchange of computer-stored messages from one user to one or more recipients via the internet. Emails are a fast, inexpensive and accessible way to communicate for business or personal use. Users can send emails from anywhere as long as they have an internet connection. Emails are a great way to communicate with colleagues, students, and parents, as well as to share information, resources, and feedback.

Besides communication, you need an email to access and use the majority of educational tools. Therefore, it is advisable for teachers to have two email accounts: one on Gmail and one on Microsoft. The Gmail account allows you to use Google's free products, while the Microsoft account enables you to access Microsoft's products.

Implication to Teaching

Please note down your reflections on the following prompts, which will serve as key takeaways and future action points:

- Reflect on the insights gained from the session, including any new abilities and knowledge acquired. How do you intend to integrate these into your teaching methods?

- Share your discoveries about the use of email. How do you foresee implementing email communication moving forward?
- List down at least five educational applications provided by Google.
- How would you intend to use different web browsers for educational purposes?

Self-Assessment

1. How does a monitor help you interact with your computer?
   A. It translates calculations into a visual form.
   B. It allows you to type instructions.
   C. It processes information.
   D. It stores data.
2. Smartphones can be used for educational purposes by:
   A. Restricting access to certain websites.
   B. Downloading social media apps.
   C. Providing access to educational apps and the internet.
   D. Making phone calls.

3. Web browsers allow you to access:
   A. Your computer's files
   B. Websites on the World Wide Web
   C. Only educational resources
   D. Video games

4. Which of the following is NOT a popular web browser in Ethiopia?
   A. Google Chrome
   B. Mozilla Firefox
   C. Microsoft Edge
   D. None of the above

5. Email is primarily used for:
   A. Storing documents online
   B. Sending messages electronically
   C. Playing games
   D. Watching videos

6. Why might a teacher need two email accounts (Gmail and Microsoft)?
    A. To separate personal and professional emails.
    B. To access specific educational tools.
    C. Because Gmail is free and Microsoft is not.
    D. There is no specific reason; one account is sufficient.

Reference Materials

Type	Resources
Watch	Components of Computer System
Watch	Usage of Smartphones
Read	Computer Organisation and Design Books
Read	Set up Google Workspace on an Android device - Google Workspace Learning Center
Read	Microsoft Support
Watch	What is Web Browser?
Watch	How to create email account on Outlook?
Watch	Google Workspace Beginner Guide

UNIT THREE: THE USE OF SOCIAL MEDIA FOR EDUCATIONAL PURPOSES

Introduction

In this unit, you will explore the possibility of leveraging social media platforms, specifically Telegram and Facebook, for educational purposes. These platforms offer a myriad of possibilities for enhancing teaching and learning experiences. By harnessing their features, educators can engage with students, foster collaborative learning environments, share resources, and facilitate discussions. Whether it's creating study groups, disseminating course materials, or encouraging peer interaction, these social media channels hold immense potential to enrich educational practices. Participants will explore strategies, best practices, and activities that demonstrate how these platforms can be effectively integrated into the teaching and learning process, ultimately contributing to improved learning outcomes.

Learning Objectives

At the end of this chapter, you will be able to:

- Explore the use of social media for educational purposes.
- Utilize social media platforms such as Telegram and Facebook to improve your teaching and learning practices.

Session One: Social Media for Educational Purpose

Introduction

In this session, we will explore the use of social media like Facebook and Telegram to facilitate communication between teachers, students, and parents. Using such platforms facilitate discussions, Q&A sessions, and announcements.

Social media can also liven up learning with interactive features like polls and quizzes, while sharing educational resources like videos and articles keeps students engaged. By integrating social media strategically in their teaching and learning, teachers can create a dynamic and engaging learning environment that fosters collaboration, critical thinking, and engagement

Activity 1.1. Using Telegram as Educational Tool (Group work – 10 minutes)

Figure 7;Source@Google Image

In group of four to six, discuss on the following questions.

- What are the benefits of using Telegram in educational settings?
- How can teachers use Telegram for teaching and learning?

Demonstration (20 minutes)

Use the following Instruction and create a Telegram group. Add your peers or contacts from you address book as a member. Please practice sharing questions, videos and create poll in your telegram group.

What to do:

Step 1: Create Telegram Account

- **Connect to the Internet/Turn on mobile phone data.**
- **Click on play store/App store.**
- **Download Telegram on your phone Step.**
- **Install Telegram application.**

Step 2: Form Telegram Group

- **Launch Telegram application.**
- **Select new group.**
- **Add your students by selecting from phone book.**
- **Name the group.**
- **Start posting learning materials in the form of images, documents or texts to the group.**

Facilitator Note

Create a group of four participants (group them by subject matter) and take them through the telegram app. Assist them to create group, post assignment, videos, create poll and complete other functionalities on the app.

Optional: Show them the five-minute video on the use of the Telegram app and then ask participants to create group, post assignment, videos, create poll and complete other functionalities on the app.

Activity 1.2. Using Facebook for educational purposes (Group Work - 10 minutes)

Facebook can be utilized for educational objectives in various ways, enhancing interaction, involvement, and a sense of community beyond the traditional classroom setting. By establishing private groups for your classes, you can encourage ongoing discussions, host question-and-answer sessions, and share educational materials outside of regular school hours.

Figure 8;Source Google Image

In groups of four to six discuss on the following questions:

- Do you have Facebook account? What is your experience of using Facebook?
- Have you used it for educational purposes? How Facebook will be used for educational purposes?

Demonstration (10 minutes)

Demonstrate how to create private groups on Facebook and then support your trainees to do the same in groups. Follow the below steps as you create closed group on Facebook.

Activity 1.3. Creating Group or Page on Facebook (Group Work - 30 minutes)

Use the following instruction and create a Facebook Group Page in your specific subject matter expertise and share relevant resources, initiate chat among your students, run live Facebook videos and complete other activities which you might think are relevant for your teaching and learning.

What to do:

- **Make sure you have a personal Facebook account.**
- **On your Facebook homepage, navigate to the "Groups" section if you want to open Facebook group or navigate to the “pages” section if you want to open Facebook page on the left-hand menu and click the ‘create group’ button on the page.**

- **Group Name: Choose a clear and appropriate name that reflects the class or subject.**

- **Privacy: Select "Closed" from the privacy options. This ensures only approved members can see the group's content.**

- **Description (Optional): Provide a brief description outlining the group's purpose and intended audience (e.g., students enrolled in Biology class).**

- **Start by inviting your students who have Facebook accounts (with parental permission if necessary). You can search for them by name or email address.**

- **As the group admin, you can approve membership requests, monitor discussions, pin important announcements, and manage content within the group.**

Key Ideas

Telegram

Telegram is a software used for communication and instant messaging and offers many possibilities such as sending various media files, in addition to making voice or video calls. The Telegram program can be used in education in many ways and means, some of which can be mentioned as follows:

- Send assignments, reading materials and tasks by students to the teacher.
- Create groups and channels for classroom.
- Create polls and quizzes
- Communicate with students from other school.
- Parents communicate with teachers to follow their children performance
- Provide e-content for the home side in the reverse learning strategy.
- Make video, audio and text announcement, lecture, and resources, etc.

Facebook

Teachers might also consider using Facebook for educational purposes in several ways, fostering communication, engagement, and community outside the classroom. You can create

private groups for your students to facilitate discussions, Q&A sessions, and sharing of resources beyond classroom hours. Through private group on Facebook, we will encourage the following activities among students.

- Collaborative Projects: Encourage students to work together on projects by using Facebook groups for brainstorming, sharing research findings, and coordinating tasks.
- Sharing Learning Resources: Post links to educational websites, articles, videos, or even create online document folders within the group for students to access relevant materials.
- Polls and Quizzes (informal): Conduct quick polls or quizzes (using third-party apps within Facebook) to gauge student understanding or gather feedback on topics.
- Announcements and Reminders: Share important updates, homework reminders, or upcoming events with the entire group or specific students through private messages.
- Virtual Field Trips and Events: Utilize Facebook Live or pre-recorded videos to share virtual tours of museums, historical sites, or connect with guest speakers remotely.
- Digital Citizenship Lessons: Facebook provides real-world context for teaching online etiquette, responsible content sharing, and critical thinking about information found online.

Important Considerations:

- Privacy is Key: Ensure groups are private and only accessible to students and parents/guardians with permission.

- Set Clear Guidelines: Establish ground rules for respectful communication and appropriate content sharing within the group.

- Parental Involvement: Keep parents informed about the group's purpose and encourage their involvement if necessary.

Additional Tips to create a Closed Facebook Group for educational purposes.

- Consider creating a separate Facebook account specifically for educational purposes, keeping it separate from your personal profile.

- Encourage students to add their full names for easier identification.

- Regularly post relevant resources and discussions to keep the group active and engaging.

Implication to Teaching

Please note down your reflections on the following prompts, which will serve as key takeaways and future action points:

- Reflect on the insights gained from the session, including any new abilities and knowledge acquired. How do you intend to integrate these into your teaching methods?
- Identify the features of Telegram that could be beneficial for educational activities?
- Outline your strategy for utilizing social media platforms like Facebook and Telegram to enhance educational experiences in the forthcoming period?

Self-Assessment

1. Telegram Group Engagement Task: Post a welcoming message on your previously created Telegram group page or channel. Here's a suggested greeting: "Welcome, students! This is our dedicated space for learning and growth. Let's embark on this educational journey together with enthusiasm and curiosity." Share the Telegram link with your facilitator and peers.
2. Facebook Interaction Task: Initiate a discussion on your Facebook page by posting a topic related to your subject discipline.

Reference Materials

Read	Social Media in Education
Watch	The Use of Telegram for Educational Purposes
Watch	The Use of Facebook for instruction
Watch	Social Media in Education

UNIT FOUR: ONLINE EDUCATIONAL TOOLS

Introduction

This chapter will empower teachers to leverage technology in their classrooms. You will explore a variety of online educational tools that are suited for diverse subjects and learners. The session in this unit will help you to develop the ability to select the most appropriate platforms and resources for specific learning objectives. Teachers practice how the tools might be used appropriately and incorporated into teaching and learning in a way that supports students in developing both subject knowledge and digital literacy. You will need internet access to practice these tools. But you are encouraged to critically analyse the tools in terms of developing critical thinking, problem-solving, analytical skills, etc among students. As you review each tool, please think about how possibly you apply them in your classrooms or outside all aims at improving learning outcomes.

Learning Objectives

By the end of this chapter, you will be able to:

- Identify different types of online educational technology tools that suits for teaching and learning.
- Select appropriate online tools and platforms for different purposes and audiences.
- Utilize communication, assessment and creative tools in their teaching and learning.
- Participate in online learning communities that foster digital skills among teachers, and other stakeholders.
- Utilize artificial intelligence tools during the preparation of lesson plans, assessments, and instructional materials.

Key Topics

Session One: Communication and Collaboration Tools

Session Two: Assessment Tools

Session Three. Creative Tools

Session One: Virtual Communication and Collaboration Tools

In this session, you will explore different communication and collaboration tools that help you facilitate online discussion and collaboration among students. These tools provide you with various functionalities such as live meetings, document sharing, collaborative works and many more tasks. In addition, you will explore possibilities of creating and managing your groups, and channels, share files and documents, and communicating with students.

Activity 1.1. Using Google Meet

Google Meet allows educators to easily connect and collaborate with students through links or codes, making it perfect for both planned lessons and quick discussions. This fosters remote learning by enabling online classes and virtual tutoring, regardless of location. Engagement is boosted through features like screen sharing and presentations. Google meet is accessible from both web browsers and mobile apps.

Figure 9. Google Meet; Source @Google Image

Question and Answer (5 Minute)

Could you share your experience and familiarity with Google Meet? Have you used it before or observed others using it? Have you participated in online meetings organized through the Google Meet platform? What was your experience?

Facilitator Notes:

Encourage participants to discuss their experiences with Google Meet. While it's not essential to pose every question listed previously, consider using them to guide the conversation and extract detailed insights regarding the participants' usage of Google Meet.

Demonstration (25 minutes)

Use the following instruction and demonstrate how to organize and schedule online meetings using Google Meet. Once you completed the demonstration, create your own instant meeting using Google Meet. Then allow share the meeting link with others/your peers and allow them to join the meeting and practice how you would potentially run an online meeting.

What to do: Starting a Google Meet Meeting:

There are two ways to start a Google Meet meeting:

1. **From the Google Meet website:**

- **Go to https://meet.google.com/.**
- **Click "New meeting."**
- **Choose an option:**
  - **Create a meeting for later: Get a meeting link to share and schedule the meeting for a specific time (optional).**
  - **Start an instant meeting: Join a meeting directly without needing a link beforehand.**
    - **You'll be the host of the meeting, and others can join using the meeting link or code.**

2. **From Google Calendar (if integrated):**

- **If Google Meet is integrated with your Google Calendar, you can schedule a meeting directly within Calendar.**
- **Create a new event or edit an existing one.**
- **Click "Add video conferencing" and choose "Google Meet."**
- **A meeting link will be automatically added to the event details.**
- **Invite participants to the event, and they can join the meeting using the link at the scheduled time.**

3. **Basic Controls During a Google Meet Meeting:**

- **Microphone: Mute or unmute your microphone by clicking the microphone icon.**
- **Camera: Turn your camera on or off by clicking the camera icon.**

- **Chat: Send text messages to other participants in the chat window.**
- **Screen share: Share your entire screen or a specific window with other participants.**
- **Presentation: Present content from your computer (slides, documents, etc.).**
- **Leave meeting: End the meeting for yourself (if you're the host) or leave the meeting as a participant.**

Additional Tips:

- **You can adjust your meeting settings (background blur, captions, etc.) by clicking on the three dots in the bottom right corner.**
- **Google Meet works on most web browsers and also has mobile apps for Android and iOS.**

Facilitator Notes

Please take few minutes to discuss about Google Meet and how to access the app with participants. While the trainees are trying to demonstrate and create an instance meeting or schedule using google meet please round about and assist them.

Activity 1.2. Group Discussion about your Google Meet Experiences (15 minutes)

Discuss the following questions with your group members.

- What are your thoughts on the app?
- In what ways do you intend to integrate Google Meet into your educational practices?
- Could you share your experiences with setting up and conducting an online session? Do you find Google Meet user-friendly?
- Would you be willing to take a lead in organizing concurrent online meetings via Google Meet within your department to facilitate the exchange of experiences and collaborative learning among your friends?

Activity 1.3. Exploring Padlet (Question and Answer - 10 minutes)

Figure 10;Padelt; Source @Google Image

Padlet is a digital dashboard tool designed for online collaboration and information sharing. It works like a virtual wall where users can post various content, making it an asset in the educational landscape.

- What is your experience of using Padlet as a teacher? Have you used the app before or seen others use the app for educational purposes?
- How can teachers use Padlet to foster collaborative and engaging learning experiences?
- What tasks are well-suited for an online tool like Padlet in educational settings or during instructional processes?

Facilitator Notes:

Encourage participants to discuss their experiences with Padlet. After the discussion, summarize the session with the below information about the use of Padlet for instructional purposes. Demonstrate how to set up a free padlet account and share the link with your trainees. Then ask each participant to write two personal goals on the link provided. Setting personal learning goals is an important way to guide your progress and set expectations for yourself throughout this course. write two personal goals you hope to achieve while taking this course. (Click on the + sign to write your personal goals)

Example of Personal Goals:

1. Learn about education technology and its use in classrooms

2. Practice different online educational tools

Activity 1.4. Practising using Padlet (Individual Task 15 minutes)

Using your mobile phone, create free Padlet account and use the Padlet as online presentation board to discuss a topic or assignment from your specific subject area (If your mobile phone is not functional; please work in pairs or groups).

What to do:

- **Go to https://padlet.com/ and create a free account with your email address or sign in if you already have one.**
- **Click on "Create a Padlet" button.**

- **Choose a layout for your Padlet (Wall, List, Stream, etc.) based on your content and purpose.**
- **Give your Padlet a title and description (optional).**
- **Click "Create Padlet."**
- **Click the "+" button on your Padlet to add content.**
- **Choose how you want to add content:**
  - **Text: Write directly on the Padlet.**
  - **File: Upload an image, document, or other file.**
  - **Link: Include a link to a website or resource.**
  - **Video/Audio: Embed a video or audio clip from YouTube, Vimeo, etc.**
- **Add a title and description to your content (optional).**
- **Click "Save" or press "Enter" to add the content to your Padlet board.**
- **Click the "Share" button in the top right corner.**
- **Choose a sharing method:**
  - **Copy Link: Share the link with anyone who has access.**
  - **Embed Code: Embed the Padlet on a website or learning management system.**
  - **Social Media: Share the Padlet on social media platforms.**
  - **Set privacy options for your Padlet (public, private, password-protected).**

Session Two: Assessment Tools

Introduction

In this session, we delve into a variety of online assessment tools designed to support teachers in the development of both formative and summative assessment questions for your classroom. Specifically, you will gain an understanding of diverse assessment tools and articulate their applications within an educational context. You'll also get hands-on practice with these tools, integrating them into your lesson planning. Additionally, you'll be guided through the process of creating accounts to access and utilize these various assessment tools effectively.

Activity 2.1. The use of Quizizz (Question and Answer - 5 minutes)

Figure 11;Source @Google Image

Quizizz is an online interactive tool to assign homework and provide feedback, present quizzes in the form of games and have a real-time understanding of students' academic progress.

- What is your experience of using QUIZIZZ as a teacher?
- Have you use the app before or seen others use the app for educational purpose or in a training setting?

Activity 2.2. Online live activity using QUIZIZZ (20 minutes)

How much do you know about Educational Technology? Run the below assessment using Quizizz platform (https://quizizz.com/admin/quiz/6403b3ddfe08dd001db7681d?source=quiz_share)

Facilitator Notes

During the session, ensure to comprehensively demonstrate the app's functionalities, including its ability to generate complete graded reports for each student and how to access and edit premade questions from Quizizz library. Additionally, acquaint participants with the various modes of conducting the session, such as the 'assignment' feature and the paper mode, to provide a thorough understanding of the app's functionality in different contexts.

Activity 2.3. Create your personal free QUIZIZZ account (Individual task - 15 minutes)

Use your mobile phone to create a free quizizz account and explore resources in your subject area (If your mobile phone is not functional; please work in pairs or groups). You can also download the app from Play Store or App Store for optimal use of the app.

What to do:

- **Go to https://quizizz.com and log in, or if you are a new user, click 'Get started' and create a new account by using your email address.**
- **To use an existing quiz, select the 'Search for quizzes' box and browse. If you want to create your own quiz, select 'Create a new quiz', enter a name for the quiz, and choose the relevant subjects. Choose a type of question and fill in the question, as well as answers.**
- **Add a title image if desired. Select the appropriate language and grade range and add tags to make it easier to search for.**

- **Either select 'Play live' or 'Assign HW' and choose the desired attributes. Then share the quiz with your students by sending them the link and 6-digit code.**
- **Students can go to https://quizizz.com/join, click 'Join a game', and type in the 6-digit code to participate in the live quiz or complete it at homework. Once the students are finished, the teacher can refresh the page to view the results.**
- **You can also access to several quizzes and assignments in the library. You just need to review the questions and use for yourself.**

Activity 2.4. Introducing Slido (Question and answer – 5 minutes)

Slido is the ultimate Q&A and polling platform for live and virtual meetings and events. It offers interactive Q&A, live polls and insights during your meetings/events. What is your experience in using slide for educational purpose or in any other setting?

Activity 2.5. Create free slido account (Demonstration - 15 minutes)

Using the following what to do instruction and create a free slido account and explore the different functionality of the app. Then, support trainees to create their accounts. After participants create their account ask them to design audience questions and provide answer links with their groups.

What to do:

- **To create slido account follow the below easy steps:**
- **Go to https://www.slido.com/Links to an external site.**
- **Sign up for free**
- **Start using slido**

Activity 2.6. Exploring Survey Collection Tools (Google Form)

From time to time, educators engage in research or action research to enhance their teaching methods and contribute to educational progress. Google Forms provides a convenient platform for creating online forms and surveys, complete with various question types. You can easily share these forms with your audience. Additionally, Google Forms facilitates result analysis, allowing you to gain insights from your audience's responses. Furthermore, it's a useful tool for preparing quizzes for your classroom.

Question and answer (5 minutes)

Have you used Google Form before? When did you use it and for what purpose? What was your experience in using Google Forms?

Create survey or quiz with Google Form (Demonstration - 20 minutes)

Follow what to do instruction given below and please demonstrate how to create a survey or quiz using Google Forms or you can show participants a demonstration video. Once you completed the demonstration, ask participants to do the following:

- work in pairs and prepare a quiz using Google Forms; share it with at least 10 participants and present the result of your survey with your group members.
- Prepare a short survey using Google Forms and share it with your facilitator and students, then present the result of the survey to whole class (As you prepare the survey refer your specific learning area or subject matter).

What to do:

- **Go to https://docs.google.com/forms in your web browser. You'll need a Google account to access it (same as Gmail or YouTube).**
- **Click the "+" button or choose "Blank form" to start from scratch.**
- **You can also choose a template for specific purposes like event registration or contact forms.**

- **Click on the "Untitled Question" box and type your question.**
- **Select the question type from the dropdown menu (multiple choice, short answer, checkbox, etc.).**
- **Customize the question further by adding answer choices, making it mandatory, or shuffling options.**
- **Drag and drop questions to rearrange their order.**
- **Add sections with titles to categorize related questions.**
- **Use images, videos, or descriptions to provide additional context.**
- **Click on the "Settings" tab to configure options like:**
  - **Who can access: Choose whether anyone can submit the form or require a Google account.**
  - **Collecting responses: Decide how to collect responses (one response per person or allow multiple submissions).**
  - **Quiz settings (if applicable): Set grading options, time limits, and feedback for quizzes.**
- **Click on the "Send" button to share your form. You can:**
  - **Copy and paste the link to share anywhere.**
  - **Embed the form directly on a website.**
  - **Send the form via email with a personalized message.**
- **All responses to your form are automatically collected in a Google Sheet.**
- **Access the sheet by clicking the "Responses" tab.**
- **You can view individual responses, analyze data with charts and graphs, and even export the data to other formats.**

Facilitator Notes

Support participants as they create their own survey/quiz. Encourage them also to share the form through varies platforms like Facebook and Telegram pages.

Activity 2.7. Practicing Using EvalBee Application

EvalBee apk.

1. Assume a mathematics teacher who teaches three sections of grade ten and two sections of grade eleven, for a total of five sections with an average of 45 students in each class. How long will it take the teacher to check a student answer sheet in an examination that encompasses 40 objective-type questions out of 50?

2.Using your smart phone download the Eval Bee android app from the Play Store, create account and Sign in. Then using the Instruction below practice using EvalBee Optical mark readers App.

What to do:

- **Go to google play or app store on your smartphone and download Evalbee apk or https://evalbee.com on web browser and create an account.**

Steps to create optical mark reader or recognition (omr)

- **Decide the roll number digits (Make it 2)**
- **Insert an exam set (exam codes).**
- **Decide Exam Sets (Codes) and**
- **The number of subjects Make it 1**
- **Write the subject name in the subject box**
- **Decide the number of types of items on the section box**
- **Insert type of the item in sections 1,2 and 3**

***Section 1* :- Replace it with I. True or False**

- **True or False items in section 1**
  - ✓ **Decide number of questions for True or False items**
  - ✓ **Decide possible options from question type box**
- **You can allow partial marks (if necessary)**

***Section 2* :- Replace it with II. Matching**

- **Decide number of matching items**
- **Decide possible options**
- **You can allow partial marks**

***Section 3*:- Replace it as III. Multiple Choice**

- **Decide number of matching items**
- **Decide possible options**

- **You can allow partial marks**
- **SAVE**
  - **Write class name e.g Grade 10**
  - **Exam Name:- Mathematics**
  - **Select Exam Date It is mandatory**
  - **Finally SAVE.**
  - **Once you set answer sheet click on exam**
  - **Go to Exam management**
  - **Click on Answer Key and set it**
  - **Finally Save it**
  - **Download and print the answer sheet**
  - **Administer the Exam**
  - **Scan each answer sheet**
  - **Go to report**
  - **Record the each student result**

Session Three: Creative Tools (Artificial Intelligence)

Introduction

Artificial Intelligence (AI) is a branch of computer science that deals with the creation of intelligent agents, which are systems that can reason, learn, and act autonomously. AI research has been highly successful in developing effective techniques for solving a wide range of problems, from game playing through enhancing services in varies sectors such as education, agriculture and health.

Activity 3.1. Understanding AI (Question and Answer -10 minutes)

- What is Artificial intelligence?
- Have you used it so far or seen while others use it for different purpose including teaching and learning?

Facilitator Notes

Show them AI videos on power point slides and provide highlight of the current development of AI globally. AI is bringing exciting possibilities to classrooms around the world. There are various AI tools available to help teachers with their tasks. We will explore some of the commonly used AIs in the below activity. As conclusion show the AI video on the power point.

Activity 3.2. Stream your task through AI (Gemini and Bing) Lecture – 5 minutes

Copilot/Bing and Bard/Gemini are the two popular apps easily accessible in Ethiopia for varies tasks. Copilot/Bing is developed by Microsoft and Bard is created by Google AI respectively. Both AIs focuses on generating text, translating languages, and answering questions in an informative way.

These AI tools can be a game-changer for teachers by:

- Simplifying lesson planning: Generate ideas, find relevant resources, and outline learning objectives with AI assistance.
- Crafting engaging assignments: Design interactive exercises, propose different question types, and personalize learning pathways for each student.
- Exploring innovative teaching methods: Discover new approaches to explain concepts, spark creativity in activities, and create a dynamic learning environment.
- Provide Educational resources such as images and videos for your lesson and other activities.

By harnessing the power of AI tools like Copilot and Bard, teachers can free up valuable time and focus their expertise on what matters most: guiding their students and fostering a love of learning.

Activity 3.3. Demonstrate how AI works for schools/teachers - 10 minutes

Demonstrate the use of Bing and Bard through performing the following activities:

- Prepare lesson plans, assessment questions and instructional resources for one of the subject matters using Bard?

- Prepare instructional resources for the above topic using Bing AI – ask the AI to provide you with pictures or simulation activities for the above topic?

Facilitator Notes

As you showcase the capabilities of AI, emphasize that it's incredibly user-friendly. Teachers can conveniently access the service via a mobile app, making it even more accessible. Encourage them to download the Bing app on their phones for future use.

Activity 3.4. Practicing the use of AI (Individual Activity - 20 minutes)

Go to Edge or Chrome browsers and use either Bing or Bard as you prepare your next week plan, please generate the following and share it with your group members.

- Lesson Plan for your next week classes.
- Assessment Questions for your next week classes.
- Ask Advise for Methodologies and Teaching aids you might use in your class.

Key Ideas

Communication and Collaboration Tools

Virtual classrooms can be transformed by online communication and collaboration tools, fostering richer educational experiences for students. Platforms like Google Meet, Microsoft Teams, and Zoom create virtual meeting spaces for live video sessions, real-time interaction, screen sharing, and even breakout rooms for focused group discussions.

These tools empower educators to conduct engaging lectures and discussions, address student queries, and facilitate collaborative projects where students can work together on assignments, share ideas, and develop teamwork skills. Additionally, inviting guest speakers from various fields becomes a possibility, enriching students' learning with diverse perspectives. Virtual field trips further broaden horizons, allowing students to explore museums, historical sites, or natural wonders from anywhere in the world. Assessment is also streamlined, with online quizzes, tests, and even oral exams conducted effectively.

Beyond video conferencing platforms, online tools like Padlet offer a dynamic digital canvas. Imagine a virtual bulletin board where students can brainstorm ideas, organize thoughts, create mind maps, share research findings, project summaries, and creative works. It's a space for

collaboration, visual presentations, and receiving peer feedback or reflecting on learning experiences.

Similarly, Jamboard, Google's interactive whiteboard tool, fosters a collaborative environment for drawing, writing, and brainstorming. Students can use it to visualize complex concepts, problem-solve across various subjects, dissect scientific phenomena through visual aids, or even create engaging storyboards. From brainstorming sessions to collaborative problem-solving and visual storytelling, these online tools unlock new possibilities for enriching virtual classrooms. Below are easy guide on how to use some of these tools.

Assessment Tools

Interactive tools like Quizizz gamify quizzes, transforming them into game shows with competition and immediate feedback. Google Forms offer versatility, allowing the creation of quizzes, surveys, polls, and even short-answer assessments, with easy data analysis for personalized learning. Slido and Mentimeter prioritize real-time participation. Students can submit questions, participate in polls, and contribute to word clouds, keeping them engaged in lectures and presentations. Finally, Kahoot! takes gamification a step further, turning assessments into fast-paced game shows where students compete for the top spot. These are just a few options that can create a more engaging and data-rich learning environment, fostering interactive assessment platforms.

Artificial Intelligence

The ultimate purpose of using AI in education should be to improve student learning outcomes. AI can be a powerful tool in this journey, but it's crucial to use it wisely. Here are some key points for teachers:

- **Supportive Partner, not a Substitute:** AI can assist with various tasks, from crafting lesson plans and designing exams to assessing student work and managing records. However, it shouldn't replace teacher expertise. Review and adapt AI-generated materials to fit your specific classroom context.

- **Combating Plagiarism:** Simply submitting student work generated by AI can lead to plagiarism. If you suspect AI use, consider using AI plagiarism detection tools to verify the originality of student responses.

- **Empowerment, not Automation:** AI is here to enhance, not replace, teachers. Be creative! Explore AI-powered apps to streamline grading and free up valuable time. This allows you to focus on what matters most: guiding your students and fostering a love of learning.

- **Strategic use of AI:** By using AI strategically and maintaining a critical eye, educators can leverage its potential to personalize learning, streamline processes, and ultimately, improve student outcomes.

- The Eval Bee application is designed to help teachers create and scan Optical Mark Recognition (OMR) answer sheets for objective types of examinations such as True or False, Matching, and Multiple Choice and generate result reports in real time by scanning the OMR sheet using their phone's camera. It is an Efficient App for Teachers that makes assessment Easy & Effective in No time. Creating answer sheet design in a few clicks, Scan answer sheets in real-time. Using Eval Bee allows the error-free scan and evaluation of printed OMR answer sheets through pre-trained AI and machine learning-based algorithms in real-time. This saves a lot of time and energy for teachers and makes it easy for students and parents to get quick evaluation results.

Implication for Teaching

Record your responses to the following questions as your key learning and future considerations on your handouts.

- What did you learn about communication and collaboration tools?
- What is your plan to communication and collaboration tools in your teaching and learning or any other related task in your school?
- What did you learn about online assessment tools?
- What did you learn about Artificial Intelligence?
- What is your plan to use AI like Bard and Bing in your teaching and learning or any other related task in your school?
- What new skills, experience, knowledge have you got?
- How would you like to apply the new skills in your subject teaching learning activities (consider also exploring anything you took as a learning apart from the platform)?

Self-Assessment

1. Which of the following is NOT a benefit of using online communication and collaboration tools in virtual classrooms?
   A. Streamlined assessment through online quizzes and tests
   B. Increased difficulty for students to brainstorm ideas
   C. Enhanced real-time interaction with teachers and classmates
   D. Broader learning experiences with virtual field trips
2. Platforms like Google Meet and Zoom primarily enable:
   A. Individual research and writing assignments
   B. Collaborative brainstorming and project work
   C. Accessing and reading online textbooks
   D. Taking timed multiple-choice quizzes
3. Jamboard, an interactive whiteboard tool, is most useful for:
   A. Conducting live video sessions with guest speakers
   B. Administering online polls and surveys
   C. Visualizing complex concepts and problem-solving collaboratively
   D. Providing individual feedback on written assignments

4. Which of the following statements accurately describes Quizizz?
   A. It's a tool for creating traditional written quizzes.
   B. It offers a game-show style format for assessments with immediate feedback.
   C. It's primarily used for conducting online surveys.
   D. It requires students to write code to answer questions.

5. Google Forms allows teachers to create all of the following EXCEPT:
   A. Multiple-choice quizzes
   B. Open-ended essay questions
   C. Live word cloud activities
   D. Short answer response assessments

6. The primary benefit of using tools like Slido and Mentimeter in the classroom is:
   A. To assign homework for students to complete independently.
   B. To facilitate real-time interaction and participation during lectures.
   C. To provide in-depth feedback on written assignments.
   D. To create static presentations for students to view at their own pace.

7. Which one of the following is true about Artificial Intelligence (AI) in education?
   A. AI will replace teachers altogether in the future classroom.
   B. AI tools like Gemini and Copilot will provide additional support to educators.
   C. AI is not currently relevant to the field of education.
   D. Students should be trained in AI development as the primary learning objective.

8. 8. Which one the following is not true about Eval Bee?
   A. It generates error free or 100% accurate reports
   B. Saves a lot of teachers time and Energy
   C. It has room for various fractional markings
   D. It has very limited contribution on avoid exam cheating

Reference Materials

Watch	Using Google Meet
Watch	Online Educational Communication Tools
Watch	The use of padlet for educational purposes
Watch	Online Assessment Tools for Teachers
Watch	The use of Quizziz for teaching and learning
Watch	AI for Educational Purposes
Watch	(690) HOW TO MAKE ANSWER SHEET IN EVALBEE - YouTube

UNIT FIVE: CREATE AND ACCESS TO DIGITAL CONTENTS

Introduction

In this chapter you will discuss on how to access, use, and create digital resources and contents for your teaching and learning. Digital contents can be accessed either online or through hard disks like CDs or flash cards. You will also cover different subject specific Open Educational Resources (OERs) and Ministry of Education digital library portals.

Learning Objectives

By the end of this chapter, you will be able to:

- Create engaging digital content using different platforms for your lesson.
- Explore basic Word and PowerPoint processers functions.
- Learn how to navigate the Ministry of Education's online library and find subject-specific digital resources that will enrich your teaching.
- Explore innovative ways to integrate digital content both for classroom and remote teaching.
- Access different subject specific Open Educational Resources (OERs) for their classes.

Key Topics

Session one: Create Digital Contents

Session Two: Access Digital Contents

Session Three: Ministry of Education Digital Libraries

Session Four: Open Educational Resources (OERs)

Session One: Digital Contents

In this session, you will comprehend about digital content and explore your digital content experience on how to access authenticated resources from online sources.

Activity 1.1. What is Digital Content? (Question and Answer - 10 minutes)

Discuss with the whole class on the following questions:

- What is digital content?
- Give examples of digital contents?

Facilitator Notes

Ask participants the above questions; the objective of this activity is to provide some general understanding of digital content among participants. Finally, conclude the session by mentioning that digital contents can be produced and accessed in various ways and it encompasses materials published, distributed, and stored in electronic formats, including text, voice recordings, video clips, photographs, and animations.

Activity 1.2. Exploring your digital content experience (Group discussion - 15 minutes)

In group of four to six, discuss the following questions:

- Share your experience of using digital content in your classroom?
- What was the topic of your lesson? How you used the digital content?
- Where did you get the content (source)?

Activity 1.3. A Teacher's Journey

Case Scenario 2: Enhancing Learning with Digital Content (20 minutes)

Scenario: Mrs. Almaz's Biology Class

Mrs. Almaz, an experienced biology teacher, is passionate about creating engaging and effective lessons for her students. She believes that integrating digital content can enhance learning experiences and foster student engagement. Here's how she approaches this:

Mrs. Almaz starts by identifying the learning objectives for her lesson. She considers why the topic is important for her students and how digital content can support those objectives. She selects digital materials that align with the curriculum and provide relevant information. For example, she might use interactive maps, videos, or online simulations to illustrate cell concepts from MoE digital Library or authenticated open educational resources such as Khan

Acadamy. Mrs. Almaz evaluates the quality and accuracy of the digital resources. She checks the credibility of the sources, ensuring that the information is up-to-date and reliable. Mrs. Almaz believes that active student participation is crucial. She chooses digital materials that encourage interaction, such as quizzes, polls, or virtual field trips.

She ensures that the chosen digital content is accessible to all students. She considers factors like internet connectivity, device compatibility, and any necessary accommodations. She provides alternative formats (e.g., transcripts for videos) to accommodate diverse learning needs. After the lesson, Mrs. Almaz seeks feedback from her students. Did the digital content enhance their understanding? Was it engaging?

In small group, discuss about the criteria Mrs. Almaz took into account when selecting digital contents for her lesson? List down all the consideration she has made.

Facilitator Notes:

During the discussion on factors to be considered during digital content selection, inform participants to refer to a similar exercise in Chapter one. As you conclude the discussion, emphasize that teachers need to assess digital content based on at least the following criteria:

- *Accessibility: Ensure that the content is accessible to all students.*
- *Relevance: Consider whether the content aligns with the learning objectives.*
- *Interactivity: Evaluate the level of engagement and interaction among students.*
- *Production Quality: Check for high-quality visuals, audio, and overall presentation.*
- *License Information: Be aware of the content's licensing terms.*

Session Two: Creating Digital Contents

Digital content can be considered as any type of media that exists in the form of digital data, including text, images, audio, video, and more. It can be accessed and distributed through electronic devices and online platforms. In this session you will learn different mechanism to create digital contents for your classroom instruction.

Activity 2.1. Preparing PowerPoint Slideshow

Slideshows are very good way to present information in a visually engaging way. They can be used for anything from showcasing visual display of teaching and learning materials to delivering a compelling presentation at work. In education, we don't use slideshow for only sake of presenting

information, rather the goal is to enhance the learning experience, not to overwhelm students with too much information or distract them with overly complex slides.

Questions and Answers (5 minutes)

What is your experience of using slides for teaching and learning? When did you use it? For what purpose? What was the challenge?

Lecture (10 minute)

Present the development of an educational slideshow (PPT). Creating a slideshow for teaching and learning purposes involves several key steps to ensure that the presentation is effective and engaging. Here's a guide to help you create an educational slideshow.

- Define the Objectives: Set clear learning goals for your presentation.
- Know the context: Understand the strengths, weaknesses, and needs of your students. Consider their age, language skills, accessibility and ability to interpret concepts.
- Plan Your Content: Think of what you want to put on your slide - tables, charts, diagrams, or timelines, etc.
- Design the Slides: Use a clean and simple design. Use your placeholder wisely.

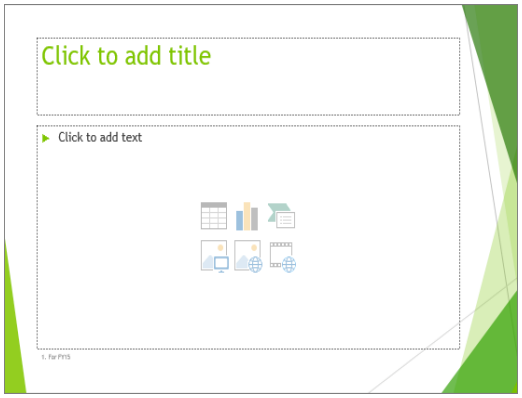


Figure 12. Placeholder

- Make It Interactive: Engage your students by incorporating questions, discussions, or problems to solve.
- Make it short: Don't overwhelm students with too much information or distract them with overly complex slides; use the general rule of 5/5/5. 5 words in each line, 5 lines in each slide, 5 text heavy slide on a subject.
- Practice and Delivery: Rehearse your presentation to ensure smooth delivery.

Demonstration (20 minute)

Demonstrate what you have explained. Open your slideshow, select a topic and create PowerPoint presentation; find an image and paste it as well. Add a caption to your image too. If you have time and think they are ready for it, you could show animation, design options and

other functionality for the power point at this point too. Design options on PowerPoint will suggest designs for your slide given what you have put on it already. Alternatively, you can also show participants a five-minute video.

Once you completed demonstration, ask participants to create their slideshow with text and images. They should make no more than 3-4 slides here. Give them some time (10 minutes) to do this. Additionally, please ask participants to **record** themselves while presenting the slideshow. After recording, they should share the recordings with their respective groups.

Activity 2.2. Using Google Slide to Create a Presentation (10 minutes)

If you don't have access to a laptop or desktop; you can create PowerPoint using Google Slides with your phone. Follow the following steps to download and create PowerPoint using Google slide.

Creating a PowerPoint presentation using Google Slides on your phone is a convenient option when you don't have access to a laptop or desktop. Here's a simple guide to get you started:

- Go to your phone's app store (Google Play Store for Android or App Store for iOS).
- Search for "Google Slides".
- Download and install the app.
- Open the Google Slides app.
- Sign in with your Google account. If you don't have one, you'll need to create it.
- Tap on the "+" icon, usually located at the bottom right of the screen.
- Select "New Presentation" to start creating your slides.
- Google Slides will offer you a variety of themes to choose from.
- Select one that suits the style and purpose of your presentation.
- Tap on the slide where you want to add content.
- Use the toolbar to insert text, images, shapes, and more.
- You can add new slides by tapping on the "+" icon near the slides preview.
- Your presentation will be automatically saved to your Google Drive.
- You can share it with others by tapping on the "Share" icon and entering their email addresses.

Activity 2.3: Using Word Processing (Question and Answer – 5 minutes)

Word processing software is a powerful tool used for creating, formatting, and editing various types of documents. Whether you're jotting down thoughts, taking meeting notes, drafting emails, or writing standard operating procedures word offer much more than the typewriters of old.

- How comfortable are you with word processing programs?
- How often do you use them?

Activity 2.4: Practice using Word (20 minutes)

Go to this link Basic Function of Word and explore how to create a text document. Then using a Microsoft word prepare a text document based on the guidance on the resource. Align your document with your subject discipline.

NB: As they create their worksheet, don't forget to practice using features like select, copy, paste, and other functions of the Word.

Activity 2.5: Using Google Docs to create a Word document (20 minutes)

Google Docs is an online word processor that lets you create and format documents and work with other people using Google Docs. On your computer or phone open Google Docs. You can access Google Docs through the nine dots on Chrome browser (Please refer accessing Google Apps in unit two).

Activity 2.3. Accessing Image for your instruction (Group Discussion - 10 minutes)

This activity focus on how to find and copy images from the internet to use in your teaching as a resource. This can be a valuable way to enhance your lessons and engage students. In group of four to six, discuss on the following questions:

- Where did we get images for our worksheets? Or when we need images for different instructional purpose?
- How do we copy images?
- Do we need to consider anything as we copied images?

Figure 13;Free Source of Images; Source @Google Image

Facilitator Notes:

Ask if participants have ever downloaded an image from the internet and where they sourced it from, with Google Images likely being a common response. Educate them on various platforms where teachers can access free and legal images, emphasizing the importance of looking for images with a

Creative Commons (CC) license. Mention that search engines like Google Images and Bing Images allow users to filter for CC images.

Highlight that platforms such as Pixabay and Unsplash specialize in providing free images. Additionally, introduce the Noun Project as a valuable resource offering free icons for various purposes, particularly beneficial for educators creating worksheets or presentations.

Guide participants on how to search for legally usable images on search engines like Google by navigating to the Usage Rights menu and selecting Creative Commons Licenses. This filter ensures that only images with the CC license are displayed.

Demonstration (15 minutes)

Do an example with Google Images, Unsplash, Pixabay and Noun Project. Take participants through the steps of copying images and use on a working document.

Group Work (15 minutes)

In group of four to six, ask participants to access images from one of the above sources for a lesson in their specific subject area. Let groups work on different source of image such as Bing AI image, Google Images, Unsplash, Pixabay and Noun Project at a time. Finally, allow them to present their result to the whole class. Ask them also to reflect on their experience.

Session Three: Open Educational Resources

Open Educational Resources (OERs) are teaching, learning and research materials in any medium that can be found in the public domain or have been released under an open license that permits no-cost access, use, adaptation, and redistribution by others with no or limited restrictions. Below are some educational resources for your consideration:

Subject specific open educational resources (OER) are learning materials that are tailored to a particular subject or discipline, such as mathematics, history, or engineering. They can include full courses, course materials, modules, textbooks, videos, tests, softwares, etc. Subject specific OER can help teachers and learners to find relevant and quality resources for their teaching and learning needs.

Some examples of platforms that offer subject specific OER are:

- https://oercommons.org/: A public digital library of OER that allows users to search and browse OER from various sources and subjects. Users can also create and publish their own OER using the Open Author tool.
- https://merlot.org/merlot/.A curated collection of free and open online teaching, learning, and faculty development services contributed and used by an international education community. Users can search for OER by discipline, material type, audience, language, and more.
- https://phet.colorado.edu/: Simulations and animations for STEM subjects.
- https://literacy.concordia.ca/en/: Resources for English Language.

Activity 3.1. How to Use OERs (Presentation/Lecture/ -10 minutes)

When we use resources from OERs, it is very important to ask ourselves the following questions:

- How does the content related to my learning outcomes?
- Who created the content? who is using the content?
- When was last updated?

It is also important to apply the 5R activities: retain, reuse, revise, remix, and redistribute as you plan to use contents from open educational resources.

- Retain a copy of an OER on your device or cloud storage for future use.
- Reuse an OER in its original form for your lesson, such as showing a video or assigning a reading.
- Revise an OER by modifying it to suit your needs, such as adding annotations, comments, questions, or feedback.
- Remix two or more OER by combining them to create a new resource, such as integrating a text with an image or a quiz.
- Redistribute an OER by sharing it with others, such as your students, colleagues, or online.

Group Discussion (20 minutes)

In small groups, review one of the examples of open educational resources provided in previous pages and explain on how to apply the 5R principles as you select content for your lesson.

Activity 3.1. Exploring Ministry of Education e-library Resources

Ministry of Education Ethiopia has established e-library for teachers and students to access relevant educational resources online through cloud technology. The e-library enable teaching and learning resources to be available online through computers and smart phones. Through this platform teachers and students will have access to approved resources for teaching and learning use.

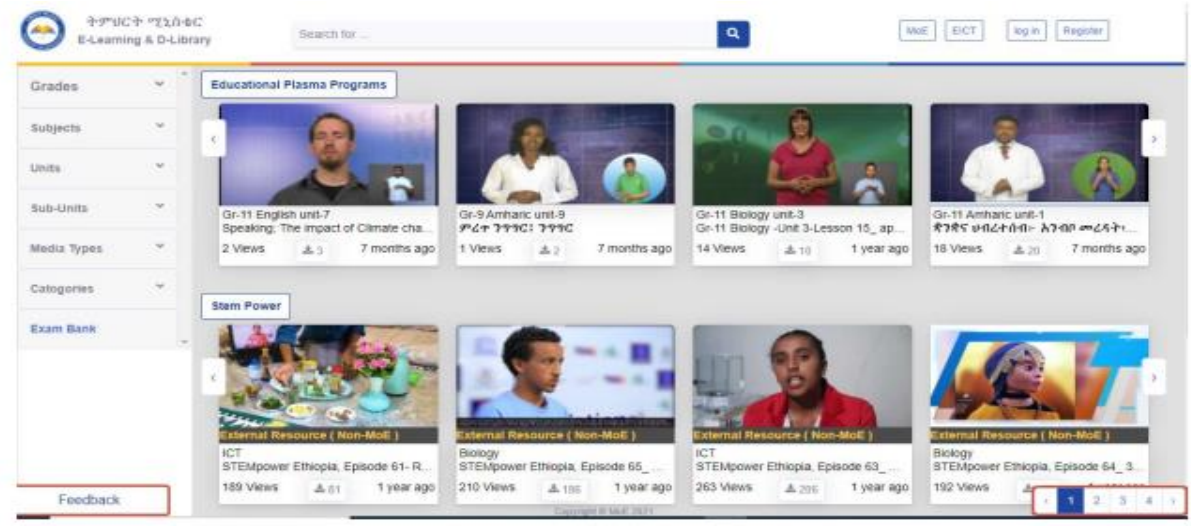


Figure 14. MoE Digital Library

Group Discussion (15 minutes)

In groups of four to six, discuss on the following questions:

- Have you ever utilized digital content from the MoE digital library portal?
- What specific topic or subject was covered in the lesson where you used digital content from the portal?
- Describe how you incorporated the digital content into your teaching.
- Was the content beneficial for enhancing your lesson?
- When selecting content from the portal, what criteria did you consider?

Demonstration (20 minutes)

Use the following what to do Instruction and Demonstrate how to access digital content from MoE Digital Library. Please select contents which are relevant to your subject matter area and describe to your colleagues on how you would use it in your lesson?

What to do:

Step 1: Go to: http://elearn.moe.gov.et.

Step 2: Select content of your choice based on grades, subjects, units, media types, and categories on the left side of the page.

Step 3: Use selected content for the work at hand.

Activity 3.3. MoE Learn English Platform (https://learn-english.moe.gov.et/)

MoE learn English platform is a free of charge or **zero rate** site for learning English language and skills. It offers various resources and activities for different levels of learners, from grade KG to grade 12. You can find videos, podcasts, and quizzes on topics such as grammar, vocabulary, pronunciation, listening, writing, and more. You can also create an account to access the site and track your progress. The site is developed by Ministry of Education Ethiopia in partnership with ethiotelecom. The site is updated regularly with new content and features.

Figure 15. MoE Learn English Website

Group Work – Review MoE Learn English Website (20 minutes)

In group of four to six, review MoE Learn English Website (https://learn-english.moe.gov.et/)

- What are your impressions of the site?
- Does it use zero rating or charge you for data usage?
- Are the contents useful and relevant for your teaching and learning?

Activity 3.4. Review Khan Academy Resources (https://www.khanacademy.org/)

Khan Academy is one of the examples of open educational resources that deliver high-quality educational content across multiple disciplines. This platform provides on its website, or on the Khan Academy's YouTube™ channel, an advanced learning analytics module with useful visualizations. The Khan Academy platform enables online courses in which lessons are produced in the form of videos, interactive activities, and challenges.

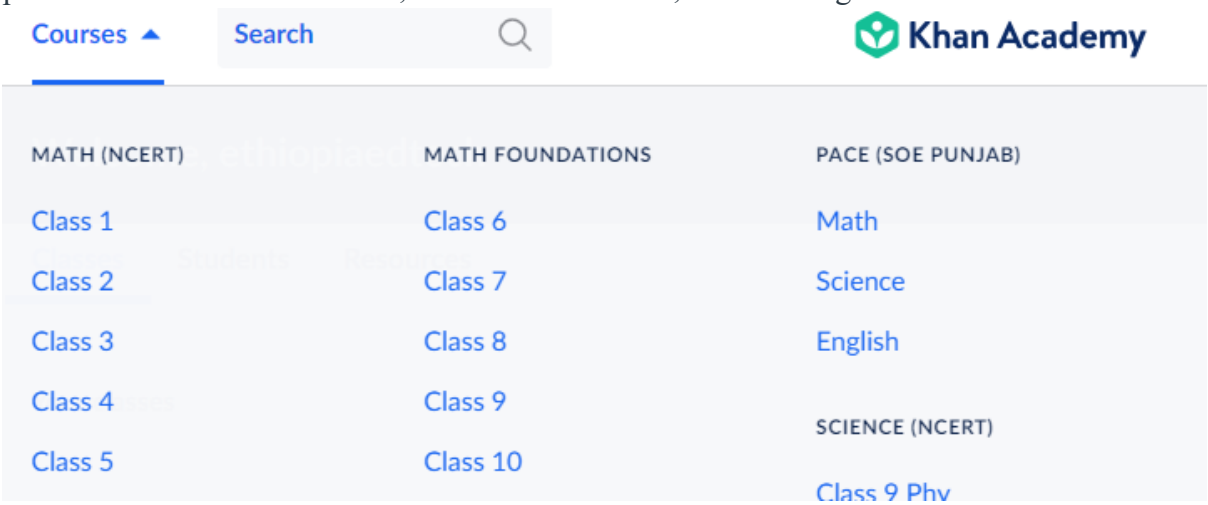


Figure 16. Khan Academy

Students can watch videos and solve supplementary practice exercises to understand various lessons and concepts more easily. Also, teachers can make use of Khan Academy to supplement the teaching process and provide extra content to learners to enhance learning.

Individual Task (15 minutes)

Go to https://www.khanacademy.org/ and identify content related to your subject area. Which content do you identified? How are you going to use the content to enhance learninig outcomes among students? How do you explain the whole experiences of accessing content from Khan Academy?

Activity 3.5. YouTube as Source of Educational Contents

YouTube is not open educational resources, but it can be a powerful tool for teachers to enhance their lessons and cater to different learning styles. Here are some ways teachers can leverage YouTube for educational purposes:

- Finding educational content: YouTube offers a vast library of educational videos on almost any subject imaginable. Teachers can find documentaries, lectures, experiments, simulations, and instructional videos created by educators or educational institutions.

- Visualizing complex concepts: Scientific phenomena, historical events, or abstract ideas can be brought to life through engaging and informative videos. This can be particularly helpful for students who learn better visually.

- Introducing new topics: A captivating and well-made video can spark students' curiosity and introduce a new topic in a stimulating way.

- Flipped classroom approach: Teachers can use YouTube videos for students to watch at home, freeing up classroom time for discussions, activities, and deeper exploration of concepts.

Additional tips for teachers using YouTube for Educational Purpose:

- Carefully curate content: Since not all YouTube content is created equal, teachers need to preview videos and choose those that are accurate, age-appropriate, and meet learning objectives.
- Consider copyright: Copyright laws apply to YouTube videos. Teachers should be familiar with fair use guidelines to ensure they are using content legally.
- Engage students with the video: Simply showing a video isn't enough. Teachers should prepare discussion questions or activities to help students process the information and connect it to the lesson.

Individual Task (15 minutes)

Go to YouTube and identify content in your subject matter for any topic you might think to explore further. Which content do you identified? How are you going to use the content to enhance learning outcomes among students? How do you explain the whole experience of accessing content from YouTube?

Activity 3.6. Exploring Digital Skills Training for Educators (EdTech 101 online course)

The EdTech 101 Course has been thoughtfully prepared as a complement to the face-to-face digital training. Its primary purpose is to allow educators (teachers, principals and supervisors)

to continue practising the use of digital tools and platforms once they return to school. In addition to the content covered during in-person sessions, this online course provides additional insights on how to seamlessly integrate digital technologies into teaching and learning practices.

The course is suitable for both new and experienced teachers, offering comprehensive coverage of essential topics. Participants will explore an introduction to educational technology, delve into various digital platforms, discover open educational resources (OER), and gain an understanding of digital citizenship. To fully grasp the material, participants can expect to invest approximately two weeks in completing the course. However, the flexibility of the course allows educators to take it at their own pace, anytime and anywhere that suits them. Based on their choice, teachers can also choose to focus on specific sections that interest them once they joined the course.

Join the training on Canvas with the following steps:

- **Open a Browser and Go to: https://canvas.instructure.com/enroll/CX4AC8**
- **Complete the Request Form**: Fill in the required information:
  - New user details (if applicable).
  - Full name.
  - Email address.
  - Agree to the terms of use.
  - If there's a Captcha form, complete it as well.
  - After submitting the form, you'll be directed to the course dashboard.
  - Here, you'll find information related to the training course.
- **Activate Your Account via Email**:
  - Check your email inbox for an activation email from Canvas.
  - Click the activation link provided in the email.
  - You'll be taken to a page where you can set your password.
- **Access the Course**:
  - Now that your account is activated, you can log in to Canvas using your email and the password you just set.
- **Mobile Access**:

- For convenience, you can also download the Canvas Student App from the App Store or Google Play Store on your phone.
- Use the app to attend the course on the go.

Individual task (45 minutes)

Get registered yourself on the course. Please follow the link provided to register for the course. Explore the course features, check your email, and activate your account using the activation email. Your facilitator will guide you through the registration process.

Key Ideas

Digital Content

Digital content can be a useful tool if teachers use it appropriately in improving learning outcomes among students. Digital tools might be employed in diverse ways to enhance learning experiences. One significant advantage of using digital content is its capacity to explain complex concepts in a more captivating manner. Teachers leverage interactive tools, simulations, and educational games to simplify the topic under discussion. Moreover, digital content facilitates differentiation, catering to students with varying learning styles and paces. Learners can revisit lessons and access supplementary resources online, fostering a self-directed learning environment. Additionally, digital content streamlines tasks for teachers—pre-made materials, online assessments, and grading software save valuable time, allowing personalized feedback to students.

Below are some of the factors we might consider as we select digital resources for our lesson.

- Learning outcomes: What knowledge, skills and attitudes do you want the learners to achieve? In fact, technology should not drive learning but rather the set learning outcomes.
- Age of learners: the technology tools to be used should consider learner development stage and their readiness to use it.
- Access to technology: What technology is available for use in the teaching and learning process.
- Learner centeredness: Does the technology chosen allow the learners to learn collaboratively on their own and can they be able to use it without depending on the teacher.
- Creativity and innovation: does the technology arouse creativity and innovation in the learners? Can the learners suggest other ways in which they can use the technology?
- Safety of learners: This should be a paramount importance especially when learners are expected to use online tools and resources.

- Teacher competence: How the teacher use the technology with confidence as he facilitates learning.
- Inclusiveness: technology instructional design should be accessible to all learners including those with special needs.

Images

Using visuals such as images play a crucial role in enhancing both teaching and learning. They capture students' attention, simplify complex ideas, and act as translators for abstract concepts. Thought-provoking images also stimulate discussions and critical thinking. For younger learners and those acquiring a new language, pictures bridge the gap between words and their meanings, reinforcing vocabulary acquisition. By incorporating a variety of visuals, teachers create an inclusive learning environment that fosters deeper understanding and a lifelong love of learning.

Power Points

Teachers and educators often utilize presentation tools like PowerPoint and Google Slides to create educational content for their students. These platforms allow them to save time and seamlessly incorporate various resources into their materials. Additionally, some educators choose to record their presentations using PowerPoint's recording feature, making it convenient to share with students for future reference.

Ministry of Education e-Library

Ministry of Education e-Library provides a wealth of educational content, most of them verified and approved. Access a variety of engaging formats to suit your learning style, including educational videos, audiobooks, and textbooks. Follow the below steps to access resources from MoE e-Library.

Open Educational Resources (OERs)

Open educational resources (OERs) are transforming classrooms by offering teachers a treasure of free and adaptable learning materials. These resources, which can include digital textbooks, interactive exercises, and multimedia content, empower teachers in several ways. Firstly, OERs tackle the issue of cost. By incorporating them, teachers can reduce the financial burden on students who might otherwise struggle to afford traditional textbooks. Secondly, OERs are incredibly flexible. Many come with open licenses, allowing teachers to modify and tailor them to their specific curriculum and student needs. This fosters a more personalized learning

experience. Additionally, OERs can tap into the power of collaboration. Teachers can share and adapt resources developed by colleagues around the world, promoting innovation and the exchange of best practices. Ultimately, OERs empower teachers to create dynamic and engaging lessons that cater to diverse learning styles, all while promoting a more equitable and accessible learning environment for all students.

Implication for teaching

Record your responses to the following questions as your key learning and future considerations on your handouts.

- What did you learn about digital content and how are you planning to use them in the future?

- What is your plan to use images from different sources for your teaching and learning or any other related task in your school?
- What is your plan to use slideshow presentations in your teaching and learning or any other related task in your school?
- What did you learn about MoE e-Libraries and Learn English platforms?
- What are Open Educational Resources and How are going to use them going forward?
- What is your plan to use MoE Digital Library and Learn English Platform for your teaching and learning or any other related task in your school?
- How are you going to encourage your students to access the MoE digital libraries and other OERs?
- What did you learn about Khan Academy and YouTube?
- How are you going to encourage your students to access digital content from YouTube and Khan Academy Sources?

Self-Assessment

1. What is one significant advantage of using digital content in education?

   A. It saves teachers time by automating grading.
   B. It fosters self-directed learning among students.
   C. It replaces traditional textbooks entirely.
   D. It simplifies complex ideas through interactive tools.

2. How do images enhance teaching and learning?

   A. By providing pre-made materials for teachers.
   B. By bridging the gap between words and meanings.

C. By automating assessments.

D. By replacing traditional textbooks.

3. Which presentation tools are commonly used by educators?

   A. Google Sheets and Excel
   B. PowerPoint and Google Slides
   C. Word and Notepad
   D. Prezi and Keynote

4. How can teachers create a PowerPoint presentation using Google Slides on their phones?

   A. By downloading the Google Slides app and signing in with their Google account.
   B. By using a laptop or desktop computer.
   C. By searching for "Google Slides" in the app store.
   D. By selecting a theme from a variety of options.

5. What does the Ministry of Education e-Library provide?

   A. Free laptops for students
   B. Educational videos, audiobooks, and textbooks
   C. Online assessments
   D. Grading software

Reference Materials

Read	Importance of Using PowerPoints and Word as a Teacher
Read	The Basics of Word
Read	The Basics of PowerPoints
Watch	How to use Google Docs and Slides
Watch	Creating Quality Digital Contents
Read	Best Practice for Teaching with Digital Content
Read	How to use image effectively in your lesson
Read	Why Should I use OERs?
Watch	Impactful use of OER
Read/Watch	http://elearn.moe.gov.et.
Watch	https://learn-english.moe.gov.et/
Read	How to join online course on Canvas

UNIT SIX: DIGITAL CITIZENSHIP

Introduction

In this chapter, you will discuss about safe use of technologies such as mobile phone, computers, tablet, and the internet. Specifically, you will discuss on risks in connection with internet use and safety measures.

Learning Objectives

By the end of this chapter, you will be able to:

- Explore safe and responsible behaviour in using internet and communication technologies.
- Explain the risks associated with using the internet and communication technologies.
- Contextualize e-safety rules and guidelines for their schools.

Key Topics

Session One: Internet Risks and e-Safety

Session Two: Computer and Smartphones Safety

Session One: Internet Risks and e-Safety

Activity 1.1: Exploring the concept of e-Safety. Think Pair Share (10 minutes)

What is e-Safety? With what concept or term does e-Safety connected?

e-Safety is often synonymous with online, or internet safety and it is concerned with being safe and appropriate use of technologies without compromising personal security and safety.

Activity 1.2: Unpacking Risks Associated with Internet

Group Discussion (15 minutes)

Students are often unaware of the potential danger in relation to internet and are susceptible to unsafe online behaviour. Now, in group of four to six, discuss on potential e-Safety risks. After you finish your discussion, share with your facilitator on any convenient platform for you.

Activity 1.3: Exploring e-safety risks.

Group Discussion (15 minutes)

In small groups, discuss on the following potential e-safety risks. (Each group might discuss at least on two of the risks mentioned below). Then, prepare online presentation using Google Slides or any convenient platform and present for the whole class.

1. Social Networking Risks
2. Age restrictions
3. Sharing Online profiles/Security risk
4. Publishing content
5. Uploading Photos and Videos
6. Cyberbullying
7. Copyright
8. Exposure to inappropriate online content
9. Excessive time online

Activity 1.4: Fake News

Being online exposes children to number of fake news and unverified information which put them and even others to risks of different kind.

Whole class discussion (5 minutes)

- What is fake news? what is news?
- Give examples of fake news on digital platforms?

Facilitator Notes

- ***News*** *is factual information about a recent event that is new to people and will be of interest to them.*
- ***Fake news*** *is lies and/or propaganda told for a political or commercial purpose and influence millions of people. It's often deploying through digital technology, social media, news networks to go viral and reach people very quickly.*

Activity 1.5: Fact, Opinion and Fake news

Whole class discussion (10 minutes)

- What is the difference between facts and opinion?
- Give some examples of facts, opinion and fake information on the similar topic?

- How can we help students to differentiate between facts, opinions, and fake information?

Example of Fact and Opinion

- **Fact:** Ethiopia is one of the Country in East Africa.
- **Opinion:** Ethiopia will soon become middle income Country.
- **Fact:** Abebech Gobena has provided education opportunity for many Ethiopians through her NGO.
- **Opinion:** Abebech Gobena is a well-remembered person in Ethiopian philanthropy work. Fact: Addis Ababa is the capital of Ethiopia.
- **Opinion:** Pollution is the main problem facing Addis Ababa.

Media Detection questions

Always encourage your students to ask themselves the following questions as they come across media contents.

Figure 17. Media detection questions

Activity 1.6: Adopting e-Safety rules for your school

Group Discussion (15 minutes)

Do you have e-safety rules at your school? In small group discuss on possible e-Safety rules for students and teachers in your school. Then, post your answers with your group name on top of it on one of interactive platforms.

Facilitator Notes: Basic e-safety rules

Social networking poses little risk if students follow basic e-safety 'rules' such as:

- *keeping personal information private*
- *respecting the rights and feelings of others*
- *Stick to the given assignment (importance of providing specific links)*
- *thinking about the long-term consequences of what you post online*
- *reading and adhering to the terms and conditions of use*

Session Two: Computer and Smartphone safety

Activity 2.1. Using Computer and smartphones safely (15 minutes)

Make a group of four to six members and discuss on the following issues.

1. How do you give care and protect your devices from malfunctioning and break?

2. What safety measures due you take to protect and secure your devices from an allowed users, virus and cyber-attacks?

Key Ideas

Internet Risks

The following are common internet risks that we should be aware of and also educate our students.

- ***Social Networking Risks:***
  - Social media platforms can expose users to cyberbullying, inappropriate content, and privacy breaches.
  - Discuss how to manage privacy settings, avoid sharing personal information publicly, and recognize fake profiles.
- ***Age Restrictions****:*
  - Many online services have age restrictions to protect children from inappropriate content.
  - Explore the importance of adhering to age limits and the risks associated with underage access.
- ***Sharing Online Profiles/Security Risk***:
  - Sharing personal information online can lead to identity theft, phishing attacks, and stalking.
  - Highlight the need for cautious profile sharing and strong passwords.
- ***Publishing Content****:*

- Posting content online (blogs, videos, etc.) can have unintended consequences.
- Discuss responsible content creation, copyright awareness, and avoiding harmful material.

- ***Uploading Photos and Videos****:*
  - Sharing images and videos can lead to privacy breaches or misuse.
  - Talk about consent, geotagging, and the impact of sharing visual content.
- ***Cyberbullying****:*
  - Online harassment affects mental health and well-being.
  - Address strategies to prevent and respond to cyberbullying.
- ***Copyright****:*
  - Using copyrighted material without permission can lead to legal issues.
  - Educate about fair use, Creative Commons licenses, and proper attribution.
- ***Exposure to Inappropriate Online Content****:*
  - Children may accidentally encounter harmful or explicit material.
  - Discuss safe browsing habits and parental controls.
- ***Excessive Time Online***
  - Spending too much time online can impact physical health, sleep, and social interactions.
  - Explore healthy screen time practices and digital balance.

Safe Use of Computers and Smartphone

Maintaining clean digital devices is crucial for both the longevity of the devices and our own well-being. Let's explore some reasons why it's essential to keep your electronic equipment clean:

1. **Device Performance and Longevity**:
- Regular cleaning helps prevent dust buildup and clogged fans, which can lead to overheating and damage to internal components.
- Clean devices run more smoothly, ensuring optimal performance and extending their lifespan.
2. **Improved Appearance**:
- A clean device looks better and is more pleasant to use.
- Considering how much time we spend interacting with our devices, an improved appearance positively impacts our daily experience.
3. **Health Protection**:
- Think about all the surfaces you touch throughout the day. Now imagine transferring that to your devices—keyboards, screens, and touchpads.
- If you don't clean your devices, they can harbour bacteria and germs, posing health risks when you touch your face or hands.
- Safe use of devices helps your eye from being damage due to inappropriate use.
4. **Avoiding Constant Replacements**:
- Regular cleaning reduces wear and tear, preventing premature device failure.
- Frequent replacements are inconvenient and costly, so maintaining your devices can save you time and money.

Implication for Teaching

Record your responses to the following questions as your takeaway and future consideration on your handouts.

- What did you learn e-safety?
- What are the potential risks in using digital technologies (internet)?
- What new skills, experience, knowledge have you got?

- How would you like to apply the new skills in your subject teaching learning activities?

Self Assessment

1. **What is the difference between facts and opinions?**

A. Facts are subjective statements, while opinions are objective.
B. Facts are based on evidence and can be verified, while opinions are personal beliefs.
C. Facts and opinions are interchangeable.
D. Opinions are always accurate, while facts can be misleading.

2. **Which of the following statements is an opinion?**

A. Ethiopia is one of the countries in East Africa.
B. Addis Ababa is the capital of Ethiopia."
C. Abebech Gobena has provided education opportunities for many Ethiopians through her NGO.
D. Ethiopia will soon become a middle-income country.

3. **What risks are associated with social networking platforms?**

A. Exposure to cyberbullying and inappropriate content
B. Increased privacy and security
C. Enhanced communication skills
D. Improved mental health

4. **Why is it important to keep digital devices clean and in good working order?**

A. To prevent identity theft
B. To avoid copyright infringement
C. For the health of the device and the user
D. To enhance internet speed

Reference Materials

Read	Smart Phone Use Safety Tips
Read	Parental Guide to Smartphone Safety
Read	How to secure your devices
Read	e-Safety Tips
Watch	Safe Online
Watch	Digital Footprint

Watch	Four Reasons to care about your digital footprint
Watch	How Fake News Spread
Watch	Fact vs Fake

Well done! You've made it to the end of the Module! We hope you've found it useful, and you'll join us Canvas Online Digital Skills Training.