I. Teacher's Guide for Grade 10 Physics Textbook

How to use this Teacher's Guide

This teacher's guide is designed to instruct the teachers how to teach Grade 10 Textbook more useful to them as they teach the course to give them information that aids in adapting to their teaching style and to provide with an additional information and resources they may want to use in their presentations, discussions or other classroom teaching.

1. Sequence for the Teacher's Guide

Introduction (*Learning Objectives, Skill Developments and Introduction*)
Teaching (*Teaching and More Information for Teachers*)
Practice (*Suggestion for Practising and Evaluation*)
Review and Assessment (*Key for Review Question and Exercise*)

Introduction

This portion introduces the teachers to link the prior knowledge of the students and introduce new concept, and also helps the students to think more critically and analytically.

Learning Objectives

The Grade 10 Physics Teacher's Guide directs the teachers to use the learning outcomes providing a clear focus on what students should learn.

Teaching

Being a teacher, the ideas, teaching strategies and activities must be accompanied by clear directions and wide knowledge on subject to achieve learning outcomes. Common forms are direct instructions and demonstrations, but it also includes discussion, using small group works, cooperative learning, problem solving, performance activities and using information technology.

More Information for Teachers

Extending knowledge other than text will enhance teacher's creativity, help to stimulate interest in new technology and electronic resources.

Practice

To encourage good communication between teacher and students, the good teaching practice and interaction between learners should be provided. Students will be stimulated to specify the activities and know how to organize for the planned activities by providing teaching aids.

This method and practice of teaching based on evaluating a stand or decision of students with appraising, supporting, critisize them and encourage them to argue, defend. Before beginning any experimental work, call attention to CAUTION included in the procedure, and review appropriate lab safety and experiment use guide.

Review and Assessment

The teachers should reflect the student's achievement for learning objectives in each work. The activities, results and discussion of the students should be evaluated among themselves. Teachers can moderate the students' performance in the classroom.
Schedule for conducting classroom level formative assessment and summative assessment should be asked at different stages of a lesson.

2. Overview of 21st century skills

After learning these lessons the students will able to participate in courses through **5C's as important 21st century skills for learning:**

- Collaboration
- Communication
- Critical Thinking and Problem Solving
- Creativity and Innovation
- Citizenship

3. Overview of Student-centred Pedagogy

The goal of a teacher using this guide book is to encourage higher order thought in their pupils by student-centred pedagogy. In the student-centred secondary classroom, student will participate actively and collaborate with their peers by using different strategies which include quiz, assignment etc.
Teachers provide challenge and real life problem solving situation as much as possible to make the students can acquire the best formula for success.

4. Overview of Classroom Level Assessment

Assessment is the activity of finding out what students are learning and how they are learning it. Also the activity of observing how teachers are teaching and what the results of that teaching are. Assessment can be "formative assessment" when it looks at the effects of the lesson while that lesson is going (or) "summative assessment" when it is done at the conclusion of a lesson to see what the lesson achieved.

Classroom level assessment intends to inform the teachers about a student's progress, so the teacher can help the students' improvement. Teachers will need to show how best the students can learn so the teachers will able to adjust their way to improve the quality of learning. Development of soft skills is an ideal plan to develop the teacher's formative assessment capability and technique conducting differentiated into two strategies, observation and questioning. Syllabus and Year Plan are also accompanied with this teacher's guide.

Answers from textbook provide students with practice in answering multiple choice questions and problems at the end of each chapter. **Suggestion for Practical** links and directs students to relevant experiment in **Practical Physics Grade 10** for further reinforcement of the concept learnt.

5. Social Dimensions in Basic Education High School Classroom

Social dimensions meaning extends beyond classroom boundaries. To diminish social inequality in the outside world, teachers should support equal oppotunities for all students including disabilities, minorities groups and lower social economic status. Teachers will provide knowledge on exclusion of gender discrimination, 21st century competencies such as global warming and requirements of sustainable energy.

After teaching this course through **Citizenship** as **21st century skill for learning**, the the students will be developed to join the school community and encouraged to explore news ideas, to have fairness in solving problems in new ways. We hope that the teachers will provide the knowledge through which the students will have learned to understand the benefits and hazards of the material world.

II. Syllabus and Year Plan

1. Syllabus

The syllabus for Grade 10 Physics includes three content components, five soft skills and learning objectives.

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
Chapter 1 Units and Measurements •Collaboration •Communication •Creativity and Innovation	• To explain the physical quantity • To discuss the unit and standard • To distinguish between the basic and derived units	• Basic and Derived Units	•Distinguished between the basic units and derived units.	Experiment 1 Vernier Calipers	• Answer from textbook • Section Review
	• To classify the different system of units • To explain the usefulness of the SI system	• System of Units	• Examine the system of units for length, mass and time by asking each group.		
	• To write down the SI unit prefixes and their symbols • To appropriately use the power of mathematics in physics • To correctly use scientific notations	• Prefixes	• Solve the problems with prefixes.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To recognize the standards of length, mass and time for SI units • To write down the relationship between different units of length • To use the symbols for physical quantities correctly	• Standards and Units	• Differentiate length, mass and time.		
	• To discuss the various instruments to measure the length • To distinguish the accuracy of the various instruments	• Measure-ment of Length	• Measure the given objects and calculate the area and volume of that object.		
	• To distinguish the various balances for mass measurement	• Measure-ment of Mass	• Measure the mass of the given objects.		
	• To accurately used the stopwatch and stop clock	• Measure-ment of Time	• Measure the time period of given pendulum.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
Chapter 2 **Motion** •Collaboration •Communica-tion •Critical Thinking	• To distinguish scalar and vector quantities • To discuss how to solve the vector addition, subtraction and resolution • To evaluate the resultant of two vectors graphically and analytically • To resolve a vector into two perpendicular components	• Vectors	• solve the problems of vector addition, subtraction and resolution.	Experiment 2 Average Speed	• Answer from textbook • Section Review
	• To recognize the difference between distance travelled and displacement, speed and velocity • To describe the acceleration of a moving object due to change of velocity	• Describing Motion	• average speed of ball by measuring its distance travelled and time taken.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To formulate equations of motion of an object for uniform motion and constant accelerated motion • To distinguish between accelerated and decelerated motions (retardation)	• Equations of Motion	• Rewrite the equations of motion under constant velocity and constant acceleration.		
	• To sketch displacement-time graph and velocity-time graph • To find the physical quantities of motion from these motion graphs	• Motion Graphs	• plot and interpret motion graph.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
Chapter 3 Forces •Collaboration •Communica-tion •Critical Thinking •Creativity and Innovation	• To realize two initial states of motion and inertia of a body • To relate acceleration of a particle and net force acting on it • To discuss the important facts and examples of action-reaction pair	• Newton's Law of Motion	• Study the relation between force and acceleration, inertia, action and reaction.	Experiment 3 Simple Pendulum	• Answer from textbook • Section Review
	• To discuss the gravitational force between objects • To give examples of advantages of the gravitational force	• Gravitati-onal Force and Newton's Law of Gravitation	• Discuss which force causes the existence of solar system and deduce the direction of this force.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To distinguish the fundamental forces and mechanical forces • To compare the strength of fundamental forces	• Different Kinds of Forces	• Discuss the kind of objects (or) particles (subatomic particle) which can produce fundamental forces.		
	• To explain the difference between weight and mass • To formulate the relation between mass of an object and its weight	• Mass and Weight	• Discuss the relation between mass and wieght.		
	• To recognize the force acting on a freely falling body • To realize free fall motion is motion with constant acceleration	• Freely Falling Bodies	• Discuss the effect of air resistance on the freely falling bodies.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To discuss the relation of momentum and velocity • To relate momentum and net force • To realize the usefulness of law of conservation of momentum	•Momentum and Law of Conservati-on of Momentum	• Discuss the change of momentum of the object.		
Chapter 4 Pressure •Collaboration •Communica-tion •Critical Thinking	• To realize difference between force and pressure • To discuss pressure units in various field	• Pressure	• Analyze pressure, force and contact area.	Experiment 4 Hydrometer	• Answer from textbook • Section Review
	• To discuss density and observe the density of different objects	• Density	• Compare the densities of wax and water.		
	• To compare the densities of different substances	• Relative Density (or) Specific Gravity	• Measure densities of two substances, wax block and iron block.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To compare the relative density of different liquids by using hydrometer • To construct the hydrometer using test tube	•Hydrometer	• Measure the density of milk and other liquids with a hydrometer.		
Chapter 5 Work And Energy • Collaboration • Communica-tion • Citizenship	• To recognize the concept of work done • To study how to relate work, force, displacement and angle between them	• Work	• Calculate the amount of work produced by pulling (or) pushing object.	Experiment 5 Work done	• Answer from text book • Section Review
	• To identify different forms of energy • To explain the energy transformation	• Energy	• Perform the elastic potential energy and gravitational potential energy. • Study the transformation of energy.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
Chapter 6 Heat And Temperature •Collaboration •Critical Thinking and Problem Solving •Communication	• To discuss about the internal energy of the matter • To explain how to relate heat and temperature	• Heat and Temperature	• Distinguish between heat and temperature.		• Answer from textbook • Section Review
	• To identify sensitivity and linearity of thermometer • To explain why there is a constriction in a clinical thermometer • To examine the thermometric properties of substances	• Types of Thermometer	• Discuss the advantages, disadvantages of two liquids (mercury and alcohol) used in liquid-in-glass thermometers.		
	•To apply the laboratory thermometer • To discuss the relation between different temperature scales	• Units of Temperature (or) Temperature Scales	• Convert the scales between Celsius scale and Fahrenheit scale.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	•To study how the thermal expansions of substances depend on temperature • To discuss the applications of thermal expansions of materials in different area	• Thermal Expansion of substances	• Discuss the thermal expansion of substances.		
Chapter 7 Wave And Sound •Collaboration •Communi-cation •Creativity and Innovation	• To examine the wave motion as a form of energy transfer • To realize that waves transfer energy without transferring matter	• Describing Wave Motion	• Discuss the wave transfer energy without transferring matter.	Experiment 3 Simple Pendulum	• Answer from text book • Section Review
	•To perform two types of wave • To discuss the wave characteristics	• Transverse and Longitudinal Waves	• Perform the transverse and longitudinal waves by using string and slinky spring.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To discuss the physical quantities of a wave such as velocity, frequency, wavelength, period and amplitude • To recognize the relation of these quantities	•Characteristics of Waves	• Draw a wave form by observing the vibrating string.		
	• To illustrate the displacement-time graph • To construct the displacement-distance (position) graph	• Graphical Representation of Wave	• Plot the displacement-time graph and displacement-position graph.		
	• To illustrate and discuss reflection, refraction and diffraction of wave	• Reflection, Refraction and Diffraction of Wave	• Discuss the reflection, refraction and diffraction of wave.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To discuss the transmission of sound • To study audible range of sound • To investigate the dependence of speed of sound on temperature and density of medium	• Sound Wave and Speed of Sound	• Perform the experiment of the generating of sound.		
Chapter 8 Light •Collaboration •Communi-cation •Critical Thinking and Problem Solving •Citizenship	• To distinguish between self-luminous bodies and non-luminous bodies	• Sources of Light	• Describe sources of light in the environment.	Experiment 6 Reflection by a plane mirror Experiment 7 The Concave Mirror	• Answer from textbook • Section Review
	• To observe the reflection of light by a plane mirror • To explain the laws of reflection of light	• Reflection of Light	• Discuss the parallel beam and divergent beam.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To observe the reflection of light by a plane mirror • To recognize the lateral inversion and reversibility of light • To realize the applications of plane mirror	• Image Formation in a Plane Mirror	• Demonstrate the lateral inversion and discuss the properties of the image in a plane mirror.		
	• To observe the reflection of light by curved mirrors • To investigate the formation of images • To realize the applications of curved mirrors	• Reflection at Curved Mirror	• Find the approximate focal length. • Analyze the virtual image formation in curved mirror.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
Chapter 9 Electricity •Collaboration • Communica-tion • Critical Thinking	• To express positive and negative charges • To show that unlike charges attract and like charges repel	• Electric Charges and Electric Forces	• Draw the force diagram between two like charges and unlike charges.		• Answer from textbook • Section Review
	• To recognize the matter and electric charge	• Matter and Electricity	• Draw a diagram to show a neutral atom.		
	• To discuss the charged body and uncharged body • To distinguish between electrical conductors, insulators and semi-conductors	•Conductors, Insulators and Semicon ductors	• Distinguished between conductors and insulators.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	•To explain charging by rubbing (or) friction • To explain charging by induction	•Electrification	• Perform the experiment of electrification by friction.		
Chapter 10 Magnetism •Collaboration •Critical Thinking and Problem Solving •Creativity and Innovation	• To distinguish between magnetic and non-magnetic materials • To develop an explanation of the properties of magnets	• Magnets and Magnetic Materials	• Classify magnetic and non-magnetic materials.	Experiment 8 Magnetic Field	• Answer from textbook • Section Review
	• To recognize that all magnetised and unmagnetised materials consist of very tiny magnets	• Theory of Magnetism	• Perform the experiment to show the pattern of a magnetic field around a bar magnet.		
	• To define a magnetic field in which magnetic effect can be detected and illustrate the pattern of magnetic field	• Magnetic Fields	• Show obviously the pattern of a magnet by iron filings.		

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To create an unmagnetised metal to a magnetised metal by different methods	• Magnetis-ation and Induced Magnetism	• Perform the experiment for magnetisation.		
	• To differentiate the magnetic properties of iron and steel. • To recommend the magnetic materials for their own applications.	• Magnetic Properties of Iron and Steel	• Discuss the magnetic properties of iron and steel.		
Chapter 11 Quantum And Atomic Physics • Communica-tion • Critical Thinking and Problem Solving • Collaboration	• To discuss why electrons are emitted from the metal surface. • To explain the construction of vacuum tube and its application.	•Thermio-nic Emission and Vacuum Diode	• Discuss the important role of diode in electric circuits and appliances.		• Answer from textbook • Section Review

Chapter & Soft skill	Learning Objective	Topics	Activities	Experiments	Review
	• To discuss the blackbody and blackbody radiation spectrum	•Blackbody Radiation and The Concept of Photon	• Discuss the blackbody, blackbody radiation, photon and photon energy.		
	• To discuss the atomic models	• Models of Atom	• Discuss the atomic models of Rutherford and Niels Bohrs.		
	• To explain the atomic structure	• Atomic Structure	• Construct Bohr's model of hydrogen and helium atom.		
	• To realize the visible universe • To discuss astronomy, astrophysics and cosmology	• The Structure and Evolution of The Visible Universe	• Discuss the Visible Universe, Milky way galaxy, Celestial objects.		

2. Year Plan

The year plan for Grade 10 Physics Textbook includes 51 sections for 11 chapters, allocation of periods for each section, 8 practicals, review and assessment periods.

Week	Period	Chapter Title	Lesson Title	Total period for each chapter
1	1	Chapter 1 Units and Measurements	Basic and Derived Units	10
			System of Units	
	1		Prefixes	
			Standards and Units	
	1		Measurement of Length	
	1		Measurement of Mass	
	1		Measurement of Time	
2	1		Review and Assessment	
	4		Practical	
3	4	Chapter 2 Motion	Vectors	21
	1		Describing Motion	
4	3			
	2		Equations of Motion	
5	2			
	3		Motion Graphs	
6	1			
	1		Review and Assessment	
	3		Practical	
7	1			
	3	Chapter 3 Forces	Newton's Laws of Motion	23
	1		Gravitational Force and Newton's Law of Gravitation	
8	2			
	2		Different Kinds of Forces	
	1			
9	3		Mass and Weight	
	2		Freely Falling Bodies	
10	1			

Week	Period	Chapter Title	Lesson Title	Total period for each chapter
10	3	Chapter 3 Forces	Momentum and Law of Conservation of Momentum	23
	1		Review and Assessment	
11	4		Practical	
	1	Chapter 4 Pressure	Pressure	13
12	1			
	2		Density	
	2		Relative Density (or) Specific Gravity	
13	2		Hydrometer	
	1		Review and Assessment	
	2		Practical	
14	2			
	3	Chapter 5 Work and Energy	Work	13
15	1			
	4		Energy	
16	1		Review and Assessment	
			Practical	
	4			
17	2	Chapter 6 Heat and Temperature	Heat and Temperature	16
	3		Types of Thermometer	
18	4		Units of Temperature (or) Temperature Scales	
	1		Thermal Expansion of Substances	
19	4			
	1			
20	1		Review and Assessment	
	1	Chapter 7 Wave and Sound	Describing Wave Motion	20
	2		Transverse and Longitudinal Waves	
	1		Characteristics of Waves	
21	2			
	2		Graphical Representation of Wave	
	1			

Week	Period	Chapter Title	Lesson Title	Total period for each chapter
22	2	Chapter 7 Wave and Sound	Reflection, Refraction and Diffraction of Wave	20
	3		Sound Wave and Speed of Sound	
23	2		Review and Assessment	
	3		Practical	
24	1			
	1	Chapter 8 Light	Sources of Light	25
	3		Reflection of Light	
25	4		Image formation in a plane mirror	
	1			
26	5		Reflection at Curved Mirror	
27	2			
	1		Review and Assessment	
	2		Practical	
28	5			
29	1			
	1	Chapter 9 Electricity	Electric Charges and Electric Forces	9
	2		Matter and Electriciy	
	1		Conductors, Insulators and Semiconductors	
30	1			
	3		Electrification	
	1		Review and Assessment	
31	1	Chapter 10 Magnetism	Magnet and Magnetic Materials	13
	1		Theory of Magnetism	
	2		Magnetic Fields	
	1			
32	2		Magnetisation and Induced Magnetism	
	1		Magnetic Properties of Iron and Steel	
	1		Review and Assessment	
	1		Practical	
33	3			

Week	Period	Chapter Title	Lesson Title	Total period for each chapter
33	2	Chapter 11 Quantum and Atomic Physics	Thermionic Emission and Vacuum Diode	17
34	3		Blackbody Radiation and the Concept of Photon	
	2		Models of Atom	
35	2		Atomic Structure	
	3		The Structure and Evolution of the Visible Universe	
36	5		Review and Assessment	

CONTENTS

MECHANICS

MODERN PHYSICS

CHAPTER 1

UNITS AND MEASUREMENTS

Total number of lesson Periods: 5 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- work accurately with basic and derived units of measurements.
- work accurately with standard measurements and conversion between different system of units.
- correctly use the symbols for physical quantities.
- develop skills in accurate measurement of length, mass and time.
- solve problems demonstrating proper use of units, quantities and scientific notations.

Skill Development

After teaching Units and Measurements instructed by this teacher's guide, the students will get skills in

- Collaboration - when working in group
- Communication - when solving the problem
- Creativity and Innovation - when thinking the units for derived quantities.

BASIC, DERIVED UNITS AND SYSTEM OF UNITS

Number of lesson periods: 1

1.1 BASIC AND DERIVED UNITS

Learning Objectives

After completing this section, the students will be able to

- explain the physical quantity.
- discuss the unit and standard.
- distinguish between the basic units and the derived units.

Teaching Aids

Charts (basic units , derived units)

Introduction

A physical measurable quantity is specified by two items: (i) a number and (ii) a unit.

Teaching

The teacher should explain the following facts:
physical quantity, unit, standard, basic unit, derived unit

The derived units from the basic units are as follows:

Units derived from the unit of length are

- square metre (m^2), (the unit of area)
- hectare (h), which is equal to 10 000 m^2, (the unit of area)
- cubic metre (m^3), (the unit of volume)
- litre (L), which is equal to 1 000 cm^3 (or) 1 000 mL, (the unit of liquid volume)

Units derived from the unit of length and time are

- metre per second ($m\ s^{-1}$) is the unit of speed (or) velocity.
- metre per second square ($m\ s^{-2}$) is the unit of acceleration.

Units derived from the unit of length, mass and time are

- newton (N), which is equal to $kg\ m\ s^{-2}$ is the unit of force (or) weight.
- joule (J), which is equal to N m is the unit of work.
- kilogram per cubic metre ($kg\ m^{-3}$) is the unit of density.

Unit derived from the unit of time is

- hertz (Hz), which is equal to cycles per second (s^{-1}), (the unit of frequency).

Practice

Students will work in a small group to solve the problems.

- Which of the followings are the basic units? Which are the derived units?
  m, cm, ft, ft^2, m^3, kg, g, s, $cm\ s^{-1}$, $m\ s^{-2}$, $kg\ m\ s^{-1}$, $kg\ m\ s^{-3}$

Review and Assessment

1. Determine the basic units of the following:
   (i) velocity(= distance/time) (ii) acceleration(=velocity/time) (iii) density (= mass / volume)
2. Is physics useful in the study of chemistry, biology and engineering subjects?

Teacher can assess the students' understanding by discussing basic units and derived units.

1.2 SYSTEM OF UNITS

Learning Objectives

After completing this section, the students will be able to

- classify the different system of units.
- explain the usefulness of the SI system.

Teaching Aids

Metre rule, ruler, beam balance, stopwatch

Introduction

In the present physics course for Basic Education we shall be using the following three systems of units: the British system, the metric system and the SI units. The universally used system of units for scientific works is the SI system. Besides the SI system, other systems are also important in engineering and technology.

Teaching

Teacher should introduce that there are seven basic units for physical quantities but almost all quantities in the physical world can be expressed in terms of only four fundamental quantities: length, mass, time and temperature. Units for these quantities have been specified and standardized. A set of such specified units is termed a system of units. Many different systems of units have been adopted in different places at different times. Among these seven basic units such as candela, ampere, mole will be explained at Grade 11.

More Information for Teachers

Dimensional analysis is required for the following facts:

(i) Equations that relate different quantities must have the same basic units on each side of the equation. If the basic units on each side of the equations are not the same, the equation must be wrong.

(ii) When each term in an equation has the same basic units, the equation is said to be homogeneous (or) correct.

Example (1) It is suggested that the time *T* for one oscillation of a swinging pendulum is given by the equation $T^2 = 4\pi^2(\frac{l}{g})$ where *l* is the length of the pendulum and *g* is the acceleration due to gravity. Show that this equation is correct.

Answer:

For the equation to be correct, the term on the left-hand side must have the same units as all the terms on the right-hand side.

Step 1 The unit of time is s. The unit of the left-hand side of the equation is, therefore, s^2.

Step 2 The unit of *l* is m. The unit of *g* is m s^{-2}. Therefore the unit of the right-hand side is $\frac{m}{ms^{-2}} = s^2$. (Notice that the constant $4\pi^2$ has no unit.)

Since the base units on the left-hand side of the equation are the same as those on the right, the equation is correct.

Example (2) A student uses the equation $v^2 = v_0^2 + 2at$ to find the final velocity. Check whether this equation is right (or) wrong.

Answer:

Step 1 The unit of final velocity is m s^{-1}. Thus the unit of the left-hand side of the equation is (m $s^{-1})^2$ (or) m^2 s^{-2}.

Step 2 The unit of the first term of the right-hand side is (m $s^{-1})^2$. Then, the unit of acceleration is m s^{-2} and that of time is s. Therefore the unit of the second term of the right-hand side is m s^{-1}. The unit of the right-hand side is m^2 s^{-2} + m s^{-1}.

Since the units on the left-hand side of the equation are not consistent those on the right, the equation is wrong.

Practice

Students will work in a small group to examine the system of units for length, mass and time by asking each group.

Review and Assessment

1. What is the unit of length in SI unit?
2. What is the unit of mass in SI unit?

3. What do the following symbols stand for?
   g, kg, lb, m, cm, ft.

Teacher can assess the students' understanding by discussing system of units and dimensional analysis.

PREFIXES, STANDARDS AND UNITS **Number of lesson periods: 1**

1.3 PREFIXES

Learning Objectives

After completing this section, the students will be able to

- write down the SI unit prefixes and their symbols.
- appropriately use the power of mathematics in physics.
- correctly use scientific notations.

Teaching Aids

Charts (SI unit prefixes, symbols and power of ten multiple and sub-multiple values)

Introduction

Teacher should explain why prefixes are used to express the physical quantities. The prefixes may be used to indicate decimal multiples (or) sub-multiples of both basic and derived units. The scientific notation is helpful when we are faced with a computation that involves large (or) small numbers.

Teaching

Each unit in the SI system can have multiples and sub-multiples prefixes to avoid using very high (or) low numbers. When prefixes are used, the prefix comes before the unit. For example, in the unit mm, the first m is the prefix milli and the second m is the unit metre.

More Information for Teachers

Some of the more important advantages of SI are as follows:

(i) SI provides only one basic unit for each physical quantity.

(ii) SI provides a unique and well-defined set of symbols and abbreviation, each of which relates to a specific phenomenon or condition.

(iii) SI retains the decimal relationship between multiples (+) and sub-multiples (−) of the base unit for each physical quantity. Prefixes are used to simplify for multiple and sub-multiple values.

Scientists deal with very large and very small numbers. For example, the speed of light is 299 792 458 m s^{-1} and the mass of the proton is 0.000 000 000 000 000 000 000 001 67 kg. They are awkward to write and print, and errors are often made in copying them. To write such very large and very small numbers, scientists make use of a compact form called scientific notation. It is extensively used in all branches of modern science. Numbers written using powers of ten are scientific notation (or) standard form.

For example, scientists would normally write as follows.

speed of light: 2.9979×10^{8} m s^{-1}

mass of a proton: 1.67×10^{-27} kg

In writing scientific notation (or) standard form, the decimal point is placed after the first nonzero digit. Then determine the power of 10 by counting the number of places we have moved the original decimal point to the marked decimal point. If we moved the point to the left, then power is positive: and if we moved it to the right, it is negative.

For examples, write the following numbers in scientific notation.

(i) 320 000 (ii) 0.000 075

Solution:

(i) 320 000

320 000.0 $= 3.2 \times 10^{5}$

decimal point moved five places to the left

(ii) 0.000 075

0.000 075 $= 7.5 \times 10^{-5}$

decimal point moved five places to the right

The scientific notation is helpful when we are faced with a computation that involves large (or) small numbers.

Practice

Students will work to solve the problems with prefixes.

- Express the standard form : (i) radius of the earth = 6 400 000 m (ii) radius of hydrogen atom = 0.000 000 000 052 9 m.

Review and Assessment

1. Write down the values of the following quantities in powers of tens.
   (i) 60 ps (ii) 500 mg (iii) 20 000 mm
2. Convert the following to km.
   (i) 2 000 m (ii) 200 m (iii) 2×10^{4} m
3. Convert the following to s.
   (i) 50 000 ms (ii) 5×10^{7} µs
4. Using the scientific notation, write down the following in two significant figures.
   (i) 15 000 m (ii) 15 000 000 m, (iii) 0.015 m

Answers

1. (i) 60 ps $= 60\times10^{-12}$ s $= 6\times10^{-11}$ s

   (ii) 500 mg $= 500\times10^{-3}$ g $= 5\times10^{-1}$ g

   (iii) 20 000 mm $= 2\times10^{4}\times10^{-3}$ m $= 2 \times 10^{1}$ m

2. (i) 2 000 m $= 2\times10^{3}\times10^{-3}$ m = 2 km

   (ii) 200 m $= 2\times10^{2}\times10^{-3}$ m = 0.2 km

   (iii) 2×10^{4} m $= 2\times10^{4}\times10^{-3}$ m = 20 km

3. (i) 50 000 ms = $5\times10^{4}\times10^{-3}$ s = 50 s
   (ii) 5×10^{7} μs = $5\times10^{7}\times10^{-6}$ s = 50 s

4. (i) 15 000 m = 1.5×10^{4} m
   (ii) 15 000 000 m = 1.5×10^{7} m
   (iii) 0.015 m = 1.5×10^{-2} m

Teacher can assess the students' understanding by discussing the requirement of prefixes.

1.4 STANDARDS AND UNITS

Learning Objectives

After completing this section, the students will be able to

- recognize the standards of length, mass and time for SI units.
- write down the relationship between different units of length.
- use the symbols for physical quantities correctly.

Teaching Aids

Metre rule, 1 kg weight, stopwatch, stop clock, charts (symbols for physical quantities)

Introduction

Teacher should introduce standard is a fundamental reference for measuring length, mass and time. Most scientists use SI units. The basic SI units for length, mass and time are metre, kilogram and second.

Teaching

The SI unit of length is metre. A more accurate standard is now used, based on the speed of light. Any multiple (or) fraction of the standard, and sometimes the standard itself, may be chosen as a convenient unit for some specific purpose. Thus, to measure the dimensions of objects like books or tables, a unit called the centimetre is often used. For atomic dimensions, however, a unit called the angstrom unit (Å) is found more convenient, and in astronomy, a convenient unit of length is light year unit (*l*y).

The SI unit of mass is kilogram.

The SI unit of time is the second. The standard of time is our rotating earth and the standard time interval is called the mean solarday, the average time interval between successive appearances of the sun overhead.

Physical laws and principles can be fully and effectively represented in mathematical forms.

To express the relation between physical quantities in mathematical equations we need the symbols for physical quantities precisely. F is symbol for force, p is symbol for pressure and A is symbol for area. They are related in pressure as $p = \frac{F}{A}$.

Practice

Students will work to differentiate length, mass and time of the following units:

- km, µg, µm, nm, kg, m , ms, mg, ns, µs, mm

Review and Assessment

1. Find the value of
   (i) 12 µm + 256 mm (ii) $\frac{5\ \mu s \times 2\ ps}{10\ ns}$
2. The masses of a proton and an electron are 1.67×10^{-21} mg and 9.1×10^{-28} g respectively. Find the ratio of the two.
3. Which physical quantities do the following symbols stand for?
   d, s, v, a, F, w, W, P, E, T, p

Answers

1. (i) $12\ \mu m + 256\ mm = 12\times10^{-6}\ m + 256\times10^{-3}\ m$
   $= 0.000\ 012\ m + 0.256\ m$
   $= 0.256\ 012\ m$

   (ii) $\frac{5\ \mu s \times 2\ ps}{10\ ns} = \frac{5\times10^{-6}\times2\times10^{-12}}{10\times10^{-9}} = 10^{-9}\ s$

2. $$\frac{\text{mass of a proton}}{\text{mass of an electron}} = \frac{1.67\times10^{-21}\ mg}{9.1\times10^{-28}\ g}$$
   $$= \frac{1.67\times10^{-21}\times10^{-3}\ g}{9.1\times10^{-28}\ g} = 0.1835\times10^{4} = 1\ 835$$

Teacher can assess the students' understanding by asking the standard of each basic units and the family symbols for physical quantities.

1.5 MEASUREMENT OF LENGTH

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- discuss the various instruments to measure the length.
- distinguish the accuracy of the various instruments.

Teaching Aids

Ruler, metre rule (or) half-metre rule, measuring tape, vernier calipers, micrometer (screw gauge)

Introduction

Teacher should introduce the instruments for measuring length, mass and time. Teacher should explain standard of a metre.

Teaching

In length measurement, we must choose an instrument that is suitable for the length to be measured. In many cases ordinary metre rules cannot be used for measuring lengths of objects accurately. In some cases where metre rules are applied directly, it is only possible to obtain accurately the first decimal place of centimetre, and the second decimal place of centimetre has to be estimated. To measure small lengths accurately, a vernier caliper is used. Therefore, vernier (or) slide calipers must be used to obtain lengths accurately up to the second decimal place in centimetre measurements. For measuring the diameter of fine wire, the thickness of a paper and similar small distance, a micrometer (screw gauge) (commonly shortened to micrometer) is used. It must be used when the third decimal place of centimetre is required.

The appropriate use of a metre rule, vernier calipers, micrometer (screw gauge), depending on the length to be measured and the accuracy required, will normally suffice for work.

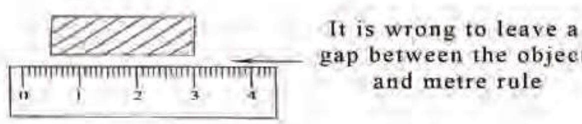
Practice

Students will measure the length, breadth and thickness of the table-top in your classroom. (For lengths greater than about 15 cm, a metre rule (or) a half-metre rule calibrated in millimetre (mm) will give reasonable accuracy.) Measure length, breadth and thickness of the table-top three times each and find their average values. From the measured values, calculate the area and volume of the table-top and convert the results in m^2 and m^3.

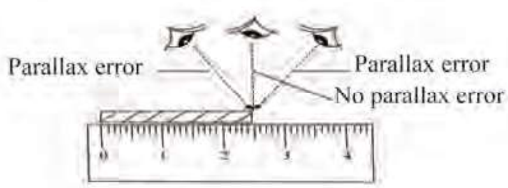
Precautions when using metre rule:

(1) For length measurements in elementary physics laboratories, we use metre and half metre rules.

(2) You must make surely to have no gap between the metre rule and the object to be measured.



(3) When the observer's eye is not directly above the markings of the metre rule, parallax error in measurements will occur.



Review and Assessment

1. Write down the following lengths in m.
   (i) 30 mm (ii) 4 000 cm (iii) 65 km
2. A cube has 5 cm in each side. What is the surface area? What is its volume?

Teacher can assess the students' understanding by discussing the instruments for measuring length.

1.6 MEASUREMENT OF MASS

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- distinguish the various balances for mass measurement.

Teaching Aids

Beam balance, sliding balance, spring balance, electronic balance

Introduction

Teacher should explain which instrument is measuring for mass. The mass of an object is a measure of the amount of matter in it. It depends on the number of atoms it contains and the size of those atoms.

Teaching

Mass is measured by using a balance such as the beam balance or electronic balance. Until recently the sliding mass balance (basically a beam balance) was used in most laboratories. The unknown mass is placed on the pan of the beam balance and its mass is obtained by sliding the given mass on the beam until the beams balance. In the last few years the modern electronic balance (or) top-pan balance has become more common. In this case, the object is placed on a pan and its mass read directly from a display screen.

The mass of an object can be found using a balance like this. The balance really detects the gravitational pull on the object on the pan, but the scale is marked to the mass.

Practice

Students will work to measure the mass of an object with a proper balance such as (beam balance (or) electronic balance)

Review and Assessment

- If the mass of a small purified drinking water bottle is 350 g, what is its mass in kg?

Answer

- $350\ g = \frac{350}{1000}\ kg$
  $= 0.35\ kg$

1.7 MEASUREMENT OF TIME

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- accurately use the stopwatch and stop clock.

Teaching Aids

Stopwatch, stop clock , digital stopwatch

Introduction

Teacher should introduce to measure the accurate time by using clock and stopwatch. Clocks and watches need something that beats at a steady rate. Some old clocks used the swings of a pendulum. Modern digital watches count the vibrations.

Teaching

All timing devices make use of some regular process. Most clocks use a process which depends a regularly repeating motion, such as the swing of a pendulum. Such repeating motions are termed oscillations. The most accurate clocks depend upon the oscillation of atoms in certain molecules.

Since such oscillations are very regular, the time in which one oscillation occurs should be constant. This time is referred to as the period of the oscillation.

Most common modern clocks and watches depend on the vibration of quartz crystals to keep time accurately. The energy to keep these crystals vibrating comes from a small battery. The smallest time interval which a student will encounter in general physics laboratory will be just a few tenths of a second. Therefore, a stop watch (or) a stop clock can be chosen to measure the time. Digital stop watches can measure up to 0.01 s.

The most accurate clock is the cesium atomic clock which depends on the oscilation of a cesium 133 atom. This clock is accurate to 1 second loss or gain in every 20 million years. In research works carried out in laboratories and in measuring very short times it is more appropriate and suitable to use the atomic standard instead of the earlier astronomical standards.

Practice

Students will work in a small group to measure the time period of the pendulum, one should observe from the place where the rest position can be recorded accurately. The pendulum is then set swinging with a small amplitude. Timing of the oscillation is begun by counting nought as the bob passes through the rest position and simultaneously a stop clock is started. Counting is continued, each time the bob passes through the rest position the same direction. The time period of the pendulum can be obtained by dividing the time taken by the number of oscillations.

Review and Assessment

- How long does it take light travelling at 3×10^8 m s^{-1} to across a room 6 m long?

Answer

- time taken $= \dfrac{\text{distance}}{\text{speed}}$

$$= \frac{6 \text{ m}}{3\times10^{8} \text{ ms}^{-1}} = 2\times10^{-8} \text{ s} = 20\times10^{-9} \text{ s} = 20 \text{ ns}$$

Teacher can assess the students' understanding by discussing the instruments for measuring mass.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 1 **Vernier Calipers**

In experiment 1, Vernier calipers is useful tool for measuring both the internal and external diameters. The small dimension of an object (less than 10 cm) can be measured by vernier calipers. Some vernier calipers which have vernier scale 20 divisions has least count 0.005 cm.

Teacher can assess the students' understanding by discussing the instruments for measuring time.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

2. (a) speed $= \dfrac{\text{distance}}{\text{time}}$

the unit of speed $= \dfrac{\text{m}}{\text{s}}$

$= \text{m s}^{-1}$

(b) volume = length × width × height

the unit of volume = m × m × m

$= \text{m}^3$

(c) density $= \dfrac{\text{mass}}{\text{volume}}$

the unit of denisty $= \dfrac{\text{kg}}{\text{m}^3}$

$= \text{kg m}^{-3}$

3. density of water $= 1 \text{ g cm}^{-3}$

$$= \frac{1 \text{ g}}{1 \text{ cm}^3}$$

$$= \frac{1 \times 10^{-3} \text{ kg}}{(10^{-2} \text{ m})^3}$$

$$= 10^3 \text{ kg m}^{-3}$$

4. The area of one page $= 20 \text{ cm} \times 25 \text{ cm}$

$$= 500 \text{ cm}^2$$

$$= 500 \times (1\text{cm})^2$$

$$= 500 \times (10^{-2} \text{ m})^2$$

$$= 500 \times 10^{-4} \text{ m}^2$$

$$= 0.05 \text{ m}^2$$

5. (a) $60 \text{ nF} = 60 \times 10^{-9} \text{ F} = 6 \times 10^{-8} \text{ F}$

(b) $500 \text{ MW} = 500 \times 10^{6} \text{ W} = 5 \times 10^{8} \text{ W}$

(c) $20\,000 \text{ mm} = 2 \times 10^{4} \times 10^{-3} \text{ m} = 20 \text{ m}$

(d) $400 \text{ μC} = 400 \times 10^{-6} \text{ C} = 4 \times 10^{-4} \text{ C}$

6. The average thickness of one sheet of paper $= 1.04 \times 10^{-4}$ m

7. 350 g

8. 10^{11} stars

9. 2.76×10^{-7} m

CHAPTER 2
MOTION

Total number of lesson Periods: 16 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- distinguish between a scalar quantity and a vector quantity.
- demonstrate correct use of vector symbols.
- find the sum and difference of two vectors and resolve a vector into two (or) more components.
- explain distance, displacement, speed, velocity and acceleration.
- study the equations of motion to analyze the motion under constant velocity and constant acceleration.
- illustrate and interpret motion graphs, namely, distance-time, speed-time graphs.
- solve problems demonstrating proper use of units, quantities and scientific notation for describing motion.

Skill Development

After teaching Motion instructed by this teacher's guide, the students will get skills in

- Collaboration - when solving the problems of vector addition and resolution
- Communication - when discussing the type of motions and equations of motion
- Critical Thinking - when thinking to solve challenging problems of kinematic.

2.1 VECTORS

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- distinguish scalar and vector quantities.
- discuss how to solve the vector addition, subtraction and resolution.
- evaluate the resultant of two vectors graphically and analytically.
- resolve a vector into two perpendicular components.

Teaching Aids

Graph paper, compass box

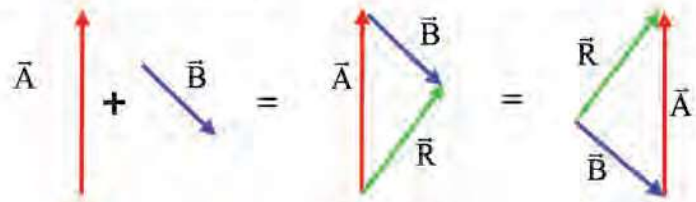
Introduction

Unlike scalars, vector quantities have both magnitude and direction. In a vector diagram, a vector quantity is represented by an arrow. When we want to add scalars, we add their magnitudes only. When we add two (or) more vectors, we must use the method of vector addition.

Teaching

The teacher should explain the following fact for vector addition, subtraction and resolution. If we want to add the two vectors, the vector diagram can be drawn the two methods. (i) head to tail method and (ii) parallelogram method.

The head to tail method for vector addition is illustrated below.



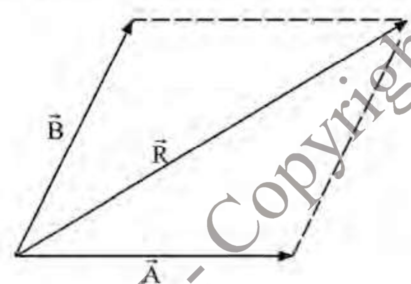
The parallelogram method is illustrated the following steps:

(i) Draw two vectors, starting at a common point.

(ii) Complete the parallelogram whose side are $\vec{A}$ and $\vec{B}$.

(iii) Draw the diagonal of this parallelogram starting at the common point.

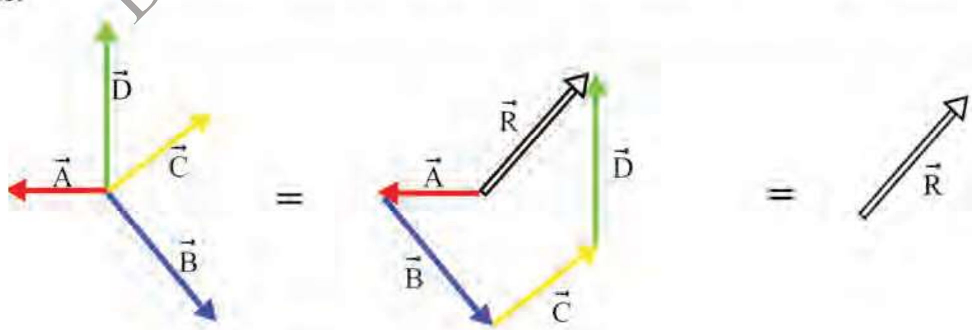
(iv) This diagonal represents the resultant of $\vec{A}$ and $\vec{B}$.



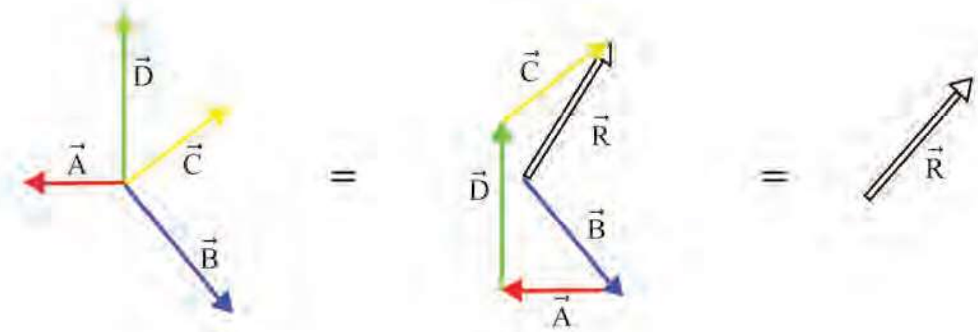
In vector addition, the order in which the vectors are added, does not affect the result.

$$\vec{A} + \vec{B} = \vec{B} + \vec{A}$$

Example: The following vector diagrams show to set the resultant vectors of given four vectors. The four vectors can be taken in any order and added, and still the resultant vector is the same.



(a)

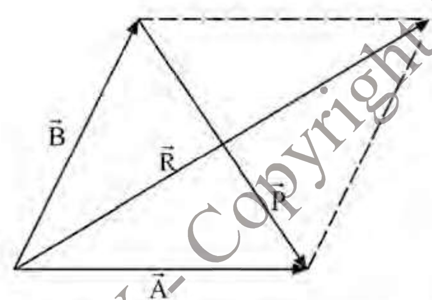


(b)

More Information for Teachers

Two vectors can be also added and substracted by constructing a parallelogram. The following vector diagram expresses that one of the diagonal $\vec{R}$ will represent the resultant vector.

To subtract these two vectors, the remaining diagonal $\vec{P}$ will represent the subtraction of two vectors.



$\vec{R} = \vec{A} + \vec{B}$

$\vec{P} = \vec{A} - \vec{B}$

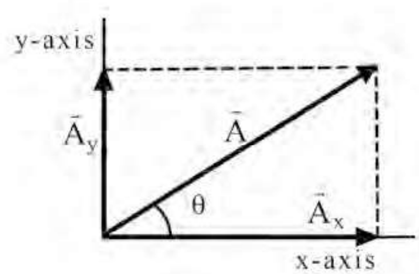
To make the resolution of a vector (or) to find the perpendicular components of a vector, we can draw the vector diagram according to the following steps:

(i) draw perpendicular axes x and y,

(ii) take the origin of axes as the starting point of the vector,

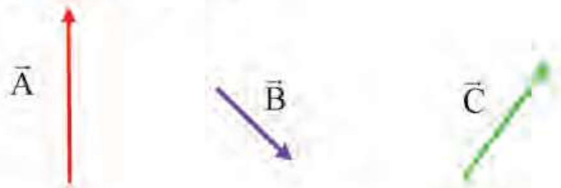
(iii) draw the parallel lines to the axes from the tip of the vector

(iv) mark the point on each axes where the line intersect the axes.



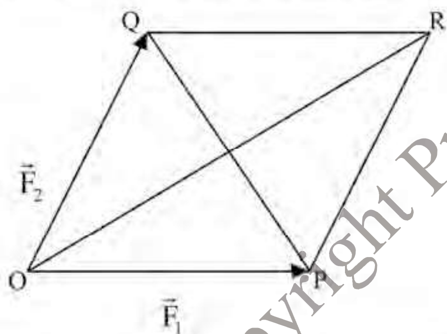
Practice

Students will work in a small group to draw the diagrams of $\vec{A}+\vec{B}$, $\vec{B}+\vec{C}$, $\vec{B}-\vec{C}$ and perpendicular components of $\vec{B}$ and $\vec{C}$.



Review and Assessment

1. In the diagram, $\vec{F}_1$ and $\vec{F}_2$ represent two forces in magnitude and direction. The point R completes the parallelogram (OPRQ). Which diagonal represents the resultant force?



2. Two (or) more of the following sets of displacement, when carried out in the order shown, have the same resultant, which are they?
   (a) 2 m east, 3 m north, 4 m west
   (b) 2 m north, 3 m west, 4 m east
   (c) 2 m east, 4 m west, 3 m north
   (d) 3 m north, 2 m east, 4 m west

3. Which one (or) more of the following pairs can be the components of a velocity of 30 m s^{-1} east?
   (a) 20 m s^{-1} east, 10 m s^{-1} east
   (b) 35 m s^{-1} east, 5 m s^{-1} west
   (c) 20 m s^{-1} east, 15 m s^{-1} west

Answers

1. The diagonal OR represents the resultant force.
2. They are (a), (c) and (d).
3. (a) and (b).

Teacher can assess the students' understanding by asking the procedure of vector addition and vector resolution.

2.2 DESCRIBING MOTION

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- recognize the difference between distance travelled and displacement, speed and velocity.
- describe the acceleration of a moving object due to change of velocity.

Teaching Aids

stopwatch, measuring tape (or) metre rule, track

Introduction

Teacher should remind that students have learnt the motion of an object in the previous level. In this chapter, the distance travelled, displacement, speed, velocity and acceleration of a moving object are defined exactly.

Teaching

The distance travelled is total path length covered by a moving object regardless of the direction of motion. It is a scalar. Displacement is the distance measured in a straight line in a specific direction. Displacement is a vector.
Instantaneous speed can be determined at any instant of time. In a car, the reading of speedometer is instantaneous speed. If we take into account the direction of motion it is instantaneous velocity.

In uniform motion, the value of average speed is equal to the instantaneous speed and the value of average velocity is equal to the instantaneous velocity. Any change in velocity gives rise to acceleration. Velocity changes when there is change of direction, change of speed , (or) change of both direction and speed.
The acceleration due to increasing velocity is positive acceleration. The acceleration due to decreasing velocity is negative acceleration (or) deceleration.

Practice

Students will work in a small group to measure the distance, time taken for motion of a ball moving on a track (or) inclined plane. Students can calculate the average speed from the data obtained.

Review and Assessment

(i) Is it possible to run around an oval running track at constant velocity?
(ii) Two objects moving with the same speed may not have the same velocity. Why?
(iii) What can be said about the speed of two objects if they have the same velocity?
(iv) An object moving in a circle with constant speed is said to be accelerated. Explain.
(v) Can an object be moved if its acceleration is zero?

Teacher can assess the students' understanding by discussing quantities of motion.

2.3 EQUATIONS OF MOTION

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will

- formulate equations of motion of an object for uniform motion and constant accelerated motion.
- distinguish between accelerated and decelerated motions (retardation).

Teaching Aids

Stopwatch, measuring tape, metre rule, track

Introduction

All the different kinds of motion can be classified as two main types: uniform motion and accelerated motion.

Teaching

In uniform motion, the velocity of the moving body is constant. Motion with changing velocity is called an accelerated motion. If the velocity of moving body is changing at a constant rate, its acceleration is constant. It is said to be constant accelerated motion.

For uniform motion, with constant velocity, $\vec{a} = 0$, $s = v\,t$

For constant accelerated motion $v = v_0 + at$, $\bar{v} = \dfrac{v + v_0}{2}$, $s = \bar{v}\,t$

$$s = v_0 t + \frac{1}{2}at^2;\ v^2 = v_0^2 + 2as$$

Practice

Students will work in a small group to derive the equations of motion with constant velocity and motion with constant acceleration. Teacher should discuss with them on the basic equation.

Review and Assessment

1. Are uniform accelerated motion and uniform motion the same?
2. An object accelerates from rest at a constant rate of 4 ms^{-2} for a distance 200 m. How fast is the object moving at that time? How long did it take for the object to reach that velocity?

Answer

1. No.
2. $v^2 = v_0^2 + 2as$

   $v^2 = 0 + 2 \times 4 \times 200$

   $v^2 = 1600$

   $v = 40\ ms^{-1}$

   $v = v_0 + at$

   $40 = 0 + 4 \times t$

   $t = 10$ s

Teacher can assess the students' understanding by discussing type of motion and equation of motion.

2.4 MOTION GRAPHS

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- sketch displacement-time graph and velocity-time graph.
- find the physical quantities of motion from these motion graphs.

Teaching Aids

Graph paper, compass box

Introduction

Teacher should introduce that motion can be described conveniently with the help of graphs represented displacement-time graph and velocity-time graph.

Teaching

If an object is moving with a constant velocity, the displacement-time graph is a straight line. The slope of dispacement-time graph gives the velocity of the moving object.The velocity-time graph is a straight line parallel to the time axis (i.e. horizontal axis). In this case, acceleration is zero.

If an object is moving with constant acceleration, the velocity-time graph is a straight line with positive slope (for positive acceleration) and negative slope(for negative acceleration).

The slope of velocity-time graph gives the acceleration of the moving object. The area under the velocity-time graph gives the displacement (or) distance travelled.

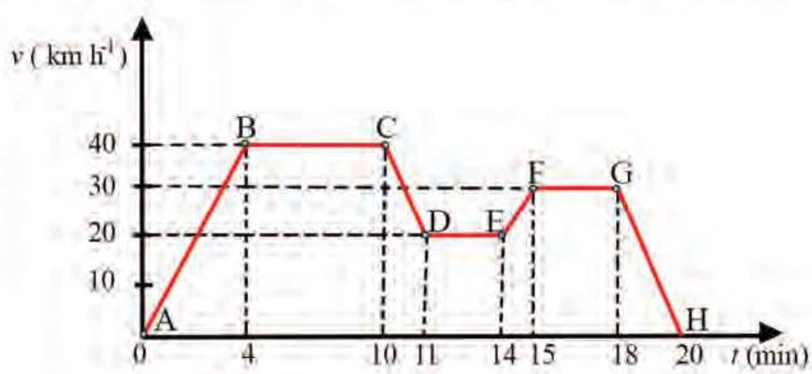
Practice

Students will work in a small group to plot the motion graph such as displacement - time graph. They will also find velocity from the graph.

time / s	0	1	2	3	4	5
distance / m	0	4	8	12	16	20

Review and Assessment

1. The figure represents graphically the velocity of a car moving along a straight level road over a period of 20 minutes. (a) Describe the motion of the car between A and B. (b) Describe the motion of the car between D and E. (c) How far has the car travelled between B and D? (d) Find the acceleration of the car between G and H.



Answer:

(a) The motion of the car between A and B is motion with constant acceleration.

(b) The motion of the car between D and E is motion with constant velocity (or) uniform motion.

(c) distance travelled between B and D = area under BC + area under CD

= area of rectangular + area of trapezium

$$= 40\,\text{km} \times \frac{(10-4)}{60}\text{km} + \frac{1}{2} \times \frac{(11-10)}{60}(20+40)\text{km}$$

$$= 4 + \frac{1}{2} \times \frac{(11-10)}{60} \times (40-20) + 20 \times \frac{(11-10)}{60}$$

$$= 4 + \frac{1}{2} \times \frac{(11-10)}{60} \times 20 + 20 \times \frac{(11-10)}{60}$$

$$= 4 + 0.5 = 4.5\text{ km}$$

(d) The acceleration of car between G and H = slope of GH

$$= \frac{0 - 30\text{ km h}^{-1}}{20 - \frac{18}{60}\text{ min}}$$

$$= \frac{0 - 30}{\frac{20 - 18}{60}} = -15 \times 60\,\text{km h}^{-1}\text{ min}^{-1}$$

$$= -0.069\text{ m s}^{-2}\text{ (deceleration)}$$

Teacher can assess the students' understanding by observing the problem solving.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 2 **Average Speed**

In experiment 2, average speed of moving marble can calculate. From this experiment types of motion of marble can be discussed. Moreover, track rails must have small friction.

Answers from textbook

3. 6.708 N

4. (i) 10 units
   (ii) 11 units

8. average velocity $= \dfrac{\text{displacement}}{\text{time taken}} = 0$

   average speed $= \dfrac{\text{distance travelled}}{\text{time taken}} = 8\,\text{m s}^{-1}$

   The magnitude of average velocity is not the same as the value of the average speed.

9. 3 mi h^{-1}, 2.126 mi h^{-1}

10. $a = 4.4$ ft s^{-2}
    $s = 275$ ft

11. $a = 4$ m s^{-2}
    $v = 216$ km h^{-1}

12. -2 m s^{-2} (deceleration)

13. (a) 7.5 m s^{-1}

    (b) 75 m

    (c) 0.5 m s^{-2}

14. -0.83 m s^{-2}

    60 m

17. $v_0 = 36$ km h^{-1} = 10 m s^{-1}

    $v^2 = v_0^2 + 2as'$

    $0 = 10^2 + 2(-2)\ s'$

    $s' = 25$ m
    $s = 28$ m

Since the distance moved of the car is less than 28 m, the car will not hit the cow.

CHAPTER 3

FORCES

Total number of lesson Periods: 18 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- describe concept of inertia.
- explain force as a cause for change of state of motion.
- recognize gravitational force between two masses which obeys inverse square law.
- distinguish between mass and weight.
- classify different kinds of forces.
- examine momentum and the application of the law of conservation of momentum.
- determine the characteristics of the freely falling bodies.
- demonstrate basic knowledge and skill related to gravitational force and frictional force.
- use mathematical relationships to solve problems and predict events.

Skill Development

After teaching Forces instructed by this teacher's guide, the students will get skills in

- Collaboration - when working in group to discuss the net force acting on a body
- Communication - when solving the appropriate problems of dynamics
- Critical Thinking - when thinking the new idea for momentum conservation
- Creativity and Innovation - when explaining new idea for the suitable practice.

3.1 NEWTON'S LAWS OF MOTION

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- realize two initial states of motion and inertia of a body.
- relate acceleration of a particle and net force acting on it.
- discuss the important facts and examples of action-reaction pair.

Teaching Aids

Two different mass of wooden blocks, trolley, inclined plane

Introduction

Teacher should introduce that in this section, they will look at how forces affect objects as they move. The effects of balanced forces (net force = 0) and unbalanced forces (net force ≠ 0) on an object are described. Forces appear when two objects interact with each other.

Teaching

Force can be defined precisely and explicitly in physics by Newton's laws of motion.

First law

Although two equal and opposite forces act simultaneously on a particle at rest, the particle will continue at rest. In this case, since the net force acting on the particle is zero, its initial state does not change. In the absence of a net force, a body can be in a state of rest (or) of motion at a constant velocity.

Example If the forces acting upon an object are balanced, can the object be accelerated?

Since the forces acting upon an object are balanced , the net force is zero. $\vec{F}_{\text{net}} = 0$, $\vec{a} = 0$, the object cannot be accelerated.

Second law

According to second law , the net force acting on a particle can produce acceleration. The acceleration of the particle depend on its mass.

$$\vec{a} = \frac{\vec{F}_{\text{net}}}{m}$$

Although the same net forces acting two different bodies the greater mass of body will get the smaller acceleration as shown in figure.

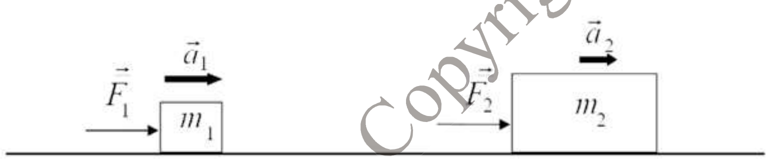


Figure 3.1 The relation between mass and acceleration

The greater the mass of a body, the more difficult it is to start to move (or) to stop it. This means that the greater the mass of a body, the greater will be its inertia.

Newton's first law is a particular case of Newton's second law. If velocity is constant, acceleration is zero then net force is zero.

Example If 10 N force is applied horizontally in turn to two bodies of different masses, which one will get greater acceleration?

By using Newton's second law, $\vec{F}_{\text{net}} = m\vec{a}$, $m_1\vec{a}_1 = m_2\vec{a}_2 = 10$ N. For only magnitude

$\frac{m_1}{m_2} = \frac{a_2}{a_1}$, the body of smaller mass will get greater acceleration.

Third law

A single object cannot experience a force by itself. Forces always occur in pair called action-reaction. Action-reaction forces act on two different bodies. For every action, there is an equal and opposite reaction.

For example, when a person is standing on the floor, he exerts a force on the floor with the same magnitude of his weight and he is pushed with the same magnitude of force.

Practice

(i) Students will work in a small group to discuss the relation between force and acceleration by using trolley, horizontal (or) an inclined plane and different masses to discuss. They can notice the relation between mass and acceleration. They will observe that when the mass on the trolley is increased, the acceleration of trolley decreases.

(ii) Students will work in a small group to study on inertia of a body by using wooden block and moving ball. They will try to move a wooden block which is initially at rest and to stop a moving ball. They noticed that object with a large mass have a large (or) inertia depend on the mass. They will be able to understand the inertia is the property of a body (or) its natural resistance to change in its state of motion.

(iii) Students will perform the following example for action and reaction: If they push on the wall, then the wall must also push back on them. They can examine the action force and reaction from this work.

Precaution

- Action-reaction forces are not balanced forces.

Review and Assessment

1. A 4.0 kg object is moving across a friction-free surface with a constant velocity of 2 m s^{-1}. How much the horizontal forces is needed to maintain this state of motion?
2. Two forces is acting on an object of 5 kg mass simultaneously. If one force of 8 N pulls to the left and another force of 20 N pulls to the right, what is its acceleration?
3. Do action and reaction pairs of forces balance one another?
4. A water skier is being pulled at a constant speed 12 m s^{-1} by a speed boat. The tension in the cable pulling the skier is 140 N. How large a frictional force is opposing the skier's motion?

Answers

1. v = constant, $\vec{F}_{net} = 0$, since frictional force is zero, no horizontal force is needed.

2. The direction towards right takes as (+) sign.

$$F_{net} = (+20)\text{N} + (-8)\text{N} = +12 \text{ N}$$

$$F_{net} = ma$$

$$a = +\frac{12 \text{ N}}{5 \text{ kg}} = +2.4 \text{ m s}^{-2}$$

The acceleration is directed towards right.

4. Tension in cable T = 140 N

Frictional force f = ?

v = constant, $\vec{F}_{net} = 0$

$$T + (-f) = 0$$

$$T = f = 140 \text{ N}$$

Teacher can assess the students' understanding by discussing the relation between mass and acceleration, concept of inertia and action-reaction forces.

3.2 GRAVITATIONAL FORCE AND NEWTON'S LAW OF GRAVITATION

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- discuss the gravitational force between objects.
- give examples of advantages of the gravitational force.

Teaching Aids

Cardboard, different size of balls

Introduction

Isaac Newton put forward the law in 1687 and used it to explain the observed motions of the planets and their moons. Teacher should introduce that there is a force between planet and moon. This is gravitational force.

Teaching

Newton's law of gravitation states that any two bodies exert a gravitational force of attraction on each other. The direction of the force is along the line joining the bodies.

The gravitational force between two bodies depends on the product of masses and the square of distance between two bodies, $F = \frac{Gm_1m_2}{r^2}$.

Newton's law of gravitation is also called inverse square law ($F \propto \frac{1}{r^2}$).

The gravitational force causes the earth and the other planets to orbit the sun. The gravitational force of the earth keeps us on the ground and causes objects to fall. The earth's gravity keeps the water on earth while the moon's gravity causes tides. Newton's law of gravitation is very applicable to study the planetary orbits.

Practice

Students will work in a small group to discuss the force between earth and moon and deduce the direction of this force.

Precaution

- The distance r is measured between the centers of their masses. For the force exerted on the second body by the first body, the direction of $\vec{F}$ is from the first body to second body.

Review and Assessment

1. The sun contains the gases, which force holds the gas in the sun ?
2. If you throw up a ball in air, the ball comes down again. Which force causes this effect?

Answers

1. Gravitational force
2. Gravitational force

Teacher can assess the students' understanding by asking the advantages of gravitational force.

3.3 DIFFERENT KINDS OF FORCES

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- distinguish the fundamental forces and mechanical forces.
- compare the strength of fundamental forces.

Teaching Aids

Magnets, spring

Introduction

The fundamental forces are field forces. Mechanical forces are contact forces such as elastic force, frictional force and tension.

Teaching

The gravitational force, weak force, electromagnetic force and nuclear force are four fundamental forces.

The weak and nuclear (strong) forces are effective only over a very short range and dominate only at the level of subatomic particles. Gravitational force and electromagnetic force have infinite range (or) are long-range forces.

When an elastic material (spring) is stretched (or) compressed, the force produced by the spring is elastic force which retains the original form of spring. Frictional force is generated by two surfaces that are in contact and slide against each other. Frictional force opposes the motion of an object.

The tension force is transmitted along a string when it is pulled by forces acting from opposite sides.

Practice

Students will work in a small group to explain which fandamental force is the weakest (or) the strongest, which are long range (or) short range force and discuss the kind of objects (or) particles (subatomic particle) which can produce fundamental forces.

Review and Assessment

- Which force is greater strength either gravitational force (or) electromagnetic force?

Answer

- Electromagnetic force

Teacher can assess the students' understanding by discussing the strength of fundamental forces.

3.4 MASS AND WEIGHT

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- explain the difference between weight and mass.
- formulate the relation between mass of an object and its weight.

Teaching Aids

Beam balances, spring balance, weight box

Introduction

Mass is a measure of actual amount of material contained in a body while weight is the force of gravity on a body.

Teaching

Mass is a measure of inertia, $m = \frac{F}{a}$. It is also called inertial mass.

Weight of an object is a measure of gravitational force between the object and the earth. We can calculate the weight of an object as follow :

$$w = G\frac{mM}{R^2} = m\frac{GM}{R^2}$$

where M = mass of earth, R = radius of earth.

$$\text{Since } w = mg,\ \frac{GM}{R^2} = g = \text{accleration due to gravity}$$

$$m = \frac{w}{g}\ ;\ \text{this mass is called gravitational mass.}$$

In the textbook, only the word 'mass' will be used without differentiating between inertial mass and gravitational mass. The variation of weight is due to the change in the value of the gravitational force as the distance from the body to the centre of the earth changes. The more massive an object is, the stronger its gravitational force.

Mass is measured by using a balance to compare a known amount of matter to an unknown amount of matter. Weight is measured by spring balance. Mass of an object on the earth and on the moon are the same however its weight changes according to gravitational accelerations on the earth and on the moon.

Practice

Students will work in a small group to measure the mass and weight of different objects by using a spring balance and a beam balance. They can discuss the relation between mass and weight.

Precaution

- A weighing scale calibrated for use on earth cannot be used on the moon.

  For a beam balance the unknown mass object can be measured by comparing the known mass object (standard weight). ($w_1 = w_2$, $m_1g = m_2g$, $m_1 = m_2$). The mass measured whether on the earth (or) the moon will be the same.

Review and Assessment

1. How are mass and weight related?
2. Can the mass of a body change according to its location? Explain.
3. Which balance must be used, a spring balance (or) a beam balance, to measure the weight of an object?

Answers

1. $w = mg$
2. The mass of a body cannot change according to its location. Mass is always constant.
3. A spring balance must be used to measure the weight.

Teacher can assess the students' understanding by discussing how to measure the mass and weight.

3.5 FREELY FALLING BODIES

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- recognize the force acting on a freely falling body.
- realize free fall motion is motion with constant acceleration.

Teaching Aids

Stopwatch, measuring tape

Introduction

A freely falling body is any body moving freely under the influence of gravity alone, regardless of its initial motion.

Teaching

The motion of freely falling body is constant accelerated motion. Its acceleration is acceleration due to gravity g.

To solve the problem concerning free fall, downward direction of g is (−) sign. Downward direction of velocity and displacement are (−) sign, upward direction of velocity and displacement are (+) sign.

If a body is thrown upward with a velocity v_0, its acceleration g is directed downward as well as a body dropped from a height. The maximum height h the body reached can be obtained as follow:

At the highest point velocity $v = 0$, by using $v^2 = v_0^2 - 2gh$, $h = \dfrac{v_o^2}{2g}$ maximum height is depend on the initial velocity but does not depend on the mass of body.

Practice

Students will work in a small group to examine the motion of a stone and a sheet of paper dropped from the same height. Teacher should lead to discuss the effect of air resistance on the falling bodies.

Precaution

- In free fall motion, the origin of the co-ordinate system can be taken as a starting point of motion.

Review and Assessment

- Which force produces the acceleration of a freely falling body?

Teacher can assess the students' understanding by discussing how to solve problems of freely falling body.

3.6 MOMENTUM AND LAW OF CONSERVATION OF MOMENTUM

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- discuss the relation of momentum and velocity.
- relate momentum and net force.
- realize the usefulness of law of conservation of momentum.

Teaching Aids

Marbles, small wooden balls, piece of spring (20 cm length)

Introduction

Teacher should introduce that momentum is an important quantity in the study of motion. Momentum of a body depend on its mass and velocity. Law of conservation of momentum is not only one of fundamental law but also very useful law.

Teaching

Change of velocity gives rise to acceleration. If a net force is acting on a body, its momentum will change as well as its velocity will change. The net force is the rate of change of momentum.

Law of conservation of momentum is applied for both macroscopic (large enough to be seen without using a microscope) and microscopic (extremely small) objects. By using this law we can find the velocity of a body and also find the mass.

Practice

1. Students will work a small group to conduct an experiment to explain the momentum of an object (i) by throwing balls of different masses to hit the target and (ii) by varying the effort (force acting on ball).
2. Students will discuss the momentum of the ball by either increasing the mass of the ball (or) increasing its speed. Teachers should ask their observation.

Review and Assessment

1. What is relation between (i) velocity and momentum (ii) force and momentum?
2. Choose the correct answer .
   Momentum is measured in (i) g cm s^{-1} (ii) g cm s (iii) g cm^{-1} s^{-1}.

Answers

1. (i) $p = mv$,
   (ii) $\vec{F}_{net} = \dfrac{m\vec{v} - m\vec{v}_0}{t}$
2. g cm s^{-1}

Teacher can assess the students' understanding by discussing the relation between momentum and velocity, the important application of law of conservation of momentum.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 3 Simple Pendulum

In experiment 3, the relation between period *(T)* and length (l) of a simple pendulum is investigated. The period of a pendulum is the time taken for the pendulum bob to make one complete oscillation.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

1. It is more difficult to move a big stone because mass of the big stone is greater than that of a small one. The big stone has greater inertia.
2. Force exerted by the man on the earth = 600 N
3. 1.675×10^{-21} N
4. 7 200 N
5. − 9 600 N
6. 10 m s^{-2}
7. $a_1 = 3\,a_2$
8. − 4620 lb
9. 62.5 sl , 48 ft s^{-2}
10. The weight of the body will decrease.
11. The force acting on 3 M is 3 times greater. 0.32 N, 0.96 N
12. 64 N
13. 10 s
14. 2 s
15. 4 s , 20 m s^{-1}
16. 100 kg m s^{-1} north
17. 6 m s^{-1}
18. 60 kg

CHAPTER 4
PRESSURE

Total number of lesson Periods: 8 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- distinguish between the density and the specific gravity.
- skillfully construct and use hydrometer to measure the density of liquids.
- understand pressure and units of daily usage.
- apply basic knowledge of pressure and density to daily-life phenomena.

Skill Development

After teaching Pressure instructed by this teacher's guide, the students will get skills in

- Collaboration - when working in group to construct a test tube hydrometer
- Communication - when discussing the daily usage of pressure
- Critical Thinking - when thinking the importance of density and uses of density in daily life.

4.1 PRESSURE

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- realize difference between force and pressure.
- discuss pressure units in various field.

Teaching Aids

Two wooden blocks of different masses, nail, hammer

Introduction

Teacher should introduce that the concept of the pressure is very important in daily life. Pressure is the force applied perpendicular to the unit area of the surface of an object.
It is usually more convenient to use pressure rather than force to describe the influences upon fluid behavior.

Teaching

What does pressure mean? The following example is to explain this question.

If a man tried to hammer a blunt metal rod into the wall, it is hard to penetrate the wall. If he hammers with the same force on a nail, the nail will penetrate the wall. This example shows that sometimes just knowing the magnitude of the force is not enough. In the case of the nail, all the force on the nail was concentrated into the very small area on the sharp tip of the nail.

To create a large amount of pressure, you can either exert a large force or exert a force over a small area. If the knife is sharp, then the area of contact is small and we can peel any fruit with less force exerted on the blade.

Practice

(i) Students will work in a small group to analyze pressure using various rectangular blocks. They measure weight of the rectangular blocks using spring balance and they also measure the dimension of block (length, breadth, height). By placing the rectangular block on a surface with different orientation, they can calculate the pressure.

(ii) Students will work in a small group to investigate the pressure due to water. They can notice that water pressure increases with the depth of water as shown in Figure 4.1.

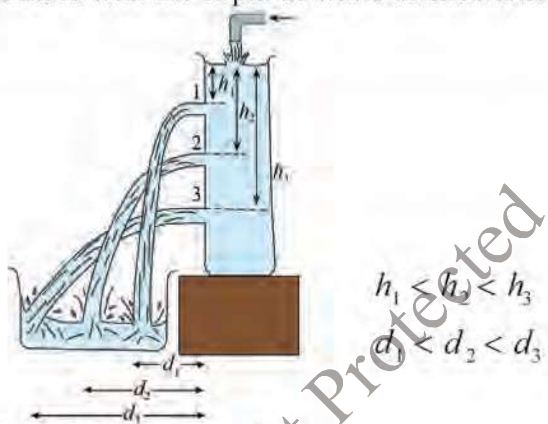


Figure 4.1 Pressure of water

Precaution

- Pressure unit and force unit are not the same. Force is a vector but pressure is a scalar.

Review and Assessment

- A 25 N force is applied to the piston of a syringe. The area of the piston is 10^{-4} m^2. If no liquid flows out of the syringe find the increase in pressure in the liquid.

Answer

- $F = 25$ N, $A = 10^{-4}$ m^2
  Increase in pressure, $p = \frac{F}{A} = \frac{25}{10^{-4}} = 2.5 \times 10^5$ Pa

Teacher can assess the students' understanding by discussing how to use the concept of pressure in daily life.

4.2 DENSITY

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- discuss density and observe the density of different objects.

Teaching Aids

Balance, measuring cylinder, weight box, wooden block

Introduction

Density is the amount of mass per unit volume. Teacher should give the imformation that density is a characteristic property of a substance. Density is widely used to check the purity of substance.

Teaching

If an object is heavy and compact, it has a high density.

If an object is light and takes up a lot of space, it has a low density. The density of a material varies with temperature and pressure. Density is a key concept in analyzing how material interact in fluid mechanics, weather, geology, material sciences, engineering, and other fields of physics. When drawing the designs of bridges, flyovers and buildings, architects and engineers have to know the densities of materials which are to be used for the construction.

Chemists can check roughly the purity of a substance by measuring the densities. Geologists can sometime identify gems by measuring their densities.

More Information for Teachers

Changes in the density of water have serious effects on ships. When a cargo ship is loaded in a sea port, the captain has to limit the load it carries if he is to sail up a river. River water with a lower density will cause the ship to sink more if it is carrying too heavy load. All ships have markings on their hulls to show how deep they submerged. These markings are called Plimsoll lines.

Practice

Students will work in a small group to explain why a wax block floats in water by comparing the densities of wax and water.

Review and Assessment

1. Find the mass of water required to fill the aquarium of length 100 cm, breadth 40 cm and depth 30 cm.
2. 'Since gold is denser than aluminum, gold is always heavier than aluminum.' Is this statement correct (or) not?

Answers

1. Volume of water $= V_w = l \times b \times h$

$= 100\times10^{-2} \times 40\times10^{-2} \times 30\times10^{-2}\ m^3$

$= 0.12\ m^3$

mass of water $= M_w = \rho V$

$= 10^3 \times 0.12$

$= 120\ kg$

2. The statement is not correct. The given statement is not complete as the masses of metals depend on their volume.

Teacher can assess the students' understanding by discussing the relationship between the density, mass and volume.

4.3 RELATIVE DENSITY (OR) SPECIFIC GRAVITY **Number of lesson periods: 2**

Learning Objectives

After completing this section, the students will be able to

- compare the densities of different substances.

Teaching Aids

Metal block,wax block, empty container

Introduction

The density and relative density concepts are not only important in mechanics of liquid but also very useful in practice.

Teaching

We have to measure mass and volume in the determination of density. Mass can be measured accurately with a laboratory balance and it can be measured with greater accuracy than volume. Therefore, the value of relative density can be measured more accurately than that of the density because it is necessary to measure the mass (or) weight only.

The relative density of a substance tells you how the density compares with that of water. It is calculated as

$$\text{relative density} = \frac{\text{density of substance}}{\text{density of water}}$$

For example, the relative density of mercury is just a number without unit,

$$\frac{13600}{1000} = 13.6$$

Relative density has no units. It is used to be known as specific gravity.

Relative density can also be defined by the following relation:

$$\text{relative density} = \frac{\text{mass of certain volume of body}}{\text{mass of equal volume of water}}$$

Since the mass of an object is directly proportional to its weight, the relation is

$$\text{relative density} = \frac{\text{weight of body having a certain volume}}{\text{weight of equal volume of water}}$$

Practice

Students will work in a small group to compare the densities of wax block and iron block with that of water. Then check which substance sinks in water.

Review and Assessment

- The density of water is 1 000 kg m^{-3}. What is the mass of 1 litre water?

Answer

- 1 kg.

Teacher can assess the students' understanding by discussing the observation of practice.

4.4 HYDROMETER

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- compare the relative density of different liquids by using hydrometer.
- construct the hydrometer using test tube.

Teaching Aids

Test tube, graded cylinder, graph paper, steel pellet or lead shot, hydrometer

Introduction

A hydrometer is an instrument used for measuring the relative density of liquid based on its properties called buoyancy.The denser the liquid, the higher an object will float in the liquid. The hydrometer makes use of this principle. It is specially designed to float vertically in a liquid and measure its density.

Teaching

When an object is placed in a liquid of a lower density, the object sinks. If it is placed in a liquid of a greater density, it floats. The amount of floating body that is submerged is inversely proportional to the specific gravity of the liquid. The more the submerged portion, the less the specific gravity.

The hydrometer is an instrument for measuring the density or relative density of liquids. It usually consists of a glass tube with a long bulb at one end. The bulb is weighted with lead shot so that the device floats vertically in the liquid, the relative density being read off its calibrated stem by the depth of immersion.

If the hydrometer floats higher, it indicates that the liquid has a higher density.

Special hydrometers are used to test the specific gravity of solutions in storage batteries. Hydrometers are typically calibrated with one (or) more scales.

Practice

Students will work in a small group to measure the density of milk and other liquids with a hydrometer and to construct a simple test tube hydrometer. Teacher should ask them why hydrometer can easily measure density of liquids.

Review and Assessment

1. Find the relative density of glycerine at 0˚C (density of glycerine = ρ_g = 1 260 kg m^{-3}).
2. Which instrument should be used to measure the relative density of a liquid?

Answers

1. The relative density of glycerine $= \dfrac{\rho_g}{\rho_{water}}$

$$= \frac{1\,260}{1\,000}$$

$$= 1.26$$

2. Hydrometer.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 4 Hydrometer

In experiment 4, hydrometer can be constructed by test tube. Then the relative density of liquids is measured by using it.

> **Note:** After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

1. 2.026×10^5 N
2. 1.43×10^4 Pa
3. 4.5883×10^6 Pa
4. 8.26×10^2 Pa, 2.6×10^3 Pa, 1.2×10^3 Pa
5. 1.133 g cm^{-3}, RD = 1.133
6. Maximum weight of water displaced= 24 000 kg
   So, It can carry 5 000 kg.

CHAPTER 5
WORK AND ENERGY

Total number of lesson Periods: 8 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- develop an understanding of work as a physics student compared to an ordinary person.
- evaluate the mathematical expressions of work done.
- investigate gravitational potential energy and the elastic potential energy.
- realize the relationship between work and energy.
- demonstrate that energy can be transformed from one form to another and how it is conserved.
- apply basic knowledge of work and energy to daily-life phenomena.
- use mathematical relationships of work and energy in solving problems.

Skill Development

After teaching Work and Energy instructed by this teacher's guide, the students will get skills in

- Collaboration - when working to apply the work done by different forces
- Communication - when discussing forms of energy and energy conversion
- Citizenship - when discussing to solve the sustainable energy.

5.1 WORK

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- recognize the concept of work done.
- study how to relate work, force, displacement and angle between them.

Teaching Aids

Small trolley, inclined plane, measuring tape, protractor, stopwatch

Introduction

When an object moves under the influence of a force, work is done by the force.

Teaching

We can calculate the work done by the force as follow:

Work = force × distance travelled in the direction of the force

(or)

Work = component of force in the direction of motion × distance travelled

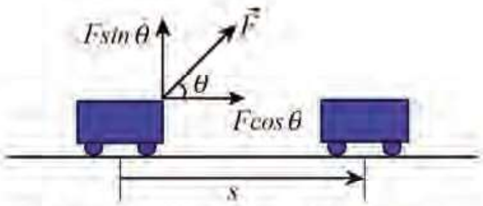


Figure 5.1 Work done by a force

$$W = Fs\cos\theta$$

Force is measured in newton (N), displacement is measured in metre (m), work is measured in joule (J).

More Information for Teachers

If direction of force and direction of motion are opposite, the work is negative value.

Practice

Students will work in a small group to investigate the amount of work by pulling (or) pushing an object along the floor with various angle between force and displacement.

They noticed that the force acting on the object depend on angle between force and displacement for the same distance travelled. After working the practice, teacher should point out that its concept can be used in daily life.

Review and Assessment

- A horizontal force of 20 N act on a box to a horizontal distance of 2 m. How much work is done on the box by the force?

Answer

- $F = 20$ N, $\theta = 0$, $s = 2$ m

  $W = Fs\cos\theta$

  $= 20 \times 2 \times \cos 0$

  $= 40$ J

Teacher can assess the students' understanding by discussing the usefulness of the concept of work in daily life.

5.2 ENERGY

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- identify different forms of energy.
- explain the energy transformation.

Teaching Aids

Retort stand, measuring tape, weight box, pendulum, rubber band

Introduction

Energy is a measurement of the ability of something to do work. Energy can be measured in many different forms. Energy can be transformed from one form into another. Whenever work is done energy changes from one form to another. Therefore energy and work are same unit.

Teaching

There are two forms of mechanical energy : kinetic energy and potential energy.

Kinetic energy is defined as the energy possessed by an object due to its motion. The amount of kinetic energy possessed by a moving object depends on its mass and speed.

$$KE = \frac{1}{2}mv^2$$

Potential energy is the energy stored due to its position (or) configuration. There are different types of potential energy: gravitational potential energy and elastic potential energy. Gravitational potential energy is the energy stored in a body due to its height from the ground. An object possesses gravitational potential energy when it is lifted to a height above the ground.

$$PE = mgh$$

Elastic potential energy is the energy stored due to its configuration. A spring (or) rubber band possesses elastic potential energy when it is compressed (or) stretched.

$$PE = \frac{1}{2}mx^2$$

Practice

Students will work in a small group to study the elastic potential energy with a stretched rubber band, compressed (or) stretched springs. They will study mechanical energy by lifting a heavy load to a height and motion of a pendulum.

Students will work in a small group to study the transformation of energy by using a ball connected to a slinky spring suspended vertically. When pulled downward from its initial position and released, the ball oscillates up and down. They will notice that forms of energy possessed by the ball during the motion.

Figure 5.2 (a) A simple pendulum

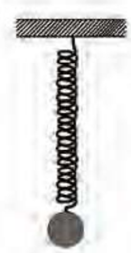


Figure 5.2 (b) A ball hanging on a spring

Review and Assessment

1. Give an example of a situation in which there is a force and a displacement, but there is no work done by the force. Explain why it does no work.
2. Is the work done on an object when you lift it up to a table?
3. How does a kinetic energy of a moving body depend on the velocity?

Answers

1. When force and displacement are perpendicular to each other, the force does no work.

   $W = Fs \cos \theta$

   $= Fs \cos 90^{\circ}$

   $= 0$

2. Yes.
3. Kinetic energy of a moving body is directly propotional to the square of its velocity.

Teacher can assess the students' understanding by asking the energy transformation and forms of mechanical energy.

Experimental work **Number of practical period: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 5 Work done

In experiment 5, work done can be determined by two methods, rubber band method and spring balance method. Unknown mass of an object can be found from this experiment.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

1. 160 000 J
2. 400 J

   When the flower pot strikes the ground the *PE* will change to *KE*.
3. 6 J
4. 5 m
5. (a) 2 J (b) 0.4 J (c) 10^5 J
6. (a) $v = 20$ m s^{-1}

   (b) *PE* = 150 J

   PE = 300 J
7. (a) 1.8 J

   (b) 1.8 J

   (c) 6 m s^{-1}

   (d) 1.25 J

   (e) $v = 5$ m s^{-1}
8. $W = 9$ J
9. 55 J
10. 1 000 J
11. 150 J
12. 31.62 m s^{-1}

CHAPTER 6

HEAT AND TEMPERATURE

Total number of lesson Periods: 15 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- identify that thermal energy as an internal energy of a matter.
- explain why heat is considered to be a form of energy.
- distinguish between heat and temperature.
- examine thermometric properties of substances and differentiate thermometric properties of mercury and alcohol.
- examine linear, area and volume expansion.
- explain heat as the energy transferred between substances that are at different temperatures.
- apply basic knowledge and skill of thermal physics to daily-life phenomenon such as thermal expansion.

Skill Development

After teaching Heat and Temperature instructed by this teacher's guide, the students will get skills in

- Collaboration - when work in small group to define the purpose of constriction in clinical thermometer
- Critical Thinking and Problem Solving - when analysing the thermometric properties of thermometer for suitable purposes
- Communication - when measuring temperature of substance gathering and sharing information about laboratory thermometer.

6.1 HEAT AND TEMPERATURE

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- discuss about the internal energy of the matter.
- explain how to relate heat and temperature.

Teaching Aids

Thermometers, calorimeter (beakers)

Introduction

At the beginning of this section, the students will be stimulated the prior knowledge and able to understand the following facts.

Heat is a form of energy. Temperature is the quantity that determines how cold (or) how hot the object is.

Teaching

The study of heat and thermal properties of matter is actually a study of energy and energy transfer. Heat is a form of energy. When heat is applied to various kinds of energies, it can supply forces to do work.

Teacher provides classroom level activities and develop the knowledge.

Practice

Teacher will try to get participation of students in learning activities.

The students will add same amount of ice to a cup full of boiling water and to another cup half-filled with boiling water. Ask the student "which cup is hotter?".

The students will determine the temperature of icy water, lukewarm water and moderately hot water by thermometer with different temperature scales.

Precaution

- In reading the thermometer scale, parallax error must be avoided.

Review and Assessment

- To measure the students' outcome, ask them to interpret the heat as energy in transit from the experiments with a cup of lukewarm water and cold water in learning.

Answer

The temperature of the cups can be recorded by thermometer since it is the degree of hotness (or) coldness. A cup with full of boiling water is hotter than cup half-filled with boiling water because of heat transfer to ice. The amount of energy exchanged between two objects due to different temperature is heat. There is more thermal energy in the cup full of boiling water than the cup half-filled with boiling water.

This assessment will be linked back to the learning outcomes that is identification of thermal energy as an internal energy of a matter.

6.2 TYPES OF THERMOMETER

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- identify sensitivity and linearity of thermometer.
- explain why there is a constriction in a clinical thermometer.
- examine the thermometric properties of substances.

Teaching Aids

Laboratory Celsius scale thermometer, clinical thermometer

Introduction

Every thermometer uses a physical property that varies with temperature. This property is referred to as the thermometric property of the thermometer. For example, the thermometric property of a liquid-in-glass thermometer is the thermal expansion of the liquid.

Teaching

Teacher might recall the thermometric properties of thermometer which have been known in previous levels.

Teacher should explain the following facts:
- properties of thermometric liquid.
- accurate temperature can only be measured with a thermometer.

Table 6.1 Thermometer and thermometric properties

Type of thermometer	Thermometric property	Examples of use
liquid-in-glass mercury-in-glass alcohol-in-glass	thermal expansion of a liquid	home, office, green house, hospital (clinical thermometer)
thermocouple	voltage between two different metals in contact	food heated in an oven, temperature variation of gas flow, data logging, remote locations
resistance thermometer	electrical resistance of a piece of metal	industrial application below $600\ ^{\circ}C$

Practice

Students will work in a small group to discuss the advantages and disadvantages of two liquids (mercury and alcohol) used in liquid-in-glass thermometers. It links back to the learning outcome as examine thermometric properties of substances and differentiate thermometric properties of mercury and alcohol.

They will outline the main design features as well as the purpose (or) working principles of the laboratory thermometer and the clinical thermometer.

Review and Assessment

1. State the physical property that varies with temperature in (a) liquid-in-glass thermometer, (b) thermocouple thermometer.
2. What is a thermocouple thermometer? How does it work?

Answers

1. (a) volume of liquid with fixed mass

   (b) Electromagnetic force (or) electrical voltage
2. Thermocouple thermometer

Thermocouple thermometers are electrical thermometers which make use of the voltage that develops when two different metals are in contact. This voltage varies with temperature. An iron wire and two copper wires may be used to make a thermocouple thermometer, as shown in Figure. One of the junctions is maintained at $0\ ^{\circ}C$ and the other junction is used as the temperature probe. The voltmeter can be calibrated directly in $^{\circ}C$.

Because of the small size of a thermocouple junction, thermocouple thermometers are used to measure rapidly changing temperatures. In addition, they can be used to measure much higher temperatures than liquid-in-glass thermometers. Also, the voltage of a thermocouple can be measured and recorded automatically.

It can be evaluated that the above questions can focus on contents of different types of thermometers and thermometric properties.

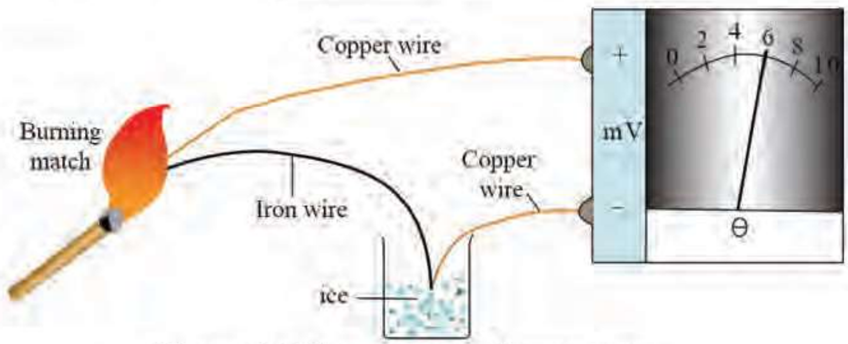


Figure 6.1 Thermocouple thermometer

6.3 UNITS OF TEMPERATURE (OR) TEMPERATURE SCALES

Number of lesson periods: 4

Learning Objectives

After completing this section, the students will be able to

- apply the laboratory thermometer.
- discuss the relation between different temperature scales.

Teaching Aids

Celsius scale thermometer

Introduction

Temperature units depend on the scales used. The temperature scales most widely used today are Celsius (Centigrade), Fahrenheit and Kelvin scales. The SI unit of temperature is kelvin (K).

Teaching

When teacher begins this new section, they clarify the purpose and learning goals on how students can be succeeded in learning about the temperature scales.

Temperature scales are degree Celsius, degree Fahrenheit and Kelvin. The thermometers marked with Celsius (Centigrade) scale and Fahrenheit scale are used for ordinary cases such as measuring room-temperature, body-temperature and the temperature of hot water. Temperature is usually expressed by writing ˚C and ˚F just after the number. C stands for Celsius and F for Fahrenheit. The third temperature scale, the Kelvin (or) the absolute temperature is used in scientific work. Temperature is expressed by writing K just after the number. K stands for Kelvin.

The relationship between the Celsius temperature T_C and the Fahrenheit temperature T_F is given by the equation

$$T_C = \frac{5}{9}(T_F - 32) \qquad \text{(or)} \qquad T_F = \frac{9}{5}T_C + 32$$

The relationship between the Celsius temperature T_C and Kelvin temperature T_K is given by

$$T_C + 273 = T_K.$$

Classroom discussion allows the students to learn from each other about the units of temperature and relation between them.

Table 6.2 A temperature scale in degree Celsius, Kelvin and Fahrenheit

Kelvin - Celsius - Fahrenheit		
Kelvin	Celsius	Fahrenheit
0 K	-273 °C	-459.4 °F
100 K	-173 °C	-279.4 °F
150 K	-123 °C	-189.4 °F
200 K	-73 °C	-99.4 °F
233 K	-40 °C	-40 °F
273 K	0 °C	32 °F
278 K	5 °C	41 °F
283 K	10 °C	50 °F
288 K	15 °C	59 °F
293 K	20 °C	68 °F
298 K	25 °C	77 °F
303 K	30 °C	86 °F
310 K	37 °C	98.6 °F
323 K	50 °C	122 °F
348 K	75 °C	167 °F
373 K	100 °C	212 °F
423 K	150 °C	302 °F
523 K	250 °C	482 °F
773 K	500 °C	932 °F
1023 K	750 °C	1382 °F
1273 K	1000 °C	1832 °F

Teachers may focus on having students do not memorize the table but mastering the process of converting.

Practice

Ask the following questions to the students to determine the level of understanding.

1. What temperature on the Celsius scale corresponds to 212 ˚F, the boiling temperature of water?
2. What temperature on the Fahrenheit scale corresponds to 37˚C , the normal body temperature of a healthy person?

Review and Assessment

1. Derive the relation between different temperature scales.
2. The most common temperature scale used is the Celsius scale. What temperares the fixed points used on this scale?

3. Fill in the blanks.
(i) A thermocouple consists basically of two of different .... join together at the ends to form two junctions.
(ii) The voltage produced in a thermocouple .... with temperature.
(iii) A thermocouple can be used to measure .... temperatures.

Answer

1. $$\frac{T_c}{100} = \frac{T_F - 32}{180}$$

$$T_c = \frac{5}{9}(T_F - 32)$$

$$T_F - 32 = \frac{9}{5}T_C$$

$$T_F = \frac{9}{5}T_C + 32$$

2. Boiling point or steam point, freezing point or ice point

3. (i) metal wires
(ii) varies
(iii) high

6.4 THERMAL EXPANSION OF SUBSTANCES **Number of lesson periods: 6**

Learning Objectives

After completing this section, the students will be able to

- study how the thermal expansions of substances depend on temperature.
- discuss the applications of thermal expansions of materials in different area.

Teaching Aids

Ball and ring apparatus, (spirit) burner, specific gravity bottle, thermometer

Introduction

When a substance is heated, its volume usually increases. The dimensions of the substance increase correspondingly. Increase in size can be explained in terms of the increased kinetic energy of the molecules.

Teaching

Teacher should explain the thermal expansion of substance (solid, liquid and gas).

Linear Expansion

Point out the thermal expansion of substances. The coefficient of linear expansion 'α' is the change in length per unit length for one degree change in temperature.

The unit of 'α' is expressed in per ˚C (or) per K. Although there is a change in unit, the value of 'α' remains the same.

Values of coefficient of linear expansion for liquids are typically about 5 times higher than that for steel; gases have expansivity values about 100 times that of steel. These values indicate that gases expand much readily than liquids, and liquids expand more readily than solids.

Practice

The students will discuss the thermal expansion of water by observation of over flow of water in container which is filled with water completely and heated from the bottom. It can be seen in daily life.

Review and Assessment

- The surface area of a solid increases with temperature according to the formula $\Delta A = 2\alpha\, A\, \Delta T$. How much does the area of a rectangular steel plate 0.5 m by 2.5 m increase when it is heated from 0 ˚C to 40 ˚C? ($\alpha = 1.27\times10^{-5}\,\text{K}^{-1}$).

Answer

$$\Delta T = (40+273)-(0+273)$$
$$= 40\,\text{K}$$
$$A = (2.5\times0.5)\,\text{m}^2$$
$$\Delta A = 2\,\alpha\, A \Delta T$$
$$\Delta A = 2\times(1.27\times10^{-5})\times(2.5\times0.5)\times(40-0)$$
$$= 2\times1.27\times40\times10^{-5}\times(2.5\times0.5)$$
$$= 127\times10^{-5}\ \text{m}^2$$

This relates to learning outcomes of examine linear, area and volume expansion.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

5. 303 K
7. -40°
8. 5.08×10^{-3} m
9. 7.62×10^{-3} m
10. 1.2525×10^{-6} m^3

CHAPTER 7
WAVE AND SOUND

Total number of lesson Periods: 14 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- examine the wave motion as a form of energy transfer.
- compare transverse and longitudinal wave and give the suitable examples of each.
- illustrate displacement-time graph and displacement-position graph.
- express the concept of wave equation and use it to solve problems.
- describe the reflection, refraction and diffraction of waves.
- apply the basic knowledge of generation, propagation and hearing of sound in daily life.

Skill Development

After teaching Wave and Sound instructed by this teacher's guide, the students will get skills in

- Collaboration - when discussing the transfer of energy by the wave without transferring matter
- Communication - when performing the transverse and longitudinal waves and discussing characteristics of wave
- Creativity and Innovation - when sharing ideas and their own thinking.

7.1 DESCRIBING WAVE MOTION

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- examine the wave motion as a form of energy transfer.
- realize that waves transfer energy without transferring matter.

Teaching Aids

Rope (string), spring

Introduction

The teacher should introduce the wave motion by dropping a stone in the water. Students can see disturbance when the stone strikes water surface. In wave motion, disturbance travels through a medium due to vibrations of particles of the medium about their original positions. In other words, energy and momentum transfer from one point to another through the medium, without transferring matter of medium in wave motion.

Teaching

Teacher should introduce the types of waves. Waves that require a medium for their propagation are called mechanical waves (water wave, wave in a vibrating string, sound wave, wave in coiled spring). Electromagnetic waves consist of vibrating electric and magnetic fields. Electromagnetic waves transmit energy through matter (or) across vacuum. Electromagnetic waves include radio waves, microwaves, infrared, visible light, ultraviolet, X-rays and gamma rays.

Practice

Students will work in a small group to perform a wave in a string by vibrating one end of a string which is fixed at another end. The students will discuss the movement of the part of the string during the process and discuss how energy transfer along the vibrating string. They will determine whether the parts of the string move (or) not from one place to another during the process.

Students will work in a small group to perform a wave in a slinky spring by vibrating one end of slinky spring which is fixed another point. The motion of part of coil of slinky spring can visualize the wave form. Students will explain that wave transfers energy from one place to another, however, part of coil does not transfer from one place to another during process. By working the above demonstrations, the students will notice the propagation of wave through the medium.

Review and Assessment

- How can electromagnetic waves differ from mechanical waves?

Answer

- Mechanical waves require a medium for their propagation. Electromagnetic waves do not require medium. They can travel through vacuum.

Teacher can assess the students' understanding by discussing the propagation of wave.

7.2 TRANSVERSE AND LONGITUDINAL WAVES **Number of lesson periods: 2**

Learning Objectives

After completing this section, the students will be able to

- perform two types of wave.
- discuss the wave characteristics.

Teaching Aids

Rope (string), slinky spring

Introduction

There are two basic types of wave. In a transverse wave, the particles of the medium vibrate at right angle to the direction of its propagation. In a longitudinal wave, the particles of the medium vibrate in a direction parallel to the direction of its propagation.

Teaching

Wave motion can be performed by using a string (or) slinky spring. The waves in a string move towards the wall, while the string particles only vibrate up and down about their original positions (equilibrium). The string is the medium through which the waves travel. It is transverse wave.

Second type of wave can also be demonstrated with series of compression which travel along the slinky spring when the segments of spring are compressed together. Regions where the segments of the spring further apart are rarefactions. It is longitudinal wave. This type of wave cannot be demonstrated on a stretched string.

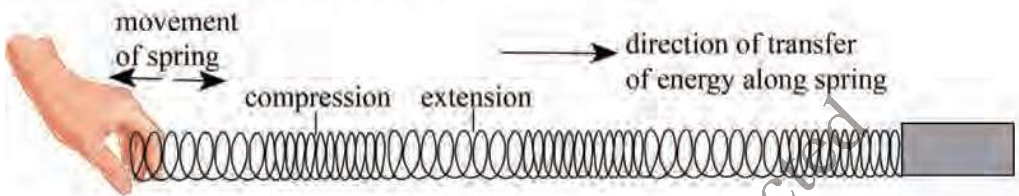


Figure 7.1 Longitudinal wave

Practice

Students will work in a small group to perform the transverse and longitudinal waves by using string and slinky spring respectively. The transverse waves can be simply created on a horizontal length of string by anchoring one end at the wall and moving the other end up and down.

A longitudinal wave can be created in a slinky spring. It is stretched out in a horizontal direction and the first parts of the slinky spring are vibrated horizontally. In such a case, each individual coil of part of the spring is set into vibrational motion in directions parallel to the direction of wave.

Review and Assessment

1. Describe the movement of particles in a transverse wave.
2. Give an example of waves which travels as a longitudinal wave.

Answers

1. In a transverse wave the displacements of particles of the medium are perpendicular to the direction of the wave.
2. Compressional waves in a slinky coiled spring.

Teacher can assess the students' understanding by asking how transverse and longitudinal waves can be distinguished.

7.3 CHARACTERISTICS OF WAVES

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- discuss the physical quantities of a wave such as velocity, frequency, wavelength, period and amplitude.
- recognize the relation of these quantities.

Teaching Aids

String, slinky spring

Introduction

In this section, the five characteristics of wave are expressed and the wave equation is derived.

Teaching

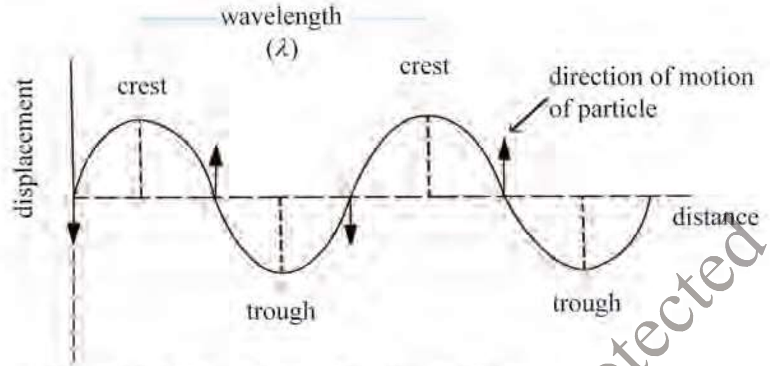


Figure 7.2 Wave in a vibrating string

A periodic wave is a wave with a repeating continuous pattern which determines its wavelength and frequency. It is characterized by the amplitude, the period and the frequency. Amplitude of a wave is directly related to the energy of a wave and it also refers to the highest and lowest point of a wave. Eight points 1,2,3,4,5,6,7 and 8 are marked at different points along the wave shown in Figure 7.2.

The highest (2 and 6) and the lowest points (4 and 8) (see Figure 7.2) are called wave crest (2 and 6) and wave trough (4 and 8) respectively. Wave crest and wave trough show the maximum displacement of vibrating particle from its rest position (or) equilibrium line. This maximum displacement is called amplitude of a wave.

The distance between any two consecutive wave crests (2 and 6) (or) two consecutive wave troughs (4 and 8) is called wavelength. In other words, the wave length of a wave is the distance between any two consecutive points which are in phase. Points 1 and 5, points 2 and 6, points 4 and 8 in Figure 7.2 are in phase.

The number of complete waves passing a point per second is called frequency of waves.

The time required for the wave to travel through a distance equal to its wavelength is called period of a wave.

Velocity of wave is the speed with which a wave crest travels.

The relationship between the frequency, wavelength and velocity of a periodic wave can be obtained by

$$v = \frac{\lambda}{T},\ T = \frac{1}{f},\ v = f\lambda$$

Practice

Students will work in a small group to form a transverse wave by vibrating one end of a string. Then they will draw a wave form by observing the vibrating string.

Review and Assessment

- Find the wavelength of a wave of velocity 10 ms^{-1} and frequency 200 Hz.

Answer

$v = 10\ ms^{-1}$, $f = 200$ Hz

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{10}{200}\ \text{m}$$

$$= 0.05\ \text{m}$$

Teacher can assess the students' understanding by asking the relationship between the wavelength and velocity of a wave.

7.4 GRAPHICAL REPRESENTATION OF WAVE

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- illustrate the displacement-time graph.
- construct the displacement-distance (position) graph.

Teaching Aids

Graph paper

Introduction

Teacher should introduce that waves may be graphed as a function of distance (or) time. A displacement against distance graph shows the displacement of points along the medium with respective position at a time instant.

A displacement against time graph shows the displacement of points with respective time at a certain position.

Teaching

Waves can be represented by graphs. The graphs representing transverse and longitudinal waves are similar. A displacement-distance graph describes the displacements of all particles at a particular instant of time. In Figure 7.3. shows displacement of particles.

A displacement-time graph describes the displacement of one particle over a time interval.

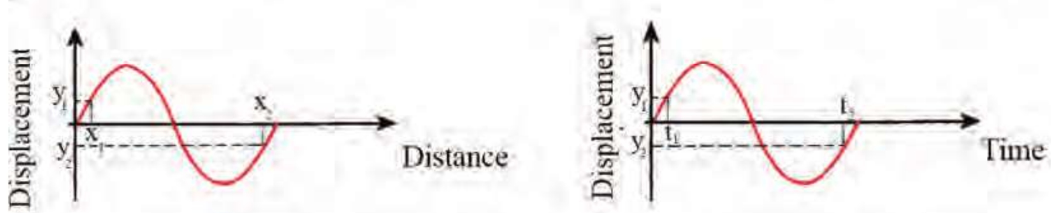


Figure 7.3 Displacement-distance and displacement-time graphs

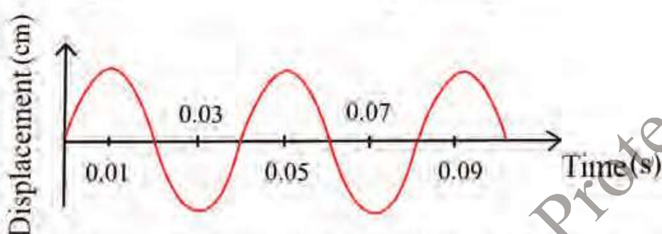
Points above the rest position are shown as positive displacements. Points below the rest position are shown as negative displacements. From the distance graph, the wavelength may be determined. From the time graph, the period and frequency can be obtained. From both together, the wave speed can be calculated.

Practice

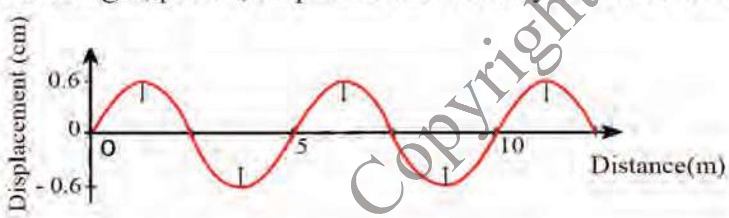
Students will illustrate the displacement-time graph and displacement-distance graph using suitable data. They can calculate the frequency, wavelength, period and amplitude of a wave. We may suggest the teacher to give the suitable data to the students.

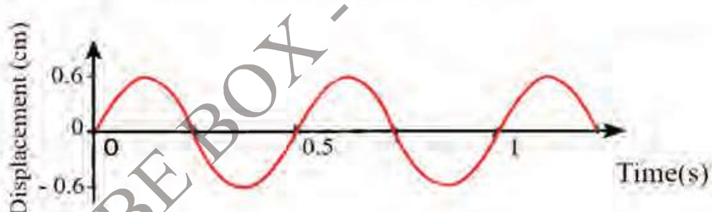
Review and Assessment

1. What is the frequency of the wave from the given figure?



2. Find the wavelength, period, amplitude and velocity of waves from the given figures.





Answers

1. From the graph figure, $T = 0.04$ s

$$f = \frac{1}{T} = \frac{1}{0.04} = 25 \text{ Hz}$$

2. Wavelength = 5 m, amplitude = 0.6 cm, period = 0.5 s, velocity = 10 m s^{-1}

Teacher can assess the students' understanding by discussing that graphical method is easy and make visual sense to study the wave motion.

7.5 REFLECTION, REFRACTION AND DIFFRACTION OF WAVE

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- illustrate and discuss reflection, refraction and diffraction of wave.

Teaching Aids

Water tank

Introduction

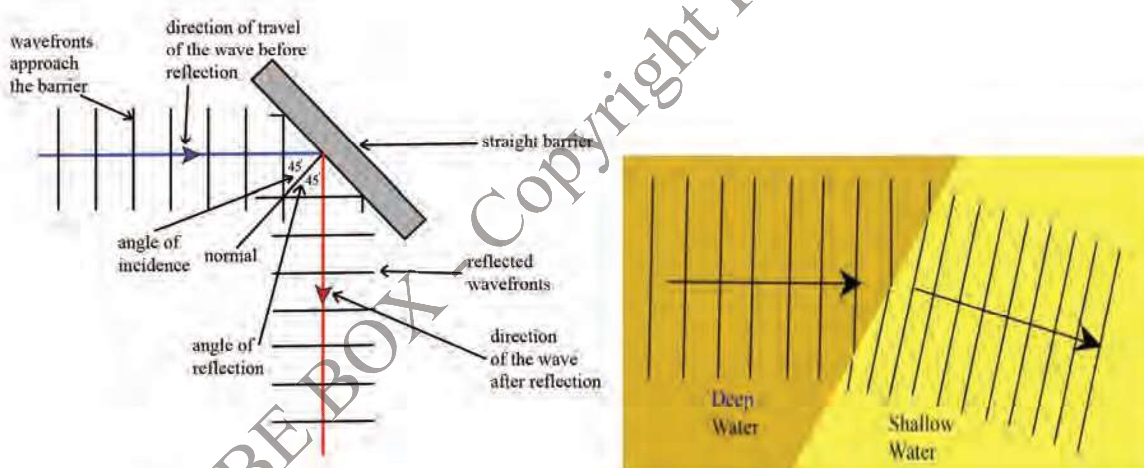
Teacher should introduce some behaviours of waves such as reflection, refraction and diffraction. Reflection involves a change in direction of waves when they bounce off a barrier. Refraction involves a change in direction of waves when they pass from one medium to another. Diffraction involves a change in direction of waves when they pass through an opening (or) around a barrier in their path.

Teaching

When a series of wave strike an obstacle, they are turned back. This turning back of waves is called reflection of waves.

When waves are incident to the boundary of different media with an angle, the direction of the waves changes. Such a change in direction is called refraction. If water waves are passing from deep water into shallow water, they will slow down. This is because of the refraction of water wave.

Diffraction is the spreading of waves from the straight-on direction through a gap (or) moves around an obstacle.



(a) Reflection of plane waves (b) Refraction of plane waves

Figure 7.4 Reflection and refraction of plane waves

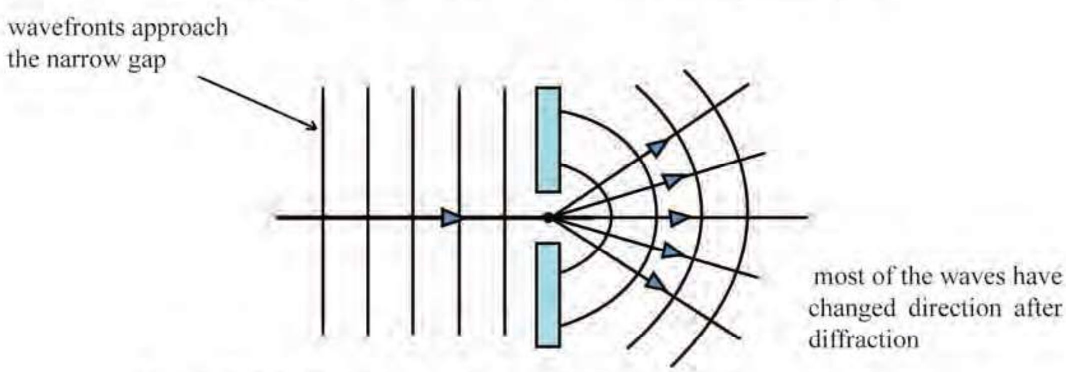


Figure 7.5 Diffraction of plane wave through narrow gap

The wavefront at any instant is defined as the locus of all the particle of the medium which are in the same state of vibration.

Two types of wavefront: spherical wavefront and plane wavefront. Plane waves represent parallel rays and circular waves represent divergent rays.

Practice

Students will perform to form ripples on the surface of water in a suitable water tank and produce reflected ripple by placing the flat metal barrier in their path. Teacher should lead to discuss their observation. For example, does the distance between water ripples change after reflection?

Review and Assessment

- Do the directions of the waves change in reflection?

Answer Yes.

7.6 SOUND WAVE AND SPEED OF SOUND

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- discuss the transmission of sound.
- study audible range of sound.
- investigate the dependence of speed of sound on temperature and density of medium.

Teaching Aids

Tuning fork, any source of sound

Introduction

Teacher should give the knowledge that any vibrating objects produce sound. Sound is a form of energy that is transferred from one place to another in a certain medium. Sound wave is produced by vibrating object placed in the medium. The air pressure changes occur alternately in the medium, when sound wave propagates.

Teaching

The compression is created in the medium as the vibrating object moves forward, since it pushes air molecules together. The compression region has higher pressure. When the object moves back, the molecules are spread out and rarefaction is created and the air pressure of that region is low. Sound energy is transferred through the medium by the successive pressure changes.

We cannot observe the displacement of air particles, but if we dip a vibrating tuning fork in water, we will see the movement of water.

The average person can only hear sound that has a frequency higher than 20 Hz and lower than 20,000 Hz. This interval of frequency is called the audible range (or) hearing range.
Sound waves travel at different speeds in different media through which it is passing.

Generally, the speed of sound depends on the density of the medium. The denser the medium is, the greater the speed.

Speed of sound in air varies with temperature. At 0°C the speed of sound in air is 332 m s^{-1}. Whenever the air temperature increases by 1°C, speed of sound will increase by 0.2 %.

The speed of sound in air can be expressed as

$$v = 332\sqrt{\frac{T}{273}}$$

The above relation can be approximated by the following relation

$v \simeq 332 + 0.6\,(T - 273)$, where T is absolute temperature (or) Kelvin temperature

Practice

Students will work in a small group to perform the experiment how sound is generated by a vibrating object. Students will work in a small group to show that sound wave needs a medium to propagate by using bell jar.

Review and Assessment

- What is the velocity of sound in air at 20 °C?

Answer

T = 20 °C = 20 + 273 = 293 K

$$v = 332\sqrt{\frac{T}{273}} = 332 \times \sqrt{\frac{293}{273}} = 343.9 \text{ m s}^{-1}$$

Teacher can assess the students' understanding by discussing how the pressure of the medium changes when the sound wave passes through it.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 3 Simple Pendulum

In experiment 3, the relation between period *(T)* and length (l) of a simple pendulum is investigated. The period of a pendulum is the time taken for the pendulum bob to make one complete oscillation.

Answers from textbook

1. D. 2. D. 3. B. 4. B. 5. C. 6. D. 7. C. 8. C. 9. B.

13. (a) False (b) False (c) False (d) True

14. $\lambda = 0.344$ m
15. $f = 400$ Hz
16. (a) $f = 1 \times 10^{10}$ Hz
    (b) f is the number of wave passing a point in 1 s.
    In 5 s, 5×10^{10} waves
17. 0.103×10^{8} Hz
18. $f = 100.6$ k Hz largest frequency
19. In sea water, $\lambda = 3.41$ m
    In CO_2 , $\lambda = 0.588$ m
20. 344 m s^{-1}
21. 7 % increased

CHAPTER 8
LIGHT

Total number of lesson Periods: 16 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- identify sources of light.
- examine the laws of reflection and the reflection of light at plane and curved surfaces.
- apply basic knowledge of optics to optical phenomena.
- draw ray diagrams for reflection of light on plane and curved surfaces.

Skill Development

After teaching Light instructed by this teacher's guide, the students will get skills in

- Collaboration - when working successfully in group
- Communication - when reporting progress on exercises and activities
- Critical Thinking and Problem Solving - when solving problem and doing activities
- Citizenship - when doing experimental work.

8.1 SOURCES OF LIGHT

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- distinguish between self-luminous bodies and non-luminous bodies.

Teaching Aids

Candle, fluorescent lamp, books, cloths

Introduction

In this lesson, the different sources of light are explained. Two sources of light are luminous bodies and non-luminous bodies.

Teaching

The teacher should show the candle flame, fluorescent lamp, books and cloths to students. The teacher should explain the following facts: the things give out their own light and light from them enters our eyes. They are self-luminous bodies. Non luminous bodies such as books, cloths are visible because the reflected light from a luminous source enters into our eyes.

Practice

Students will work in a small group to describe sources of light in the environment and to distinguish between self-luminous bodies and non-luminous bodies.

Review and Assessment

- Which of the following things are luminous bodies and which are non-luminous bodies?
  books, stars, sun, candle flame, fluorescent lamp, trees and moon

Teacher can assess the students' understanding by choosing the luminous and non-luminous bodies.

8.2 REFLECTION OF LIGHT

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- observe the reflection of light by a plane mirror.
- explain the laws of reflection of light.

Teaching Aids

Plane mirror (or) mirror strip, ruler, pencil, white paper, clips, protractor

Introduction

Reflection of light is one of the phenomena of light. If light beam strikes on the surface, some of light rebounds from the surface. This phenomenon is called reflection of light.

Teaching

The teacher should explain the rays of light and beams of light.
A beam of light received from a distant source can be considered as a parallel beam.

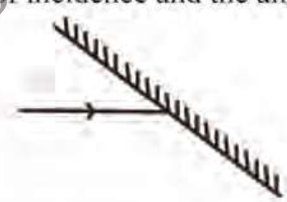
If the rays of light are directed towards a point (or) if the rays of light converge to a point, the beam of light is called a convergent beam. If the rays of light diverge from a point (or) if they appear to come from a point, the beam of light is called a divergent beam.

Practice

Students will work in a small group to give examples of parallel beam and divergent beam. Students can notice that the rays (or) beam from searchlight used in train is parallel beam. And also they can notice that the rays of beam from any luminous (or) non-luminous are divergent beam.

Review and Assessment

- Place the plane mirror in the following figure and track the reflected ray for given incident ray. Add normal and measure incident angle and reflected angle using protractor. Are the angle of incidence and the angle of reflection the same?



After completing this exercise, the students will be able to explain the laws of reflection. Teacher can assess the student's explanation.

8.3 IMAGE FORMATION IN A PLANE MIRROR

Number of lesson periods: 5

Learning Objectives

After completing this section, the students will be able to

- observe the reflection of light by a plane mirror.
- recognize the lateral inversion and reversibility of light.
- realize the applications of plane mirror.

Teaching Aids

Plane mirror, the card with any number

Introduction

The reflection of light by a plane mirror and types of images are described in this lesson. At the end of this lesson, the student will be able to explain the reflection of light by a plane mirror, lateral inversion and reversibility of light.

Teaching

The teacher explains the formation of image in a plane mirror by drawing ray diagram. For the formation of image of a point object in a plane mirror, the ray diagram can be drawn as shown in Figure 8.1.

In Figure 8.1, a point object O is placed in front of the plane mirror M. A ray OB from O is incident on the plane mirror at B and reflected along BC. BN is the normal. A ray OA from O is incident normally on the plane mirror and reflected along AO. When AO and BC are produced backward, they meet at a point I behind the mirror. I is the image of O. We are assuming here that all the rays lie in the plane which is perpendicular to the surface of the plane mirror.

From the figure, it can be proved that the object distance is equal to the image distance.

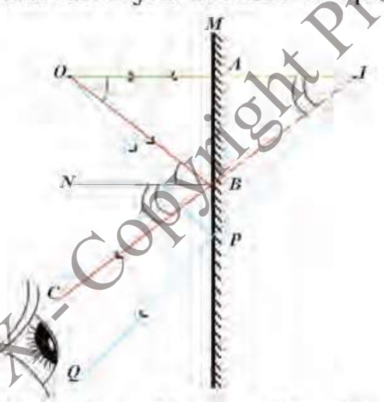


Figure 8.1 Formation of image of a point object

In Figure 8.1 OA is parallel to NB, so that

$\angle OBN = \angle AOB$ (alternate angles)

$\angle CBN = \angle AIB$ (corresponding angles)

By the laws of reflection $\angle OBN = \angle CBN$

Therefore $\angle AOB = \angle AIB$

In the triangles OAB and IAB,

$\angle AOB = \angle AIB$

$\angle OAB = \angle IAB$ (right angles)

$AB = AB$ (common side)

Therefore $\Delta OAB \cong \Delta AIB$

And $AO = AI$

AO is the perpendicular distance of the object from the plane mirror and AI is that of the image from the plane mirror. The object and image are at equal perpendicular distances from the mirror. In other words, the image is as far behind the mirror as the object is in front. The image in a plane mirror is virtual image. Virtual image cannot be focused on a screen. The reflected rays do not intersect at the virtual image position. However, the real image can be focused on a screen. The reflected rays actually intersect at the real image position.

The formation of image of an extended object in a plane mirror can be explained by using ray diagram (See textbook).

More Information for Teachers

One of the application of plane mirror is the periscope. The periscope consists of two plane mirrors facing one another as shown in following Figure 8.2 (a). They are parallel and fixed at an angle of 45° to the line joining them.

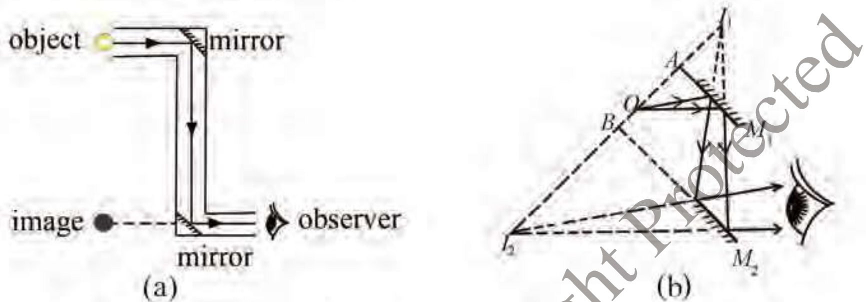


Figure 8.2 Formation of successive images in the periscope

The image I_1 formed in the mirror M_1. I_1 becomes an object for the mirror M_2. I_2 is the final image of the object seen in M_2. When constructing a ray diagram it should be noticed that $OA = I_1A$ and $BI_1 = BI_2$. In addition, the line I_1I_2 is perpendicular to the mirrors. The periscopes are used in submarines and telescope.

Practice

Students will work in a small group to demonstrate the lateral inversion and discuss the properties of the image in a plane mirror.

A student stands in front of a plane mirror. Tilts his head to the right and to the left. They notice the lateral inversion in a plane mirror.

And then, the student walks closer to the mirror and walks away from the mirror. They notice image distance changed.

Tell the students to discuss that observation.

A range of activities can be used to evaluate the student's progress and discuss the properties of the image in a plane mirror.

Review and Assessment

- An object is in front of a plane mirror. If the object and the mirror each recede x from their original positions, by how much is the distance between the object and the image changed?

Answer

- $4x$

Teacher can assess the students' understanding by calculating the distance between the object and the image.

8.4 REFLECTION AT CURVED MIRROR

Number of lesson periods: 7

Learning Objectives

After completing this section, the students will be able to

- observe the reflection of light by curved mirrors.
- investigate the formation of images.
- realize the applications of curved mirrors.

Teaching Aids

Concave mirror, convex mirror, chart, optical bench, shining steel spoon

Introduction

Two types of curved mirror are described in this section and reflection at curved mirrors are studied. In this section, the formation of images in a curved mirror can be studied by using ray diagrams. And then the formation of image can be calculated by using mirror formula.

Teaching

Figure 8.3 and Figure 8.4 show the reflection of light at a curved mirror.
The teacher should derive the relation between focal length and radius of curvature.

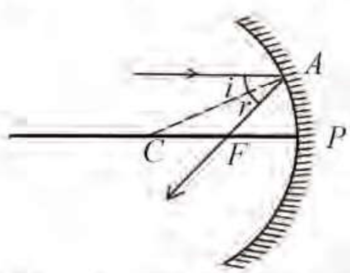


Fig. 8.3 Focal length and radius of curvature of a concave mirror

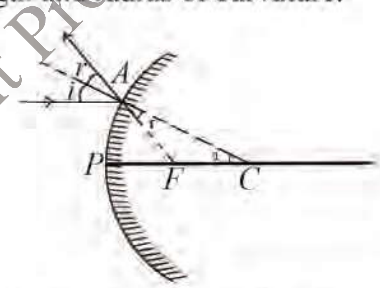


Fig. 8.4 Focal length and radius of curvature of a convex mirror

In Figure 8.3 the ray parallel to the principal axis is incident at the point A on the concave mirror and reflected through the focus F. In Figure 8.4, the ray parallel to the principal axis is incident on the convex mirror at the point A and reflected ray produced backward passes through F. The line passing through A and C is the normal. The relation between focal length and radius of curvature is calculated as follows:

By the laws of reflection, $i = r$

Since, the incident ray is parallel to the principal axis, $i = \angle ACP$

$r = \angle ACP$

Therefore, in the triangle ACF, $AF = FC$

For the rays close to the principal axis $AF = PF$

Therefore, $PF = FC$ (or) $PF = \dfrac{PC}{2}$

Since $PF = f$ and $PC = R$,

$$f = \frac{R}{2}$$

The focal length f of the curved mirror is one half its radius of curvature R.

More Information for Teachers

To study the formation of images in curved mirror we defined the principal rays of these mirrors. Principal rays are used for visualizing the image location and size. The principal rays and their properties are stated below.

1. When a ray parallel to the principal axis is incident on the concave mirror, the reflected ray passes through the focus; and when this ray is incident on the convex mirror, the reflected ray produced backward passes through the focus.
2. When a ray directed towards the principal focus is incident on the concave (or) convex mirror, the reflected ray travels parallel to the principal axis.
3. When a ray directed towards the center of curvature is incident on the concave (or) convex mirror, it is reflected along its original path.
4. When a ray directed towards the pole is incident on the pole of concave (or) convex mirror, the reflected ray is on the other side of the principal axis making the same angle with the principal axis as the incident ray.

For drawing ray diagrams, only two principal rays are necessary to show the image position and size.
By using ray diagram, the derivation of the mirror formula can be derived.

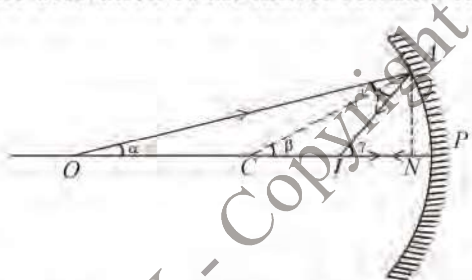


Figure 8.5 Relation between u, v and f in a concave mirror

In above figure, a point object O is situated on the principal axis of a concave mirror. The incident ray OA is reflected by the concave mirror along AI. The incident ray OP is reflected back along its original path. The point of intersection of these reflected rays I is the real image of O. CA is the normal and by the laws of reflection,

$$\angle OAC = \angle IAC = i$$

OA, CA and IA make the angles α, β and γ respectively with the principal axis.
Since the rays close to the principal axis are considered paraxial rays, these angles are very small. AN is the normal to OP. In practice, N is almost coincident with P.

As β is the exterior angle of triangle OAC,

$$\beta = \alpha + i \quad \text{(or)} \quad i = \beta - \alpha \qquad \text{------------- (1)}$$

Since γ is the exterior angle of triangle CIA,

$$\gamma = \beta + i \quad \text{(or)} \quad i = \gamma - \beta \qquad \text{------------- (2)}$$

From equations (1) and (2)

$$\gamma - \beta = \beta - \alpha$$

$$\alpha + \gamma = 2\beta \qquad \text{------------ (3)}$$

In figure, for paraxial rays,
$$\tan\alpha = \frac{AN}{ON} = \frac{AN}{OP}$$
$$\tan\beta = \frac{AN}{CN} = \frac{AN}{CP}$$
$$\tan\gamma = \frac{AN}{IN} = \frac{AN}{IP}$$

For very small angles,
$$\tan\alpha = \sin\alpha = \alpha$$
$$\tan\beta = \sin\beta = \beta$$
$$\tan\gamma = \sin\gamma = \gamma$$

Therefore,
$$\alpha = \frac{AN}{ON}$$
$$\beta = \frac{AN}{CN}$$
$$\gamma = \frac{AN}{IN}$$

The teacher should keep in mind that α, β and γ are measured in radians.
Substitution these values of α, β and γ in equation (3),

$$\frac{AN}{OP} + \frac{AN}{IP} = 2\frac{AN}{CP}$$

Dividing by AN, we get $\frac{1}{OP} + \frac{1}{IP} = \frac{2}{CP}$

Since $OP = u$, $IP = v$ and $CP = R = 2f$, the above equation becomes $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

When sign conventions are used $\frac{1}{+u} + \frac{1}{+v} = \frac{1}{+f}$ (or) $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ ------------(4)

Equation (4) has been derived for the concave mirror when the point object is beyond C on the principal axis. This equation can be derived also for the point object (or) an extended object situated somewhere on the principal axis in front of the concave mirror. The corresponding sign conventions for u, v and f must again be used.

The teacher should explain the magnification m can also be expressed in terms of the object distance u, and the image distance v as follows:

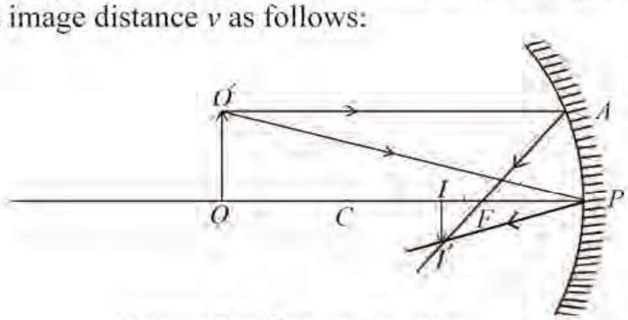


Figure 8.6 Illustration of magnification

In Figure 8.6, $\Delta\ OO'P$ and $\Delta\ II'P$ are similar

Therefore, $$\frac{II'}{OO'} = \frac{IP}{OP}$$

Since $OP = u$ and $IP = v$, we get

$$\frac{II'}{OO'} = \frac{v}{u}$$

When the sign conventions are used,

$$\frac{-II'}{OO'} = \frac{v}{u}$$

Here a minus sign is used for II' since it is below the principal axis. Thus, the formula for the magnification m can be expressed as

$$m = \frac{II'}{OO'} = -\frac{v}{u}$$

$$\text{Magnification} = \frac{\text{size of image}}{\text{size of object}} = -\frac{\text{image distance}}{\text{object distance}}$$

Practice

Students will work in a small group to find the approximate focal length of a concave mirror and analyze the virtual image formation in curved mirror.

The focal length of a concave mirror can be estimated by obtaining a real image of a distant object at its focus.

Give concave mirror, convex mirror, chart and optical bench to each group.

Hold the mirror towards distant object, a tree (or) a building and adjust a white paper in front of it to get a sharp image on the screen.

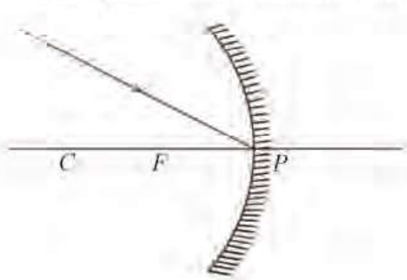
Measure the distance between the mirror and the screen.

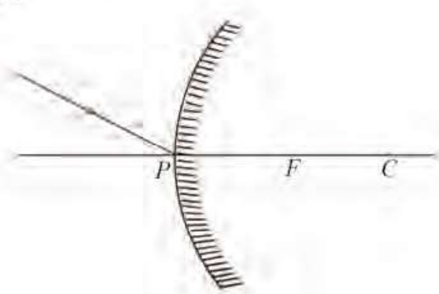
That distance is the approximate focal length of mirror.

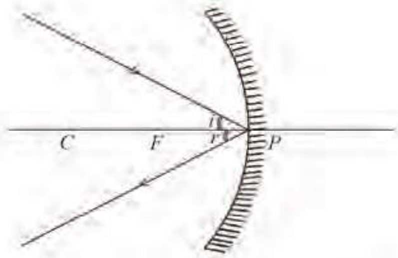
Give steel spoons to each group. The student will use a shining steel spoon as a curved mirror. By looking their faces formed in a steel spoon, they notice that a virtual image is formed in a curved mirror.

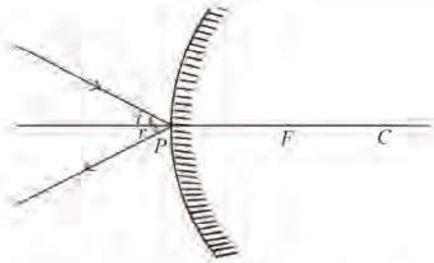
Review and Assessment

- In the diagrams, the mirror on the left is concave and that on the right is a convex spherical mirror. In each diagram, the given ray of light is incident on the mirror. Complete the ray diagram after reflection and also explain.









Teacher can assess the students' understanding by drawing the ray diagram after reflection.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 6 **Reflection by a plane mirror (Line Method & Pin Method)**

In experiment 6, the image formed by a plane mirror is virtual, upright, the same size as the object and the same distance behind the mirror as the object is in front; i.e image distance equals object distance. By the law of reflection, the angle of incidence is equal to the angle of reflection. We use the line method and pin method to prove that image distance equals object distance. Angle of incidence and angle of reflection are also measured.

Experimental work **Number of practical periods: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

Experiment 7 **The Concave Mirror**

In experiment 7, the focal length of a concave mirror is determined by using the conjugate foci method. Refer to Grade 10 practical physics.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

10. C
11. B
12. B
14. 9 cm, $\frac{2}{3}$
15. 30 cm
16. 30 cm, – 6 cm
17. – 40 cm
18. 15 cm, $-\frac{1}{2}$

CHAPTER 9

ELECTRICITY

Total number of lesson periods: 8 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- investigate electric charges.
- distinguish the repulsive and attractive force between two charges.
- discuss that a charged body has electron deficiency (or) excess.
- identify the characteristics of conductors, insulators and semiconductors.
- explain the process of charging by induction.
- demonstrate an understanding of electrification and nature of electrostatic force.
- apply basic knowledge of electrostatics to daily-life uses.

Skill Development

After teaching Electricity instructed by this teacher's guide, the students will get skills in

- Collaboration - when working successfully in groups
- Communication - when reporting progress on exercises and activities
- Critical Thinking - when finding solutions to problems.

9.1 ELECTRIC CHARGES AND ELECTRIC FORCES

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- express positive and negative charges.
- show that unlike charges attract and like charges repel.

Teaching Aids

Charts of positive charge and negative charge

Introduction

In this lesson, students will learn about electric charges. Electric charges may be either at rest (static charges) or in motion (moving charges). In this chapter, charges at rest is studied. The two kinds of static electric charge are positive charge and negative charge.

Teaching

The teacher should explain the following facts: Like charges repel and unlike charges attract. Two charged objects produce either attractive or repulsive force. The electric force between two charged objects is one of the fundamental forces of nature. Charged objects can exert forces to other charged objects without being in contact with them. The amount of electric charge is one of the quantized physical quantities. Electric charges take only discrete values that are integral multiples of charge of an electron (elementary charge). Charge is measured in coulomb (C). The charge of an electron 'e' is 1.6×10^{-19} C.

Practice

Teacher should discuss with them why the force between two charges is fundamental force.

Students will work in a small group to discuss the force between two like charges and unlike charges.

Review and Assessment

1. How many electrons are there in 1.6×10^{-10} C?
2. If the electric force between two charged objects is repulsive force, what type of charges they carry?

Answers

1. 10^{9} electrons
2. The electric force between two charged objects is repulsive force, they must carry like charges.

The teacher can assess the students' understanding by observing their calculation.

9.2 MATTER AND ELECTRICITY

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- recognize the matter and electric charge.

Teaching Aids

Cardboard, colour balls

Introduction

Teacher should introduce student how to relate the matter and electricity by asking the following questions. What is a matter? Matter has weight and takes up space. Matter is composed of atoms. What is an atom? Atoms are made up of particles, some of which are electrically charged.

Teaching

A nucleus (center) of the atom consists of two kinds of particles called proton and neutron. Electrons are orbiting nucleus. The nucleus has net positive charge because a proton is a positively charged particle and a neutron is an uncharged particle.

In an atom, number of protons is same as the number of electrons. The amount of charge of a proton is equal to that of an electron. A normal uncharged piece of matter has equal number of positive and negative electric charges. It is electrically neutral.

Practice

Students will work in a small group to draw a structure of an atom and label the parts. And also to construct an atom on the cardboard using different colour balls. The students will discuss the electrical charge of particles (electron, proton and neutron).

Review and Assessment

1. If a normal atom has four protons, how many electrons are there? Comment your answer.

2. Although a normal atom consists of positive charge (proton) and negative charge (electron), why is it electrically neutral?

Answers

1. There are four electrons. Because a normal atom has an equal number of electrons and protons.
2. A normal atom has equal number of positive and negative electric charges. So, it is electrically neutral.

According to their answers, teacher should evaluate the students' understanding on matter and electricity.

9.3 CONDUCTORS, INSULATORS AND SEMICONDUCTORS

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- discuss the charged body and uncharged body.
- distinguish between electrical conductors, insulators and semiconductors.

Teaching Aids

Dry cell, wire, bulb, copper, aluminium, iron, rubber, plastic, wood, paper

Introduction

Teacher should introduce to classify the conductor and the insulator. When electric bulb connected to a cell it will glow because charges (electrons) flow the metal wire in the bulb. Metal wire is said to be a conductor. When a cell connected to dry wooden rod, teacher can point that flow of charges cannot take place. Dry wooden rod is said to be insulator.

Teaching

Teacher should introduce free electron and bound electron by illustrating diagram. Some of electrons are near the nucleus while other electrons are further away from the nucleus. The electrons closer to the nucleus, tightly bound by the nucleus are called bound electrons. The electrons far away from the nucleus loosely bound by the nucleus are called free electrons.

The substance which has plenty of free electrons is called conductor and the substance which has very few or no free electrons is called an insulator. Some substances which contain a moderate amount of free electrons are called semiconductors. Material which allows electrons to flow through them are called conductors. Metals are the best conductor of all. Materials which do not allow to flow the charge are called insulator.

Practice

Students will work in a small group to choose the conductors and insulators from given objects.

Dry cell is connected to the electric bulb using wire. Plastic rope is used instead of wire. Write down the observation on each case.

Teacher should assess students' understanding by asking them question. For example, in a wire which part is conductor and which part is insulator.

Review and Assessment

- Which objects are conductors and which are insulators in your classroom?

Answer

- Conductors: steel spoons, steel pot, irons, copper wires
  Insulators: plastic rulers, plastic, wooden furniture, dry cloths, rubber, glass, wood, wool, paper, cork

According to their answers, teacher should evaluate the students' understanding on conductors,insulators and semiconductors.

9.4 ELECTRIFICATION

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- explain charging by rubbing (or) friction.
- explain charging by induction.

Teaching Aids

Plastic rod, comb, rubber balloon, fur and piece of paper

Introduction

Teacher should introduce how the uncharged body becomes charged body. Normal atom is electrically neutral. In normal condition neither conductor nor insulator carries electric charge. When a body contains an excess of electrons, it has a negative charge and is called negatively charged body. If it is a deficiency of electrons, it is called negatively charged body. When a body loses (or) gains electrons, we can say it is electrified.

Teaching

Teacher should give information of electrification by friction and induction. Insulators are relatively easy to charge by rubbing because any electrons which are transferred tend to stay where they are. Conductors can be charged by rubbing but only if held in insulating handles. If you rub a hand-held metal rod, any electrons transferred are immediately replaced by electrons which flow through the rod and your body, and the rod remains uncharged.

The two metal spheres (conductors) are supported by insulating stands so that any charge cannot transfer to the ground. The spheres are touched side by side so as to form two-sphere system.

The negatively charged rod is brought near to the two-spheres A and B. A negatively charged rubber rod is brought near (not touching) the sphere A. Since like charges repel the free electrons in both spheres move away from the rod and they collect at the right surface of sphere B. Now sphere A has excess positive charges, while sphere B has excess negative charges. These excess charges on the surfaces of A and B are called induced charges.

Charging by the process of rubbing by electrification is more suitable for insulator and the process of induction is suitable for conductor.

More Information for Teachers

Working of a photocopier is based on the principle of electricity. The photocopying stage by stage process is explained. The photocopier expression is aimed to be understood by teachers only.

(a) The cylindrical drum is coated with selenium. Selenium is a photoconductor that becomes conductive when exposed to light, so negative image (but some model is positive) is made on drum.

(b) When light expose on the original paper, white areas on the paper reflect light and black areas does not reflect the light. The areas that match to black portions of the paper remains negatively charged.

(c) Positively charged toner across the drum is attracted and sticks to the black areas which are negatively charged on the surface of drum.

(d) Finally a piece of paper pulls the toner image on the surface of the drum.

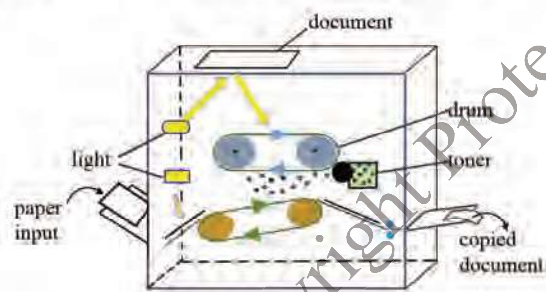


Figure 9.1 Static electricity used in a photocopier

Note that electrostatic charging is the electrons transferred, not the protons. Electric charges are not created (or) destroyed during electrostatic charging.

Some photocopiers which photoconductive drum are used negatively charged and some are positively charged. If drum is positively charged, toner will be negatively charged.

Practice

Students will work in a small group to perform the electrification by friction. Take a small piece of paper and a plastic ruler. Rub the ruler with their hair. After rubbing plastic ruler attract small piece of paper because plastic ruler becomes electrified.

For another practice, a rubber balloon becomes charged by rubbing it against your hair. They will found that when charged balloon releases, it will cling at a wall.

Teacher should discuss on the above cases and ask them questions. For example, why does ruler attract the small piece of paper? Why does the balloon cling at the wall? They can recognize that there are two kinds charge and there is a force between: (i) ruler and piece of paper, (ii) balloon and wall.

Review and Assessment

- The negatively charged rod is placed near a metal sphere which is on the insulated stand.

(i) Copy the diagram and draw the induced charge on the sphere.

(ii) If you touch the sphere at the opposite side of rod, which charge will flow through the body to the ground?

(iii) Draw the diagram of charge distribution on sphere when the rod is placed far away from the sphere.

Answers

(i)

The induced charge on the sphere.

(ii)

Negative charge will flow through the body to the ground.

(iii)

When the rod is removed , positive charges are uniformly distributed on the surface of sphere.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answers from textbook

3. (i) C.
   (ii) C.
   (iii) A.
   (iv) A.
   (v) A.
   (vi) A.
   (vii) C.

4. (i) D,
   (ii) A,
   (iii) B,
   (iv) C
5. (a) 1.25×10^{10}
   (b) 6.25×10^{12}
6. 60 C

CHAPTER 10
MAGNETISM

Total number of lesson Periods: 8 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- analyze that the attraction between a specimen and a magnet is not sufficient enough to confirm that the specimen is a magnet.
- determine that all magnetised and unmagnetised materials consist of very tiny magnets.
- define a magnetic field in which magnetic effect can be detected and illustrate the pattern of magnetic field.
- differentiate the magnetic properties of iron and steel.
- demonstrate basic knowledge of magnets and their applications.

Skill Development

After teaching Magnetism instructed by this teacher's guide, the students will get skills in

- Collaboration - when gathering and sharing information about the magnetisation by stroking methods and using direct current
- Critical Thinking and Problem Solving - when determine that a specimen is a magnet by repulsion
- Creativity and Innovation - when draw magnetic field pattern formed by pairs of poles of the magnets.

10.1 MAGNETS AND MAGNETIC MATERIALS

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- distinguish between magnetic and non-magnetic materials.
- develop an explanation of the properties of magnets.

Teaching Aids

Erasers, pieces of paper, pins, iron paper clips, bar magnet, cotton thread

Introduction

Students have learnt about on some properties of magnets, magnetic materials and non-magnetic materials from previous grade level. In this section, students will learn these properties in detail.

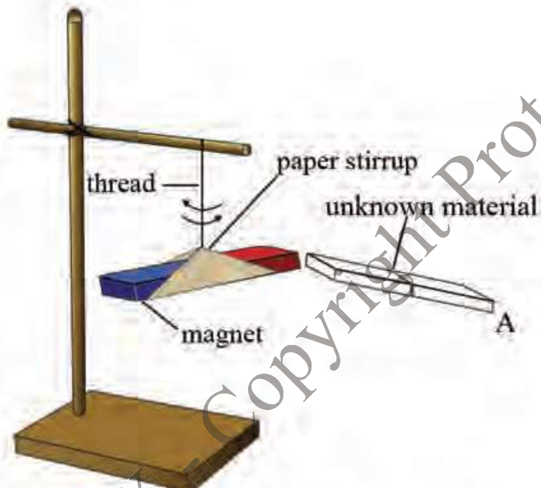
Teaching

The teacher should explain magnets, magnetic materials, non-magnetic materials and properties of magnets. Magnetic materials are materials that can be attracted by a magnet. Non-magnetic materials are materials that cannot be attracted a magnet. Steel, iron, cobalt and nickel are magnetic materials. Copper, wood, plastic, and brass are non-magnetic materials.

Students are asked to identify magnets, magnetic materials and non-magnetic materials.

To test whether an object is a magnet, we can bring one end of this object towards one end of a suspended bar magnet. If repulsion occurs then we can conclude that the object is a magnet because repulsion occurs between like poles. If the object remains stationary, it is a non-magnetic material.

If attraction occurs, then we can conclude that the end of the object is either of opposite polarity to the end of the suspended bar magnet (or) that the object is simply a magnetic material. To distinguish whether the object is a magnet (or) a magnetic material, it would be necessary to repeat the test by bringing the other end of the object to the end of the suspended magnet to see whether repulsion occurs.



Identifying magnets, magnetic materials and non-magnetic materials

Effect on A	Conclusion; A is
attracted	magnetic materials (or) magnet
repelled	magnet
remain stationary	a non-magnetic material

Practice

Students will work in a small group to classify magnetic and non-magnetic materials (erasers, pieces of paper, pins, iron paper clips and pins) by using a magnet. Student will perform to identify the north-seeking pole (north pole) and south-seeking pole (south pole) of a bar magnet.

Precaution

- Repulsion between a specimen and a magnet is the only way to determine that specimen is a magnet.

Review and Assessment

1. Give examples of magnetic materials and non-magnetic materials.
2. How can you identify magnets, magnetic materials and non-magnetic materials?

Answers

1. Magnetic materials are steel, iron, alcomax and alnicol. Non-magnetic materials are wood, plastics, brass and copper.
2. Identifying magnets, magnetic materials and non-magnetic materials due to experiment in teaching.

It can be seen that the above assessment can focus on contents of magnets, magnetic materials and non magnetic materials.

10.2 THEORY OF MAGNETISM

Number of lesson periods: 1

Learning Objectives

After completing this section, the students will be able to

- recognize that all magnetised and unmagnetised materials consist of very tiny magnets.

Teaching Aids

Chart of magnetised and unmagnetised bar constituted with tiny magnets, pins, magnet

Introduction

Students have learnt that every piece of magnets have always two poles: south pole and north pole. The tiny magnets at the end of the bar magnet spread out due to the mutual repulsion between like poles. So the poles of the magnet are present at each end of a magnet.

Teaching

The magnetic materials are composed of tiny magnets but any unmagnetised bar as the magnetic forces of its tiny magnets neutralized by adjacent tiny magnet. Teacher starts the lesson with an illustration of magnetised and unmagnetised bar constituted with tiny magnets.

Practice

Students will work in a small group to show what happens when they sprinkle some steel pins onto a magnet. If most of the pins are seem to be attracted to the two ends of the magnet, discuss that the magnetic force at end of magnetic bar is stronger than that of central portion.

Review and Assessment

1. What happen when some steel pins are sprinkle onto a bar magnet?
2. Explain why most of the pins are attracted to the two ends of the bar magnet which are poles.

The teacher could give guide to help the students summarize their learning about the positions and properties of magnetic poles.

Answers

1. Most of the pins are attracted to the two ends of the bar magnet.

2. Most of the pins are attracted to the two ends of the bar magnet which are poles because at poles the magnetic effects are strongest and attractive force on magnetic materials is strongest.

10.3 MAGNETIC FIELDS

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- define a magnetic field in which magnetic effect can be detected and illustrate the pattern of magnetic field.

Teaching Aids

A bar magnet, iron filings, drawing paper

Introduction

Students have learnt about magnetic lines of force near the magnets by using plotting compass from previous grade level.

Teaching

Teacher starts the lesson with the definition of magnetic field and explains the pattern of the Earth's magnetic field.

Practice

Students will be asked to work in small groups forming a practical with teaching aids.
To show the pattern of a magnetic field around a bar magnet, the students can sprinkle iron filings lightly on a paper, with a bar magnet underneath, and tapping the paper gently. Then the iron filings falling into a certain pattern which is the magnetic field pattern obviously.

Precaution

- The Earth's magnetic field at any particular location can be considered as uniform.

Review and Assessment

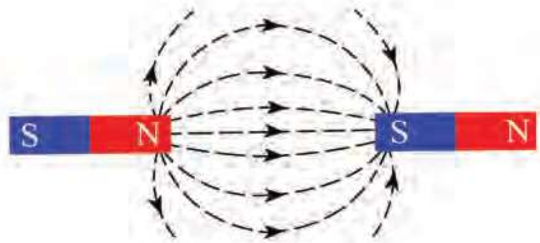
1. What experiment would you conduct to show the magnetic lines around a magnet? What is meant by magnetic lines of force ?

2. Sketch on Figure (a) and Figure (b), the magnetic field patterns formed between each pair of poles of the magnets. What is meant by the neutral point in a magnetic field? Show the position of the neutral point on the appropriate diagram.

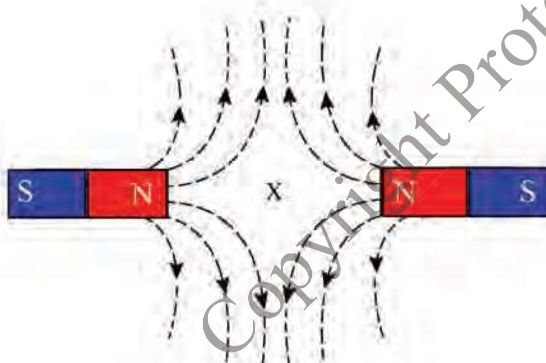
Answers

1. Magnetic lines of force are the imaginary pattern which can be plotted (by means of magnetic compass, iron filings etc) near by the magnetic objects. The direction of the lines indicates the direction of magnetic field.
   Refer to Section 10.3 and Figure 10.6.

2. (a)



(b)



X = neutral point

Neutral point is a point at which the fields from magnets cancel out each other as indicated by the absence of magnetic field.

10.4 MAGNETISATION AND INDUCED MAGNETISM Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- create an unmagnetised metal to a magnetised metal by different methods.

Teaching Aids

Steel bar, two permanent magnets, batteries, switch, rheostat and solenoid

Introduction

Students have learnt about a description of magnetisation from previous grade level.

Teaching

Teacher starts the lesson with the definition of magnetisation. Then, two types of magnetisation by stroking, and by using direct current are explained. Moreover, induced magnetism is also discussed.

Practice

Students will magnetise a steel bar by using one permanent magnet (single touch) (or) two permanent magnets (double touch).

Students will magnetise a steel bar by placing it inside a solenoid through which a direct current is passed. Students will learnt about the magnetic induction in soft iron bar by a permanent magnet.

Precaution

- In double touch, the two ends of the permanent magnets which touch the steel bar should have opposite polarities.

Review and Assessment

1. How many kinds of magnetisation methods and explain step by step the process of magnetisation?
2. Explain why the end of the steel bar where the strokes finish always has the opposite polarity to that of the end of stroking magnet in contact with it.

Answers

1. There are two kinds of magnetisation. They are magnetisation by stroking and magnetisation by direct current. The process of magnetisation has been explained in section 10.4 in textbook.
2. The end of the steel bar where the strokes finish always has the opposite polarity to that of the end of stroking magnet in contact with it because of the attraction between the unlike poles.

10.5 MAGNETIC PROPERTIES OF IRON AND STEEL **Number of lesson periods: 1**

Learning Objectives

After completing this section, the students will be able to

- differentiate the magnetic properties of iron and steel.
- recommend the magnetic materials for their own applications.

Teaching Aids

Permanent bar magnets, iron paper clips, steel paper clips

Introduction

Students have learnt about magnetising steel bar and soft iron bar by induction from previous lessons.

Teaching

Teacher starts the lesson with the magnetic properties of magnetised steel bar and soft iron bar by placing permanent magnet on tops of the bars.

Practice

Students will work in a small group to show that iron is more easily magnetised than steel. Two chains of small iron paper clips and steel paper clips are added one by one forming until no more iron clips (or) steel clips stay attached by induce magnetisation.

Now teacher asks the following questions: (Students can conclude the following questions by observing their experiment.)

(i) Which chain is longer?
(ii) When the topmost ones were removed which chain remains unchanged?

Review and Assessment

1. In which device is a permanent magnet used?
   A. An electric bell
   B. An electromagnet
   C. A plotting compass
   D. A relay
2. In which device is a temporary magnet used?
   A. Magnetic door catch
   B. Transformer
   C. Moving coil galvanometer
   D. Loudspeaker

Answers

1. C.
2. B.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Experimental Work **Number of practical period: 4**

Suggestion for Practical

- Refer to Grade 10 Practical Physics Book.

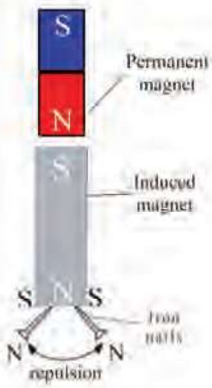
Experiment 8 Magnetic Field

In experiment 8, magnetic field lines of a bar magnet can be plotted with a compass . Teacher should direct how to draw the magnetic field lines between two like poles and also unlike poles of two magnets.

Answers from textbook

1. D.
2. C.
3. C.
4. A.
5. C.
6. B.
7. C.

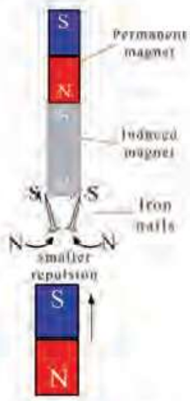
8. (a)



The two iron nails became induced magnets and showed repulsion between the far ends (Both are north poles).

When N-pole of bar magnet is brought towards the two far ends a greater repulsion occurred because of repulsion between N-pole of bar magnet and N-pole of far end.

(b)

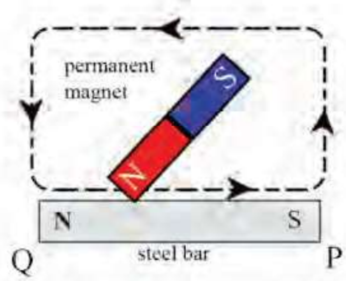


A smaller repulsion is observed because of the attraction between the S-pole of the bar magnet and N-poles of the far ends of the two iron nails.

9. The comparison of magnetic properties between iron and steel

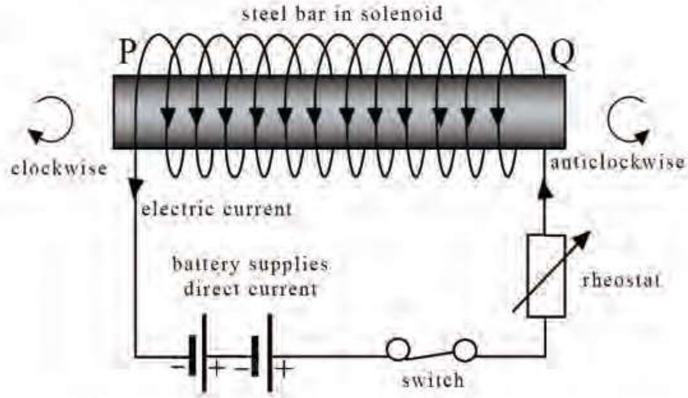
The magnetic properties of iron :	The magnetic properties of steel :
easily magnetised and de magnetized	hard to magnetise and demagnetise than iron
can be magnetised by a weak magnetic field	requires a strong magnetic field to magnetise
retains its magnetism temporarily	retains its magnetism permanently

10. (a)



The steel rod PQ is stroked by a bar magnet N pole and lifted a magnet at P to become south pole.

(b) The right end becomes North poles and marks it as N so that P is south pole.

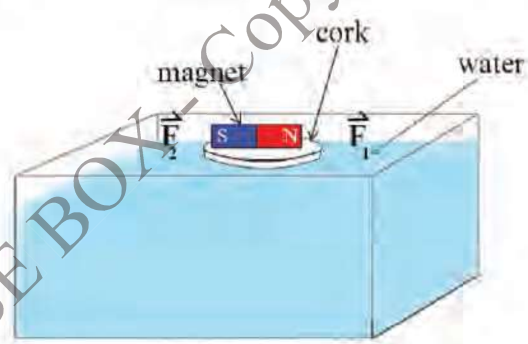


(c) Bring S pole of a bar magnet near P, if repulsion occurred it was south pole.

(d) If an alternating current is allowed to flow through solenoid, PQ is demagnetised.

11. (a) When a bar magnet is brought near a piece of iron, it becomes a magnet itself and attracted by the bar magnet.

(b) The magnetic force exerted by the earth's magnetic field on two poles of the bar magnet are equal and opposite. Therefore, these two forces cancel out and net force is zero. Hence, the cork and the bar magnet do not move towards the north.



(c) Induced magnetic north poles of two needles repelled each other.

CHAPTER 11
QUANTUM AND ATOMIC PHYSICS

Total number of lesson Periods: 12 (1 period 45 minutes)

Learning Outcomes

It is expected that the students will

- explain thermionic emission.
- describe the structure of a vacuum diode to visualize the flow of electrons from the filament to the plate.
- discuss blackbody radiation and quantum concept for microscopic particles.
- identify and explain some physical phenomena which could not be explained by classical Physics.
- describe the size of an atom and simplified models of atom.
- recognize the origin and evolution of the visible universe such as distance scales and sizes of astrophysical objects used in astrophysics.
- develop the competence in reasoning, comprehension and analysis of modern concepts of physics.

Skill Development

After teaching Quantum and Atomic Physics instructed by this teacher's guide, the students will get skills in

- Communication - when gathering and sharing data to define a blackbody with a cavity with a small hole as an example
- Critical Thinking and Problem Solving - when analysing the relation between the total amount of energy and temperture
- Collaboration - when discussing the visible universe, supporting the ideas and learning of others.

11.1 THERMIONIC EMISSION AND VACUUM DIODE Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- discuss why electrons are emitted from the metal surface.
- explain the construction of vacuum tube and its application.

Teaching Aids

Light bulb, light emitting diode (LED)

Introduction

Teacher should introduce that the metal which consists of plenty of free electrons and electrons can move in the metal (conductor).

Metals contain large numbers of free electrons. If the metal is heated the electrons acquire energy. When the temperature of the surface of metal becomes high, the electrons which acquire sufficient energy escape from the surface.

Teaching

The emission of electrons from the surface of metal at high temperature is called thermionic emission. The vacuum tube is based on the principle of thermionic emission.

Vacuum tube was basic electronic component throughout the first half of the twentieth century. It was available and common in the circuit of radio, television and other electrical appliances.

Vacuum diode is a vaccum tube which consists of two electrodes. They are a cathode and an anode. The cathode in a vacuum diode has to be heated to emit electrons.

Vacuum diode can be used as rectifiers because the current flows in one direction only from anode A to cathode K. Rectifiers convert alternative current (ac) to direct current (dc).

Practice

Students will work in a small group to discuss the important role of vacuum diode in electric circuits. Teacher should lead them to discuss the behaviours of thermionic emission in the electric bulb.

Diode Characteristic

The characteristic of a diode is a graph which shows the relation between the plate current, I_p and the potential difference, V_p, between anode and cathode. Plate current I_p flows from anode to cathode.

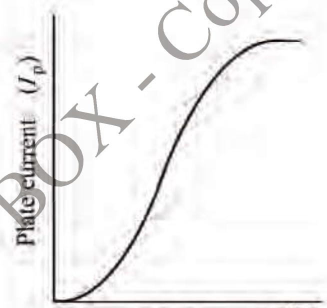


Figure 11.1 Diode characteristic curve

Review and Assessment

1. Why are electrons emitted from the surface of metal at high temperature?
2. What is the function of cathode of vacuum diode?

Answer

1. When large amount of external energy in the form of heat is supplied to the free electrons in the metal, electrons acquire sufficient energy to escape from the surface.
2. The cathode of vacuum diode emits the free electrons.

Teacher can assess the students' understanding by discussing the thermionic emission and application of vacuum diode.

11.2 BLACKBODY RADIATION AND THE CONCEPT OF PHOTON

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- discuss the blackbody and blackbody radiation spectrum.

Teaching Aids

Electric heater, electric iron

Introduction

Teacher should introduce that if light is incident on a surface, the surface absorbs some of light and emits heat (or) radiation.

Teaching

An object which can absorb all the electromagnetic radiations falling upon it is called blackbody. A good example of a black body is a cavity with a small hole in it. Any light incident upon the hole goes into the cavity and is essentially never reflected out since it would have to undergo a very large number of reflections off walls of the cavity.

A blackbody is a perfect radiator of light that absorbs and emits all radiations incident on it. Its light output depends on its temperature. The sun and stars emit radiation like a blackbody.

Moreover, the electric heater and electric stoves are regarded as blackbody. Blackbodies are used for lighting, heating and so on.

When a blackbody is heated, the radiation it emits is called blackbody radiation.

Intensity of radiation is the energy emitted from unit area of the surface in one second. The intensity of blackbody radiation against the wavelength at a given temperature is called blackbody spectrum. Two distinct features which can be observed from the blackbody spectrum are given as Wien's law and Stefan's law.

Wien's Law

The wavelength at which maximum intensity occurs (λ_{max}) is inversely proportional to the absolute temperature of the blackbody. That is,

$$\lambda_{max} \propto \frac{1}{T}$$

It means that the higher the temperature, the shorter the wavelength λ_{max}.

Stefan Boltzmann's Law

The total emissive power of a blackbody ($\mathcal{E}_o$) is directly proportional to the fourth power of absolute temperature.

$$\mathcal{E}_o = \sigma T^4 , \qquad \sigma = \text{stefan's constant}$$

Teacher can explain that the total emissive power is the rate of radiating energy. The total radiated energy increases with increasing temperature. Teacher should give the application of Stefan's Law. For example, the temperature of Sun's surface can be approximated from the energy radiated falling on the earth.

Max Planck's Explanation of the Blackbody Radiation and the Concept of Photon

Planck proposed that the radiation resulted from a large number of identical oscillators. Radiation is emitted (or absorbed) when an oscillator changes energy level. The emitted radiation from oscillator can be considered as particles called photons.

Plank assumed that the energy of a photon was proportional to its frequency,

$$E \propto f\,,\; E = hf = \frac{hc}{\lambda}$$

where the constant h is the Planck constant and λ is the wavelength of the emitted radiation (photon). The numerical value of the Planck constant is $h = 6.626 \times 10^{-34}$ J s.

Practice

Students will work in a small group to discuss the following; blackbody, blackbody radiation, photon and photon energy. Teacher should guide the students how the intensity of a source of heat (or) light relates with its temperature.

Review and Assessment

1. What is a photon?
2. Compare energy of photon in light and that of photon in ultraviolet.

Answers

1. A photon is a particle in electromagnetic radiation.
2. The energy of photon in ultraviolet is greater than that of photon in light.

Teacher can assess the students' understanding by asking the concept of photon and its energy.

11.3 MODELS OF ATOM

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- discuss the atomic models.

Teaching Aids

Pieces of cardboard, Bohr model template, three different colours of small balls

Introduction

In this section, the atomic models are explained.

Teaching

JJ. Thomson suggested that an atom might be a spherical volume of positive charge with electrons embedded inside it.

Rutherford concluded that the atom must have large empty space with all of its positive charge and most of its mass are concentrated in a small region. This concentrated volume at the center of the atom is called the nucleus. Negatively charged electrons are moving around the tiny nucleus.

In 1913, Niels Bohr proposed a new model of the atom by applying the quantum theory. In Bohr's model, the electron moves in circular orbits around the nucleus. The electric force between the positively charged proton inside the nucleus and the negatively charged electron holds the electron in orbit.

Practice

Students will work in a small group to construct the atomic model proposed by Rutherford using cardboard and small balls. Teachers should discuss with them the following facts: (i) which part is nucleus and (ii) which part is electron.

Review and Assessment

- What is the difference between Rutherford's atomic model and Bohr's atomic model?

Teacher can assess the students' understanding by discussing the difference between Rutherford's model and Bohr's model.

11.4 ATOMIC STRUCTURE

Number of lesson periods: 2

Learning Objectives

After completing this section, the students will be able to

- explain the atomic structure.

Teaching Aids

Pieces of cardboard, Bohr model template, three different colour small balls

Introduction

Teacher should remind that matters and atomic stuctures are expressed in Chapter 9. All matter is made of atoms. Atoms are composed of smaller particles called electrons, protons and neutrons. There is a central nucleus made up of protons and neutrons. Around nucleus, electrons orbit at high speed in allowed orbits.

Teaching

Protons have a positive charge and electrons have an equal amount of negative charge, while the neutrons are neutral.

Electrons are held in orbit by the Coulomb attractive force of the nucleus.
The atomic number of an element is the number of protons (or) electrons in an atom of that element.

The total number of protons and neutrons in the nucleus of an atom is called the mass number. Atoms that have the same atomic number but different neutron numbers (and thus different mass numbers) are called isotopes. For example, hydrogen has three isotopes $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$ (protium or hydrogen, deuterium and tritium)

At the end of the lesson, students will be able to describe the structure of atoms and locations of protons, neutrons and electrons.

Practice

Students will work in a small group to construct Bohr's model of hydrogen ($^{1}_{1}H$) and helium ($^{4}_{2}He$) using different colour balls and cardboard.

Review and Assessment

1. What is the smallest part of matter?
2. What are the three main parts of an atom?
3. Where are these parts located in an atom?
4. What are the mass numbers and atomic numbers of the following elements?

   (i) $^{206}_{82}Pb$ (ii) $^{193}_{80}Hg$

Answers

1. An atom is the smallest part of the matter.
2. Three main parts of an atom are protons, neutrons and electrons.
3. The nucleus made up of neutrons and protons are located at the center. Electrons orbit around nucleus.
4. (i) $^{206}_{82}Pb$, mass number = 206, atomic number = 82

   (ii) $^{193}_{80}Hg$, mass number = 193, atomic number = 80

Teacher can assess the students' understanding by discussing the explanation of atomic number and isotopes.

11.5 THE STRUCTURE AND EVOLUTION OF THE VISIBLE UNIVERSE

Number of lesson periods: 3

Learning Objectives

After completing this section, the students will be able to

- realize the visible universe.
- discuss astronomy, astrophysics and cosmology.

Teaching Aids

Chart of universe, chart of solar system

Introduction

Teacher might introduce the following facts:
The part of the universe which we can see is termed visible universe. The actual universe might be bigger than the visible universe. The sun is a star in the universe.
The Earth, our planet is a part of the solar system that contains nine planets.
The visible universe roughly consists of 10^{22} stars.

Teaching

Astronomy is a natural science that deals with the study of celestial objects, which are any natural bodies outside of the Earth's atmosphere. Examples are the Moon, the Sun, planets, stars, comets, nebulae, star clusters and galaxies.

Astrophysics is the branch of astronomy that deals with the physics of the universe, including the physical properties of celestial objects, as well as their interactions and behavior.

Cosmology studies universe as a whole and its phenomena at largest scales. The difference between Astrophysics and Cosmology is the domain and scale of the study.

Astronomical Unit (AU)

The mean distance between the Earth and the Sun is 1.496×10^8 km.

Light Year

The light year is the distance travelled by light in a vacuum in one year. 1 $ly = 9.46 \times 10^{12}$ km.

The parsec

One parsec is the distance to a star that subtends angle of 1 arc second at an arc length of 1 AU.

$1pc = 3.68 \times 10^{13}$ km.

Practice

Students will work in a small group to discuss the concepts of the followings;

Visible universe, Milky way galaxy, celestial objects.

Teacher should discuss the students that the gravitational forces are illustrated between the planets.

Teacher should make an exercise to find out an interesting facts about one of planets.

Review and Assessment

- Calculate the length of 1 light year in term of metre.

Answer

- $1\ ly = 60 \times 60 \times 24 \times 365 \times 3 \times 10^8 = 9.46 \times 10^{15}$ m

  $= 9.46 \times 10^{12}$ km

Teacher can assess the students' understanding by discussing the terms of visible universe, astronomy and astrophysics.

Note: After teaching each section of this chapter, teacher should assess the students' understanding by discussing on their practice and review exercise.

Answer from textbook

1. A.
2. D.
3. A.
4. B.
5. D.
6. D.
7. D.
8. A.
9. A.
10. B.

11. Hz
12. electron
13. proton
14. neutron
16. (a) e (b) n (c) e (d) p + n (e) e
17. (a) 13 (b) 13 (c) 14
18. different numbers of neutrons