FEDERAL DEMOCRATIC
REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

ISBN 978-2-12-345680-3

Physics Teacher's Guide – Grade 10

Physics

Teacher's Guide

Grade 10

FEDERAL DEMOCRATIC
REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

Physics

Teacher's Guide
Grade 10

Contributors:

Fikadu Eshetu (Ph.D), Writer

Mideksa Kasahun (MSc), Writer

Moges Tsega (Ph.D), Content Editor

Samuel Assefa (Ph.D), Curriculum Editor

Felekech G/Egziabher (Ph.D), Language Editor

Umer Nuri (MSc), Illustrator

Derese Tekestebrihan (Ph.D fellow), Book Designer

Evaluators:

Zafu Abraha (MSc)
Girmaye Defar (MSc)
Dessie Melese (MSc)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

HAWASSA UNIVERSITY

First Published xxxxx 2022 by the Federal Democratic Republic of Ethiopia, Ministry of Education, under the General Education Quality Improvement Program for Equity (GEQIP-E) supported by the World Bank, UK's Department for International Development/DFID-now merged with the Foreign, Common wealth and Development Office/FCDO, Finland Ministry for Foreign Affairs, the Royal Norwegian Embassy, United Nations Children's Fund/UNICEF), the Global Partnership for Education (GPE), and Danish Ministry of Foreign Affairs, through a Multi Donor Trust Fund.

The Ministry of Education wishes to thank the many individuals, groups and other bodies involved – directly or indirectly - in publishing this Textbook. Special thanks are due to Hawassa University for their huge contribution in the development of this textbook in collaboration with Addis Ababa University, Bahir Dar University and Jimma University.

PHOTO CREDIT:

Printed by:
xxxxxxxx PRINTING
P.O.Box xxxxxx
xxxxxxx, ETHIOPIA
Under Ministry of Education Contract no. xxxxxxxxxxx
ISBN: 978-999944-2-046-9

Foreward

Education and development are closely related endeavors. This is the main reason why it is said that education is the key instrument in Ethiopia's development and social transformation. The fast and globalized world we now live in requires new knowledge, skill and attitude on the part of each individual. It is with this objective in view that the curriculum, which is not only the Blueprint but also a reflection of a country's education system, must be responsive to changing conditions.

It has been almost three decades since Ethiopia launched and implemented new Education and Training Policy. Since the 1994 Education and Training Policy our country has recorded remarkable progress in terms of access, equity and relevance. Vigorous efforts also have been made, and continue to be made, to improve the quality of education.

To continue this progress, the Ministry of Education has developed a new General Education Curriculum Framework in 2021. The Framework covers all pre-primary, primary, Middle level and secondary level grades and subjects. It aims to reinforce the basic tenets and principles outlined in the Education and Training Policy, and provides guidance on the preparation of all subsequent curriculum materials – including this Teacher Guide and the Student Textbook that come with it - to be based on active-learning methods and a competency-based approach.

In the development of this new curriculum, recommendations of the education Road Map studies conducted in 2018 are used as milestones. The new curriculum materials balance the content with students' age, incorporate indigenous knowledge where necessary, use technology for learning and teaching, integrate vocational contents, incorporate the moral education as a subject and incorporate career and technical education as a subject in order to accommodate the diverse needs of learners.

Publication of a new framework, textbooks and teacher guides are by no means the sole solution to improving the quality of education in any country. Continued improvement calls for the efforts of all stakeholders. The teacher's role must become more flexible ranging from lecturer to motivator, guider and facilitator. To assist this, teachers have been given, and will continue to receive, training on the strategies suggested in the Framework and in this teacher guide. Teachers are urged to read this Guide carefully and to support their students by putting into action the strategies and activities suggested in it.

For systemic reform and continuous improvement in the quality of curriculum materials, the Ministry of Education welcomes comments and suggestions which will enable us to undertake further review and refinement.

ADDIS ABABA, ETHIOPIA
xxxxx 2022

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

Contents

Introduction to the Teacher's Guide

Generally, physics contributes to the development of our country in many ways. A knowledge and understanding of physics help students to understand the world and appreciate how it works. It contributes to a society that benefits from this understanding, and produces people who realize how the environment can be exploited in a sustainable way for the benefit of society. It prepares students for employment, both in a general way and as a preparation for careers that require knowledge of the subject, such as engineering or communications. However, a study of physics does not just mean learning facts. Physics, as with the other sciences, requires the student to develop creativity and problem-solving skill. The Secondary physics curriculum takes a competency-based, active learning approach, underpinned by three broad outcomes: knowledge, values and attitudes, and skills. The Students' Book and Teacher's Guide places emphasis on learner centered classroom and field activities, not only to help students to acquire knowledge, but also to develop problem-solving and decision-making skills, as well as a good attitude to society and the world around us. The teacher must make the students aware that science is a dynamic activity, a body of knowledge that constantly grows and is modified by experimentation. He or she can utilize new approaches to teaching and learning, involving a range of teaching styles, along with practical activities and field work, summarize in the 'Teaching Methods' section below.

General objectives of the Grade 10 physics course

When students have completed Grade 10 physics they should:

- Acquire knowledge and understandings of vector representation, vector addition and subtraction, and properties of vectors.
- Develop skills of resolving and composing vectors.
- Develop interest in solving problems using vector approach.
- Gain knowledge and understanding on uniform and uniformly accelerated motion in one dimension

- Develop skills in applying equations of uniformly accelerated motion in solving problems
- Develop skills in drawing and interpreting graphs representing uniform and uniformly accelerated motion
- Design and conduct investigations on the displacement, velocity, and acceleration of an object; analyze everyday phenomena in terms of these motions
- Gain elementary knowledge on basic properties of bulk matter such as elastic limit, density, tensile stress and strain.
- Apply the knowledge acquired now to the later advanced concepts, such as thermal expansion and fluid pressure.
- Understand and relate the principle of static equilibrium to everyday experience
- understand the basic properties of electric charge; item produce charges in different charging process and explain the charging process;
- have a conceptual understanding of Coulomb's law and the factors which effect electrical force;
- understand the concept of an electric field qualitatively and quantitatively;
- understand the relationship among voltage, current and resistance;
- describe arrangement of resistors in a combination circuit and its practical implications;
- apply the concept of electricity in solving problems in their real-life situations.
- understand the nature and characteristics of magnets;
- understand what is meant by the magnetic field;

- understand the concepts related to magnetic force;
- solve problems related to magnetism;
- appreciate simple applications of magnetism in your everyday life.
- Understand the properties and transmission of light in various media and their applications.
- Investigate the properties of light through experimentation illustrate using diagrams and optical instruments.
- Predict the behavior of light through the use of ray diagrams and algebraic equations;
- Appreciate the contributions to such areas as entertainment, communications, and health made by the development of optical devices and other technologies.

Each unit of study has specific learning competencies, and these are listed at the beginning of each unit of this Teacher's Guide, period needed for each section and teaching activity and providing a useful answer checklist for teachers.

Teaching methods

The subject content can be delivered in different ways in order to achieve the specific objectives. The type of teaching method used will affect the skills and attitudes that the students develop. The teacher will want to use the most effective methods for teaching a particular topic. In Physics, it is recommended that the teacher use more than one teaching method in a single lesson – the discussion method might be suitable for the beginning of the lesson, followed by the discovery method, or a practical activity.

Unit 1

Vector Quantities

This unit should fill approximately 9 periods of teaching time.

At the end of this unit, students will be able to:

- understand vectors and scalars;
- comprehend the techniques of vector addition and resolution;
- demonstrate vectors representation graphically;
- apply vector addition techniques to solve problems;
- discuss how vectors can be used to solve problems in real life situation;
- apply vector decomposition techniques to solve problems.

Finding the best way to teach physics is to show students how the concepts are connected together, get them to relate the concepts to their experiences and elaborate on them in their own words. It's always better to deepen understanding, reconstruct the ideas, and experiment around than just drill for the exam.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and make them understand why they need to study it. If you could also put in some activities, it would surely add to their interest. So here are some suggestions about how you could teach vector quantities to your students.You have 9 periods at your disposal for teaching the section.

1.1 Scalars and vectors

This section should fill approximately 1 periods of teaching time.

At the end of this section, students will be able to:

- define scalar and vector quantities;
- list down examples of scalar and vector quantities;
- describe the difference between vector and scalar quantities;
- compare and contrast vector and scalar quantities based their characteristics.

Lesson 1: Scalars and vectors

Starting off

Before introducing the daily lesson, ask your student, for example, what is physical quantity? What can you tell me about a physical quantity like a mass? Is it a scalar or vector? What is the difference between mass and weight? Based on your student's response, remind them about the definition of physical quantity, scalars and vectors.

Lesson description

Introduction

Dear teacher, after you remind the student about scalars and vectors using the oral question from the previous. Now you can introduce the lesson based on your students' response. Vectors are physical quantities that have magnitude and direction.

In put and model

After you introduce the lesson, give the definition of scalar and vectors, explain if possible using PhET simulation, make it clear by identifying their differences and similarities. Relate the lesson with the students' daily life experience. Engage your students to do an exercise 1.1 and 1.2. Evaluate your work and summarize the lesson.

Guide Students through Their Practice

While the students are doing the activities, you are expected to guide the students to learn by themselves.

Check for understanding

Check for students' understanding while they are exploring by utilizing your own oral questions or the question below.

1. Explain how vectors differ from scalars. Give some examples.

Exercise 1.1 Answer

Dear teacher, remind your students about scalars and vectors. Direction is for only vectors and help them to elaborate by an example.

Exercise 1.2 Answer

Dear teacher, students give their own answer based on their previous knowledge, and help them while they list scalars and vectors. For example impulse, momentum, torque etc are vectors.

Where next?

Dear teacher, you have to encourage your students to start thinking about how vectors are represented. And remind your student to have a protractor and a ruler for the next topic:vector representation.

Closure

To close the lesson, allow students to describe verbally what they understood about scalars and vectors. After taking their idea, try to summarize the important concepts of the lesson.

Answers to review questions

1. A vector quantity has a magnitude and a direction, while a scalar has only a magnitude. You can tell a given quantity is a vector or scalar: by whether or not it has a direction associated with it. Example: Speed is a scalar quantity, but velocity is a vector that specifies both a direction as well as a magnitude.

2. Force, weight and velocity have magnitude and direction, so that they are vectors. But other quantities (temperature,volume and age) have only magnitude, are scalars.

1.2 Vector representation

This section should fill approximately 1 period of teaching time.

At the end of this sectiion, students will be able to:

- identify the magnitude and direction of a vector;
- discuss how vectors can be represented graphically.

Lesson 2: Vector representation

Starting off

Dear teacher, remind the student about scalars and vectors. Then you could ask your students this question: how can you represent vectors? Based on their response, try to correlate the lesson with daily life experience and start off the lesson.

Lesson description

Introduction

Dear teacher, introduce the lesson, motivate you student to follow the lesson that you are going to deliver.

In put and model

Give short note, present the lesson, explain a parallel and anti parallel vectors. use demonstration using a computer and PhET simulation. Show them how to use ruler and protractor to represent vectors. Additionally, help your the students; when they practice activity 1.1 and exercise1.3.

Guide the Students through Their Practice

While the students are doing an activity 1.1, you are expected to guide and help the students, on scale measurement and using protractor to learn by themselves.

Exercise 1.3

Students own answer.

Activity 1.1

Dear teacher, while they are doing this activity in their group or individually, they should have a ruler and a protractor. Remind your students to put a scale of measurement before they go to measure. For example, $\vec{B} = 300km$ east is given. To represent graphically our scale should be 1: 100. and help them while they are doing this activity.

Check for Understanding

To assess students learning, you may ask your own oral questions or use review questions.

Where next?

You have to encourage students to start thinking about the importance of studying about an vector representation for their daily life activity.

Closure

To close the lesson, allow students to describe vector representation. After taking their idea, try to summarize lesson.

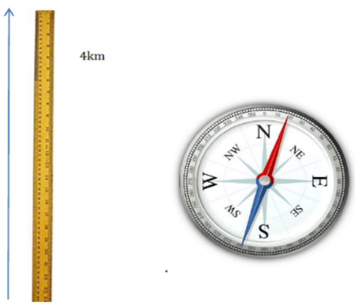


Figure 1.1 Vector **s**

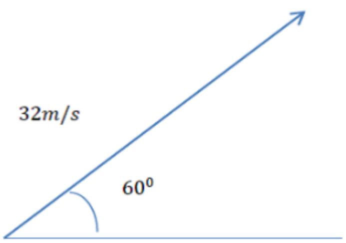


Figure 1.2 vector **v**

Answers to review questions

1. Vectors are represented algebraically and geometrically.
   For example: $\vec{C} = 20\ m\ north$.

   $\vec{F} = 100\ km; 30^o\ south\ of\ east$

2. For example: If you use scale of measurement: scale 1 cm:1km for question number 2(a) and 1cm:1m/s for the next question and use the compass to determine the direction. You can get the vectors shown in the 1.1 and 1.2

1.3 Vector addition and subtraction

This section should fill approximately 2 periods of teaching time.

At the end of this sectiion, students will be able to:

- Apply vector addition and subtraction techniques to solve real-life problems;
- define the resultant vector.

Lesson 3: Vector addition

Starting off

Dear teacher, remind your student about vector representation. Ask your student, can two parallel vectors be added? Can velocity and force be added? If they say no, why? Again, use your own oral question and try to motivate your student to actively participate.

Lesson description

Introduction

Introduce the lesson Using the students response of the question stated above and use your own approach.

Input and model

Based on the students response, try to give the short notes on the vector addition and subtraction. Dear teacher, there are some special case of two vector($\vec{A}$ and $\vec{B}$) additions.

a) When the Two Vectors are Parallel (Same Direction), the resultant vector ($\vec{R}$) becomes: $\vec{R} = \vec{A} + \vec{B}$

b)When the Two Vectors are Acting in Opposite Direction, the resultant vector($\vec{R}$): $\vec{R} = \vec{A} - \vec{B}$

c)When the two vectors are perpendicular, the resultant vector ($\vec{R}$): $\vec{R} = \sqrt{A^2 + B^2}$

Dear teacher, your students are new for inverse trigonometric function. So that, give an introduction and show, how to get the inverse trigonometric function using scientific calculator.

The inverse tangent function ($\arctan(\theta)$) is defined as the following.

The inverse tangent function is a function denoted by the $tan^{-1}(x)$ or $\arctan(x)$ that assigns to each real number x the unique number y in $(-\pi/2, \pi/2)$ such that $x = tan(y)$.

Read the user's manual for your scientific calculator and find the tangent inverse of: (a) $\arctan(0.021)$ and (b) $tan^{-1}(2)$ and help your student to use their on scientific calculator.

Guide Students through Their Practice

While the students are doing exercise 1.4 and 1.6 try help them.

Exercise 1.5 Answer

Dear teacher, two perpendicular vectors are joined either head to tail or tail to tail. So that you can use the triangle method or the parallelogram method of vector addition. Remind your student about Pythagoras' theorem and trigonometry to determine the magnitude and direction of the resultant vector.

Check for Understanding

To assess students learning, you may ask them review questions or your own question.

Where next?

You have to encourage students to start thinking about the importance of studying about vector addition and subtraction for their daily activity.

Closure

To close the lesson, allow students to describe the vector addition and subtraction. After taking their idea, try to summarize the lesson.

Lesson 4: Vector subtraction

Starting off

Dear teacher, remind your student about vector addition. Ask your student, can two parallel vectors be subtract? Can velocity and force be subtract? If they say no, why? Again, use your own other oral question and try to motivate your student to actively participate on the lesson.

Lesson description

Introduction

Introduce the lesson Using the students response of the question stated above and use your own approach.

Input and model

Based on the students response, try to give the short notes on the vector subtraction. Dear teacher, For the two vector($\vec{A}$ and $\vec{B}$) acting in Opposite direction, the resultant vector($\vec{R}$):

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

Guide Students through Their Practice Exercise 1.4 Answer

Dear teacher, actually the sum of two vectors can only be zero if they are equal in magnitude and opposite in direction. Try to help the student to explain this concept using a daily activity.

Check for Understanding

To assess students learning, you may ask them review questions or your own question.

Where next?

You have to encourage students to start thinking about the importance of studying about vector subtraction for their daily activity.

Closure

To close the lesson, allow students to describe the vector subtraction. After taking their idea, try to summarize the lesson.

Answers to review questions

1. Vector subtraction is the process of taking a vector difference, and is the inverse operation to vector addition.

2. The resultant vector is the result of adding two or more vectors together. When you add vectors, you need to add both a magnitude and a direction. In other words, the individual vectors can be replaced by the resultant where the overall effect is the same.

3.

   Given: $\overrightarrow{V} = 5\ unit$
   $\overrightarrow{X} = -5\ unit$
   required: $\vec{R}$ =?
   Solution:
   The resultant of anti parallel vectors is: $\overrightarrow{R} = \overrightarrow{V} - \overrightarrow{X}$
   $\overrightarrow{R} = 5\ unit - 5\ unit = 0$
   When two vectors are exactly opposite in direction and equal in magnitude, The magnitude of the resultant vector is zero.

4. The sum of two vectors can only be zero if they are equal in magnitude and opposite in direction, the resultant becomes twice the magnitude of the given vector when they have equal magnitude and

in the same direction.

5. Three vectors of unequal magnitude can add to give the zero vector. For example, As shown in the Figure 1.3, a vector 10 N long in the positive x direction added to two vectors of 4 N and 6 N each in the negative x direction will result in the zero vector.

Figure 1.3 Zero resultant vector for given three vectors.

1.4 Graphical Method of Vector Addition and Subtraction

This section should fill approximately 3 periods of teaching time.

At the end of this section, students will be able to:

- describe the graphical method of vector addition and subtraction;
- use the graphical method of vector addition and subtraction to solve problems.

Lesson 5: Triangle law of vector addition

Starting off

Start the topic by asking students about vector addition using triangle law of vectors through encouraging students. Remind the concepts of numerical vector addition. This helps you to know the students' level of understanding. And it is crucial for shaping their knowledge if, in case, they have misconceptions about the concept vector addition using graphical method(head to tail method).

Lesson description

Introduction

Dear teacher introduce the graphical method of vector addition and subtraction when the two vectors form the side of triangle.

Input and model

Dear teacher, before you are going to deliver the lesson, read the materials and prepare demonstration-based teaching. Order your students to have a ruler and a protractor. Discuss the three graphical techniques: the triangle method, the parallelogram method, and the polygon method of graphical vector additions. Give a short note and show the resultant vector using scale measurement: triangle and parallelogram and polygon methods

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask your on oral question and check their understanding.

Closure

Evaluate the lesson using oral questions or your own class room activity. Summarize the lesson using the triangle method.

Lesson 6: Parallelogram law of vector addition

Starting off

Start the topic by asking students for prior knowledge about vector addition and subtraction using triangle method through encouraging students. Remind the concepts of vector addition. This helps you to know the students' level of understanding. And it is crucial for shaping their knowledge if, in case, they have misconceptions about the concept vector addition and subtraction using graphical method(head to tail method).

Lesson description

Introduction

Dear teacher introduce the graphical method of vector addition and subtraction when the two vectors form the side of triangle.

Input and model

Dear teacher, before you are going to deliver the lesson, read the materials. Prepare simple demonstration in order to deliver the lesson, your students to have a ruler and a protractor. Introduce a parallelogram method vector addition. For the two vectors $\vec{A}$ and $\vec{B}$ joined head to head and is the side of the parallelogram, the resultant vector $\vec{R}$ of the two vector is diagonal of the parallelogram. Give a short note on parallelogram law of vector addition and show the resultant vector using scale measurement: head to tail method.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Activity 1.2 Answer

Dear teacher, here two vectors (**A** and **B**) are given on the text book, help the student while they measure the magnitude of the two vectors and draw the two vectors as the given instruction using head to tail method to get the length of the resultant vector **R** using the protractor and ruler.

Check for Understanding

To assess students learning, you may ask your on oral question and check their understanding.

Closure

Evaluate the lesson using oral questions or your own class room activity. Summarize the lesson using the following key therms. The triangle, parallelogram and polygon methods.

Lesson 7: Polygon law of vector addition

Starting off

Start the topic by asking students about a polygon method of vector addition through encouraging students. Remind the concepts of triangle and parallelogram law vector addition. This helps you to know the students' level of understanding. And it is crucial for shaping their knowledge if, in case, they have misconceptions about the concept vector addition and subtraction using graphical method(head to tail method).

Lesson description

Introduction

Dear teacher introduce the a polygon method of vector addition and subtraction when the more than two vectors form the side of polygon.

Input and model

Dear teacher, before you are going to deliver the lesson, read the materials and prepare demonstration-based teaching. If possible use PhET simulation. Discuss about graphical techniques: the polygon method of vector additions. Give a short note and show the resultant vector using scale measurement: triangle and parallelogram and polygon methods

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Activity 1.3 Answer

Dear teacher, here two vectors (**A** and **B**) are given on the text book, help the student while they measure the magnitude of the two vectors and draw the two vectors as the given instruction on activity 1.3 i.e join the two vectors tail to tail and draw the diagonal of the parallelogram. And its the length is the magnitude of resultant vector **R** using the protractor and ruler.

Activity 1.4 Answer

Dear teacher, for the three vectors given, using polygon method of vector addition the resultant vector can be determined. a)Represent each vector graphically with an arrow, labeling the first A , the second B , and the third C , making the lengths proportional to the distance and the directions as specified relative to an east-west line. The head-to-tail method outlined above will give a way to determine the magnitude and direction of the resultant vector. as shown in the Figure**??**.

b) Place the vectors head to tail retaining both their initial magnitude and direction. As shown in the Figure 1.5.

c) Draw the resultant vector, as shown in the Figure1.5.

d) Use a ruler to measure the magnitude of**R**, and a protractor to measure the direction of **R** ..In this case, **R** is seen to have a magnitude of 50.0 m and to lie in a direction 7.0^o south of east. By using its magnitude and direction, this vector can be expressed as **R** = 50.0 m and $\theta = 7.0^o$ south of east.

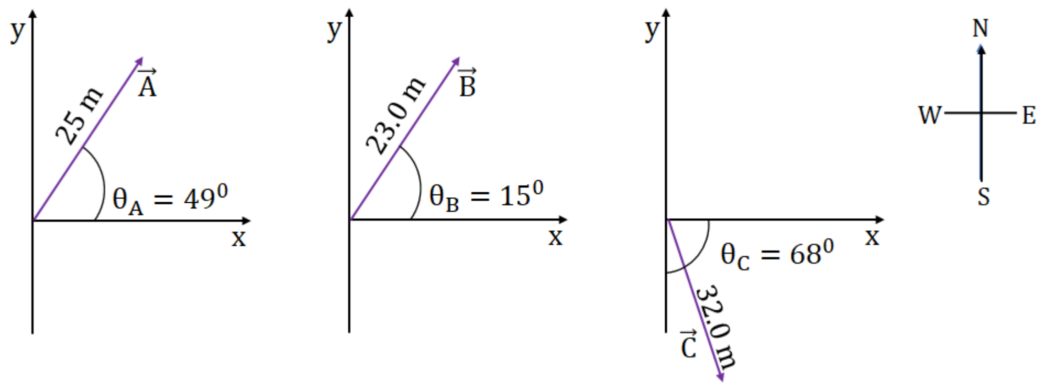


Figure 1.4 (a) Graphical representation of the three vectors.

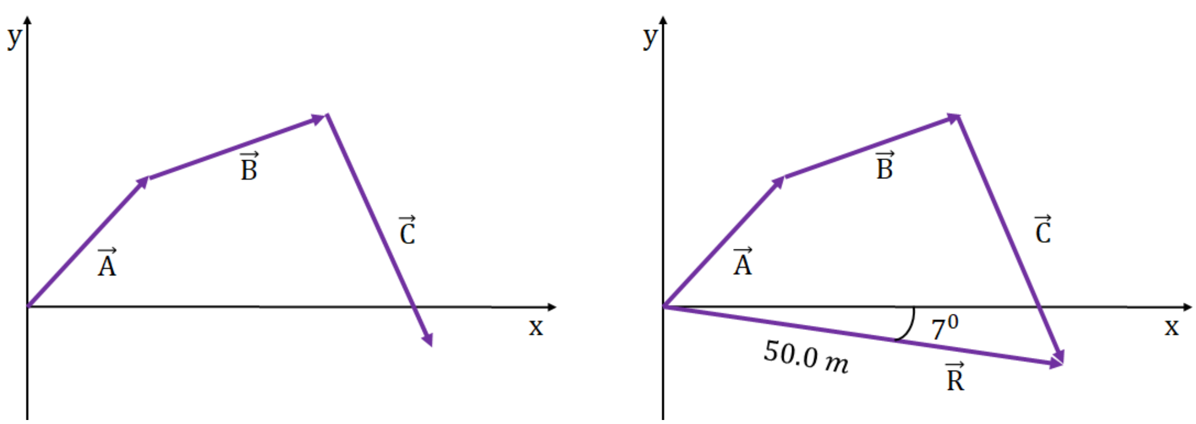


Figure 1.5 (b) The resultant vector of the three vectors.

Check for Understanding

To assess students learning, you may ask your on oral question and check their understanding.

Closure

Evaluate the lesson using oral questions or your own class room activity. Summarize the lesson using Key concept your student should remind about a polygon methods.

Answers to review questions

1. In triangle law of vector addition the two vectors are sides of triangle and the third side of the triangle is the resultant but in parallelogram law of vector addition the diagonal is the resultant.

2. For finding the resultant vector of several vectors using head to tail method.

3. Using a polygon method of vector addition, when the given six vectors are joined in head to tail then tail of the first vectors and head of the last vector is joined. So that, the magnitude of the resultant vector is zero.

4. C

5. Given:
$\vec{C} = 6$ m
$\vec{D} = 10$ m
Required: $\vec{R}$:?
Graphically the two vectors $(\vec{C}, \vec{D})$ and the resultant vector$(\vec{R})$ is shown as the in Figure1.6. Using Pythagoras theorem, the magnitude of the resultant vector $\vec{R}$ of two vectors $(\vec{C}, \vec{D})$ will be:
$R = \sqrt{C^2 + D^2}$
$R = \sqrt{6m^2 + 8m^2}$
$R = \sqrt{36 + 64}$ m

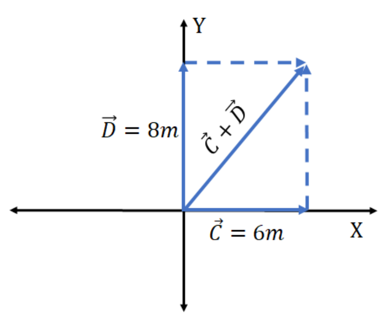


Figure 1.6 The resultant vector of **C** and **D**

$R = \sqrt{100}$ m

$R = 10$m

1.5 Vector resolution

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- resolve a vector into horizontal and vertical components;
- find the resultant of two or more vectors using the component method.

Lesson 8: Vector resolution

Starting off

Start the topic by asking students for prior knowledge about graphical vector addition and subtraction through encouraging students to relate the concepts of vector addition and subtraction in the case of the parallelogram method and vector resolution. This is crucial for shaping their knowledge if, in the case, they have misconceptions about graphical vector addition and subtraction.

Lesson description

Introduction

Dear teacher, before the lesson, remind the students about trigonometric relations and Pythagoras' theorem. Define the resultant vector.

Input and model

Explain to the students that they will be exploring resolving vectors. To do this, try to encourage students to do exercise 1.8 and 1.9, discussing in groups. And relate this topic with daily life activities.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Exercise 1.6 Answer

Dear teacher, Let us consider $\vec{A}$ having two components $\vec{A}_x$ and $\vec{A}_y$. The magnitude of $\vec{A}_x = A\cos\theta$ and $\vec{A}_y = A\sin\theta$. when you compere the magnitude of the two component it is always less the magnitude of $\vec{A}$ due to the trigonometric values.

Exercise 1.7 Answer

1. Dear teacher, a nonzero vector can have a zero component, for example any nonzero vector a long the y-axis has a zero component on the x-axis of a graph. (or vice-versa). $\mathbf{A} = 2.0 m\ east$ has non zero value on east direction but zero magnitude along north direction.

2. The two equal vectors have equal magnitude and direction so that they have equal components.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. Draw simple vector diagrams and resolve them into two components. 40 N at an angle of 30° from the horizontal.

Closure

Evaluate the lesson understanding of your students using oral question, and class room activity. To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concepts.

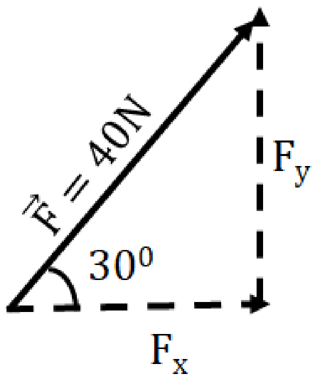
Answers to review questions

1. Resolution of vectors: Any vector directed at an angle to the horizontal (or the vertical) can have two components that lie on the axes(horizontal and vertical). The process of identifying these two components is known as the resolution of the vector.

2. **(a)**

Given: F=40 N;$\theta = 30^o$

Figure 1.7 shows the vector diagram.



The two components of the F are:

$F_x = F\ cos\,\theta\ = 40Ncos3\,0 = 40N\left(\frac{\sqrt{3}}{2}\right) = 20\sqrt{3}N$

$F_y = Fsin\theta\ = 40Nsin3\,0 = 40N\left(\frac{1}{2}\right) = 20N$

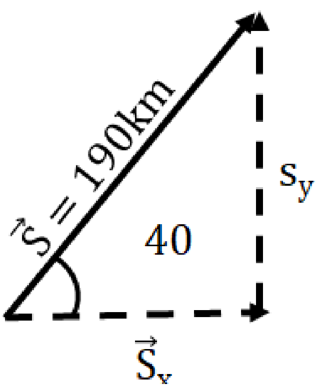
(b) Given: v=10m/s;$\theta = 80^o$

Figure 1.8 shows the vector diagram.

The two components of the v are:

$v_x = vcos\theta\ = 10m/s\ \cos 80^o = 10m/s(0.17) = 1.7m/s$

$v_y = vsin\theta\ = 10m/s\ \sin 80^o = 10m/s(0.98) = 9.8m/s$



(c) Given: S=1900 km;$\theta = 40^o$

Figure 1.9 shows the vector diagram.

The two components of the s are: $s_x = s\ cos\beta\ = 1900km\,(\cos 40^o) = 1900km(0.76) = 1444kmkm$

$s_y = s\ \ sin\beta\ = 1900km\ (\sin 40^o) = 1216km$

r.

3. The vector diagram, for the car in motion is given as in Figure**??**. And the resultant displacement can be determined graphically using scale of measurement. for example $1cm = 1km$. But algebraically using Pythagoras theorem.

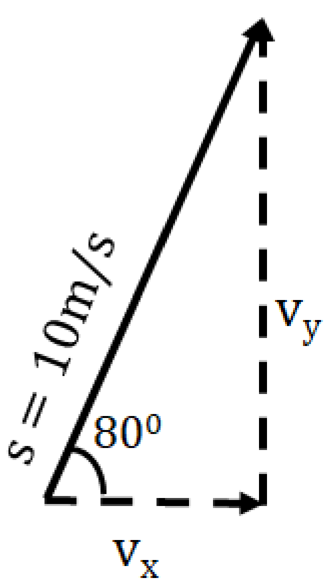


Figure 1.9 Resolving vector.

$$\vec{S} = \sqrt{\vec{S}_1^{\,2} + \vec{S}_2^{\,2}}$$
$$\vec{S} = \sqrt{10km^2 + 5km^2}$$
$$\vec{S} = \sqrt{1125km^2}$$
$$\vec{S} = 11.2km$$

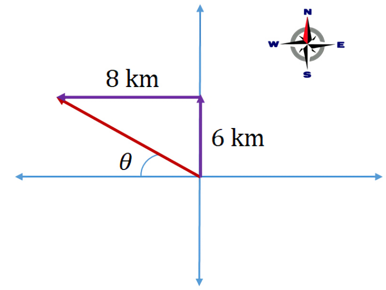


Figure 1.10 displacement oftwo vectors.

And the direction of displacement

$$\tan\theta = \frac{oppositeside}{Adjecentside}$$
$$\tan\theta = \frac{5km}{10km}$$
$$\theta = \tan^{-1}(0.5)$$
$$\theta = 26.6^0$$

The resultant displacement is $11.2km$; 26.6^o west of north.

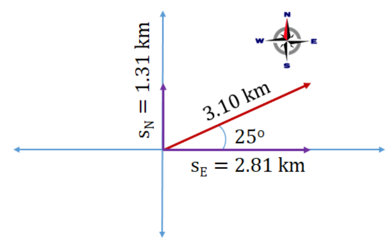


Figure 1.11

4. As shown in Figure 1.11 of the graphical representation of displacement Resultant displacement of the given motion.
   $S_E = S\,(cos25^o) = 3.10 \;\times 0.9 = 2.79km$
   $S_E = S\,(sin25^o) = 3.10 \times 0.4 = 1.24km$
   $total\ distance(s) = 2.79 + 1.24km = 4.03km$

Lesson 9: Virtual experiment

Starting Off

Start the lesson by summarizing the important points of the unit.

Lesson Description

Introduction

Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Answers to end of unit questions and problems

1. Two vectors of unequal magnitude can never add to give the zero vector. The only way that two vectors can add up to give the zero vector is if they have the same magnitude and point in exactly opposite directions.

2. C

3. Two vectors A and B is given. The resultant vector **C is**

   A) $\vec{C} = \vec{A} + \vec{B} = 6.8cm + 5.5cm = 12.3cm$

   B) $\vec{C} = \vec{A} + (-\vec{B}) = 6.8cm + (-5.5cm) = 1.3cm$

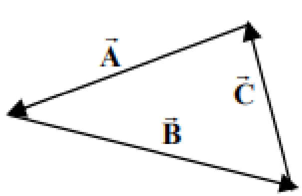


Figure 1.12

c) $\vec{C} = \vec{B} + (-\vec{A}) = 5.5cm + (-6.8cm) = -1.3cm$

4. For adding vectors, place the tail of the second vector at the head of the first vector. The tail of the third vector is placed at the head of the second vector. The resultant vector is drawn from the tail of the first vector to the head of the last vector this method is **head to tail method**.

5. Triangle, parallelogram and polygon methods.

6. The parallelogram law of vector addition is used to add two vectors when the vectors that are to be added form the two adjacent sides of a parallelogram by joining the tails of the two vectors. Then, the sum of the two vectors is given by the diagonal of the parallelogram.

7. Polygon law of vector addition states that if a number of vectors can be represented in magnitude and direction by the sides of a polygon taken in the same order, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in the opposite order.For example the three vectors **A**,**B**, **C**, the result vector **R** is shown as the Figure1.13

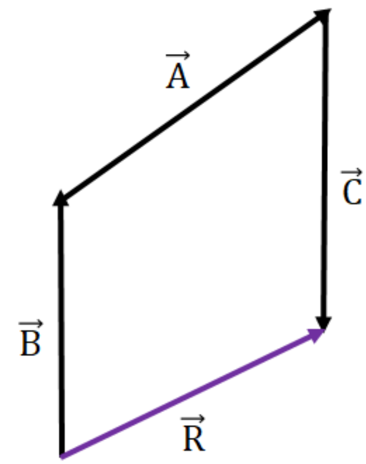


Figure 1.13 The resultant vector of the three vectors

8. The vectors for the given problem are drawn approximately as in the Figure1.14 shown. The resultant has a length of 17.5 m and a direction 19^o north of east.

   If calculations are done, the actual resultant should be 17 m at 23^o north of east. Keeping one more significant figure would give 17.4 m at 22.5^o. this shows that analytical method is more accurate than graphical method.

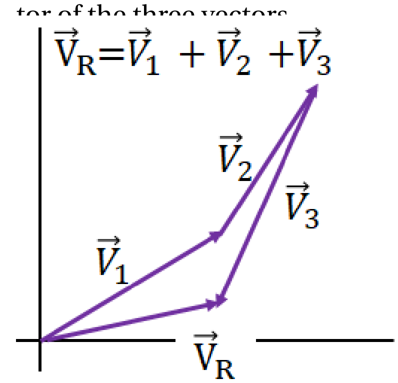


Figure 1.14 The magnitude and direction of the resultant vector.

9. Graphically the displacement can be shown as in the Figure 1.15

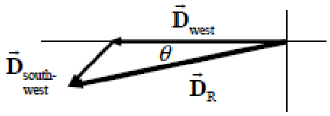


Figure 1.15 The displacement of a car.

D_R south west The resultant displacement of the car is given by; **D** = $D\ west$ + **D** $south$

displacement is (98 km) sin 45° = 69.3 km. The resultant displacement has a magnitude of

294.32 + 69.32 = 302 km. The direction is $\theta = \tan^{-1}(\frac{69.3}{294.3})$ = 13° south of west.

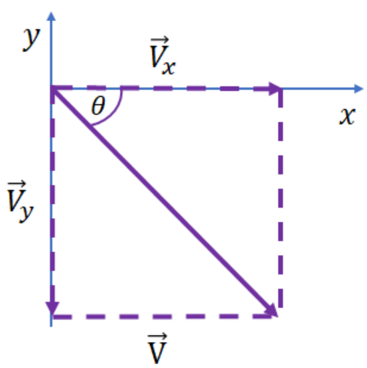


Figure 1.16 The magnitude and direction of the resultant vector.

10. Given: $\mathbf{V}_x$=9.80 unit and $\mathbf{V}_y$=-6.40 unit

    Solution:

    the magnitude of V is given by

$$V = \sqrt{V_x^2 + V_y^2} = \sqrt{9.80^2 + (-6.40\,)^2} = 11.70 unit$$

    The direction will be $\theta = \tan^{-1}\left(\frac{-6.40}{9.80}\right) = -33.1^0$

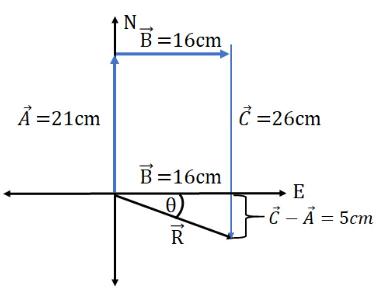


Figure 1.17 The magnitude and direction of the resultant vector.

11. Given: $\vec{A} = 21cm\ north$
    $\vec{C} = 26cm\ south$
    $\vec{B} = 16cm\ east$ and joined head to tail. As shown in the Figure 1.17
    $\vec{A}$ and $\vec{C}$ are anti parallel vectors. So that $(A \vec{-} C)$ =?
    $(A \vec{-} C) = 21 + (-26) = -5cm$ north and it is perpendicular to **B** which is 16 cm east.

    The resultant a magnitude:
    $R = \sqrt{(-5)^2 + 16^2}$ = 16.76 cm ≈ 17 cm and a direction of $\tan^{-1}(\frac{-5}{16})$ = 17° south of East.

Unit 2

Uniformly Accelerated Motion

This unit should fill approximately 13 ***periods*** *of teaching time.*

At the end of this unit, students will be able to:

- know how position and displacement are used to describe a uniformly accelerated motion;
- understand the different types of motions to describe physical phenomena;
- comprehend the nature of uniformly accelerated motion in one dimension;
- understand relative velocity in one dimension.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and make them understand why they need to study it. If you could also put in some activities, it would surely add to their interest. So here are some suggestions about how you could teach a uniformly accelerated motion to your students.Have confidence in your students' abilities, engage them in different activities. You have 8 periods at your disposal for teaching uniformly accelerated motion.

2.1 Position and Displacement

*This section should fill approximately **1 period** of teaching time.*

At the end of this section, students will be able to:

- define terms such as position, displacement, and distance
- describe the difference between of distance and displacement
- determine the total distance traveled by a certain object.
- calculate the total displacement given the position as a function of time.

Lesson 1: Position and Displacement

Starting Off

Start the topic by asking students prior knowledge about concept of position using objects in motion in your surrounding and about inertial frame of reference for an that object in motion. Dear teacher start the lesson use the brain storming given on the text book.

Lesson Description

Introduction

Explain to students about motion is relative and frame of reference should be considered. There is change in the position for an object in given frame of reference.

Input and Model

Based on the response that you received from the students, try to give a short notes on the definition of Position, distance and displacement. Help the student while they are doing activity 2.1 and 2.2. Explain using practical motion observed or you may use PhET simulation. Help student if worked example is not clear for students. Ask oral question to check their understanding of the topic.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing review questions.

Activity 2.1

A student's own answer.

Activity 2.2

Dear teacher, any measurement: position, distance and displacement must be made with respect to a reference frame. While you teach a physics lesson in class, you can use it to explain about frame of reference, displacement and distance. For example, mark your initial position using your chalk and change your position and again mark it again. Assume your initial position is at zero coordinate, ask your student to differentiate and explain about initial position, final position, distance and displacement using frame of reference. Based on your student response, you may give a short summary of this activity 2.1. Position is a measurement of a location, with reference to an origin. Distance is the actual path that is traveled by a moving body. Displacement is defined as its change in position (final position minus initial position).

Exercise 2.1 Answer

Yes! If the body travels in a straight line, then the magnitude of its displacement is equal to the magnitude of distance covered. For example: A car moves 20m in a straight line.

Exercise 2.2

A student's own answer.

Activity 2.3

A student's own answer.

Dear teacher, Let us consider, the basketball field that your students measure is 28 m length and 15 m width. The total distance traveled to measured is 43 m. But the displacement should be: $s = \sqrt{15^2 + 28^2} = 31.76$ m with

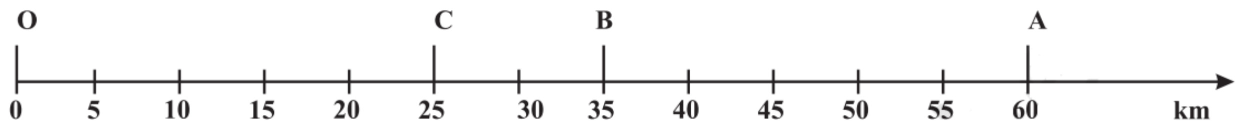


Figure 2.1 Position, distance and displacement of an an object.

direction $\theta = tan^{-1}(\frac{15}{28}) = 28^{o}$ to the side of the length of the basket field.

Were next

You have to encourage the students to start thinking about average velocity and instantaneous velocity.

Closure

To close the lesson, allow students to describe verbally what they understood about position in particular frame of reference, displacement, and distance. After taking their idea, try to summarize important concepts of: frame of reference, Position, distance, displacement.

Answer to review questions

1. Position is the location of the object. As shown in the Figure 2.1 the position of the object is at point O, C, B, and A with the coordinates of 0, 25 m, 35 m, and 60 m respectively with origin as frame of reference and at a given particular time.
   Displacement is the difference in the object's position from one time to another. For example again as shown in the figure 2.1 when an object moves from initial to final position (Point o to C) the displacement is 25 m in the given direction. Displacement is a vector quantity.

2. For example:
   A student walking to her school which is 4 km north from her start point, then she is moving 2 km south from her school. From this daily life activity example: The distance traveled: $s = 4km + 2km$
   Displacement is

$\mathbf{s} = 4km - 2km = 2km\ \ north$

s=2 km north.

and the magnitude of displacement is 2 km.

3. Given: $S_{AB} = 15\ m\ S_{BC} = 20\ m$

   Required:

   Distance(ΔS) =?

   $Displacement$ =?

   Solution:

   Distance is the total length of the path taken in going from the initial position, s_o to the final position, S. But displacement the shortest path between the initial and final position. As shown in the Figure 2.2 distance is sum of the magnitude of two perpendicular vectors and Displacement is the magnitude of the two components. $\Delta s = s_{AB}\ + S_{BC} = 15\ m + 20\ m = 35\ m$

   $\overrightarrow{s}\ = \sqrt{225 + 400}$ =25 m

   Where as the direction becomes:

   $\theta = tan^{-1}(20/15)$

   $\theta = 53.1^o$

   There fore the magnitude of displacement and direction is: $\vec{s} = 25$ m; $\theta = 53.1^o$ to the horizontal.

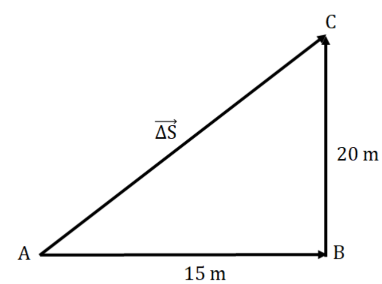


Figure 2.2 Two perpendicular vectors and their resultant.

2.2 Average velocity and instantaneous velocity

This section should fill approximately 3 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- describe instantaneous and average velocity of a body in motion;
- describe the difference between average velocity and instantaneous velocity;
- solve problems related to the average velocity.

Lesson 2: Average velocity

Starting Off

Start the lesson through asking students a brain storming question and remind about Position and displacement.

Lesson Description

Introduction

Dear teacher, introduce about an average velocity based on previous knowledge of the students responses.

Input and Model

Dear teacher, after you remind about position and displacement, define average velocity and average speed. Average velocity tells us how much an object's position changes in time; $v_{av} = \frac{s - s_o}{t - t_o}$, does not convey any information about how fast you were moving or the direction of the motion at any instant during the trip. So that we use instantaneous velocity to know the motion a body at the given instant time. remind your student about the difference and similarity between average speed and velocity. $v = \frac{s - s_o}{t - t_o}$ when $t - t_o \rightarrow 0$ For practical application of this physical concept of this section in their daily life use your own example.ask them to do exercise2.3.

Guide Students through Their Practice

While doing the activities and worked example of this section, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Exercise 2.3 Answer

Dear teacher, average velocity is defined as the change in displacement over the time of travel, while instantaneous velocity is the velocity of an object at a single point in time. For example, a car driver is driving down the highway at a constant velocity of 30km/h. The average velocity of the car is 30km/h, and no matter what time you measure, the instantaneous velocity at that moment is always 30 km/h.

Exercise 2.4 Answer

No, the speed can be different from the magnitude of velocity. For example, you drive to a store and return home in half an hour. If your car's odometer shows the total distance traveled was 6 km, then your average speed was 12 km/h. Your average velocity, however, was zero because your displacement for the round trip is zero.

Exercise 2.5 Answer

Dear teacher, as you know, cars speedometer gives information about the speed of the car at instant of time only.

Activity 2.4 Answer

Dear teacher, the two students are walking at different speeds. The speed of the second student is lower than the first student. displacement is constant in every second.

Where next

Students need to extend their knowledge of the average velocity and average speed for their daily activities.

Closure

To close the lesson, allow students to describe verbally the physical concept of average velocity and average speed. Avoid the miss conception of average velocity and average speed. Based on their idea, try to summarize the important concept.

Lesson 3: instantaneous speed and velocity

Starting Off

Start the lesson through asking students a brain storming question and remind about average speed and velocity.

Lesson Description

Introduction

Dear teacher, introduce the lesson: instantaneous speed and velocity.

Input and Model

Dear teacher, after you remind about average speed and average velocity, define instantaneous speed and instantaneous velocity. Average velocity tells us how much an object's position changes in time; $v_{av} = \frac{s - s_o}{t - t_o}$, does not convey any information about how fast you were moving or the direction of the motion at any instant during the trip. So that we use instantaneous velocity to know the motion a body at the given instant time. $v = \frac{s - s_o}{t - t_o}$ when $t - t_o \to 0$ For practical application of this physical concept of this section in their daily life use your own example.ask them to do exercise2.6.

Guide Students through Their Practice

While doing the activities and worked example of this section, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Exercise 2.6 Answer

Student's own answer.

Where next

Students need to extend their knowledge of the average velocity and instantaneous velocity for their daily activities.

Closure

To close the lesson, allow students to describe verbally the physical concept of instantaneous speed and velocity. Avoid the miss conception of instantaneous speed and velocity. Based on their idea, try to summarize the important concept.

Review questions Answer

1. Consider an object is moving between two point a and b. The initial position is (S_o) and final position (s) in the given interval of time Δt the average velocity expressed using this formula. $\vec{s} = \frac{s - s_o}{\Delta t}$.

2. The main difference between average speed and average velocity is that the first one is known to be a scalar quantity, whereas the latter one is a vector quantity. Moreover, the average speed can never be a negative. It is either positive or zero. Where as in the case of average velocity, it can either be a positive quantity or zero, sometimes even a negative quantity. The Average Speed of an object can be calculated by dividing the distance it has covered by the time it has taken to cover the latter. The average speed can help in determining the average rate that a particular body will take to cover the given distance.

3. Average speed and the magnitude of average velocity are different. There difference is shown in the following example. For example, a car moves 12 km north then turns and runs 16 km east in three hours.For this given example the average speed and the magnitude of average velocity are: $\Delta s = \sqrt{12^2 + 16^2} km = 20 km$ Average velocity($v\vec{a}v$): $v_{av} = \frac{\Delta s}{\Delta t} = \frac{20km}{3h} = 6.7 km/h$ The direction is in same to displacement. The average speed is total distance divided by total time Average speed(v_{av}):

$v_{av} = \frac{Total \ \ distance}{total \ \ time} = \frac{28km}{3h}$ = 9.3km/h. The average speed of the car is 9.3km/h, but its average velocity is 6.7km/h, in the direction of the displacement.

4. 20 m/s

5. Given: $\vec{v_{av}}$ = 48 km/h east

   $\vec{\Delta s}$ = 144 km east

   Required:

   Δt =?

   Solution:

   $\vec{V_{av}} = \frac{\vec{\Delta S}}{\Delta t}$

   $\Delta t = \frac{144km/h}{48km}$

   Δt = 3 h

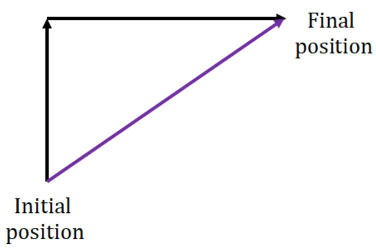


Figure 2.3 The Possible displacement.

6. Given:

   $\vec{S}_N$ = 12 km

   $\vec{S}_E$ = 16 km

   Required:

   $del\vec{t}as$ =? and $\vec{v_{av}}$ =?

   The possible displacement of an athlete run is shown in the Figure 2.3

   a)

$$\overrightarrow{\Delta S} = \sqrt{(S_N)^2 + (S_E)2}$$

$$\overrightarrow{\Delta S} = \sqrt{(12\ km)^2 + (16\ km)2}$$

$$\overrightarrow{\Delta S} = \ 20\ km;$$

$$tan\theta = \frac{opposite\ side}{adjcent\ side} = \frac{16\ km}{12\ km} = 1.33$$

$$\theta = \tan^{-1}(1.333)$$

$$\theta = 53^o$$

$\overrightarrow{\Delta S}$ = **20 km; 53^o north east**

b) Average velocity(V_{av})?

$$\vec{V_{av}} = \frac{\vec{\Delta S}}{\Delta t}$$

$$V_{av} = \frac{20km}{3h}$$

$V_{av} = 6.66km/h$; in the direction of the displacement

c) $V_{av} = \frac{Total\ distance\ traveled}{Total\ time\ taken}$

$$V_{av} = \frac{28km}{3h} = 9.3km$$

2.3 Acceleration

This section should fill approximately 3 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- explain acceleration in one dimension;
- distinguish between instantaneous acceleration and average acceleration;
- compute average acceleration.

lesson 4: Average acceleration

Starting Off

As usual, try to start the topic by asking students to remind the class about the topics that they learn in their previous lesson, i.e., about average acceleration.

Lesson Description

Introduction

Introduce the lesson using the response of the students of brain storming question.

Input and Model

First you need to start teaching the students using the previous lesson: average velocity and instantaneous velocity. Remind about the definition of acceleration they learn in grade 9. Now you are going explain about average acceleration. Activity 2.5 is about deceleration and negative acceleration. After the student give their feedback and remind them the difference between them. If somebody want to now accelerating body at specific time rather than average acceleration the instantaneous acceleration can describes the motion. so that encourage the student to correlate the concept to the next topic. Summarize lesson .

Guide Students through Their Practice

While student discuss in their group, you are expected to make all participate on the discussion and motivate all to gain knowledge in the topic. While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Exercise 2.7 Answer

Dear teacher, when velocity is constant, change in velocity is zero. So that acceleration is zero.deceleration always refers to acceleration in the direction opposite to the direction of the velocity. Deceleration always reduces speed. Negative acceleration, however, is acceleration in the negative direction in the chosen coordinate system. Use daily activity example, and try to elaborate for you students.

Exercise 2.8 Answer

Dear teacher, a zero velocity does not necessarily mean that the acceleration is zero, nor does a zero acceleration mean that the velocity is zero. (a)

For example, when you put your foot on the gas pedal of your car which is at rest, the velocity starts from zero but the acceleration is not zero since the velocity of the car changes. (How else could your car start forward if its velocity weren't changing-that is, accelerating?) (b) As you cruise along a straight highway at a constant velocity of 100 km/h, your acceleration is zero: $a = 0$, $v \neq 0$.

Where next

Encourage students to understand about average acceleration and apply in their daily life activity.

Closure

Give short summary on the physical meaning of average acceleration.

lesson 5: Instantaneous acceleration

Starting Off

As usual, try to start the topic by asking students to remind the class about the topics that they learn in their previous lesson, i.e., about acceleration.

Lesson Description

Introduction

Introduce the lesson using the response of the students of brain storming question.

Input and Model

First you need to start teaching the students using the previous lesson: average acceleration. Remind about average acceleration they learn in previous lesson. Now you are going explain instantaneous acceleration. An accelerating body value of acceleration at specific time is shown using instantaneous acceleration rather than average acceleration. The instantaneous acceleration describes the motion at the given instant of time and it is calculated for an interval of time Δt which includes the instant t, approaches as the interval of time Δt gets smaller and smaller, i.e., as

Δt approaches 0. As the time interval over which you are measuring the change in velocity gets smaller and smaller, the ratio of change in velocity to time interval as the time interval approach zero is **instantaneous acceleration**. Summarize lesson.

Guide Students through Their Practice

While student discuss in their group, you are expected to make all participate on the discussion and motivate all to gain knowledge in the topic. While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Exercise 2.9 Answer

Uniform motion

Activity 2.5 Answer

Deceleration always refers to acceleration in the direction opposite to the direction of the velocity. Deceleration always reduces speed. **Negative acceleration**, however, is acceleration in the negative direction in the chosen coordinate system.

Activity 2.6 Answer

Student's own answer.

Where next

Encourage students to appreciate the applications of the stress and strain in their daily life.

Closure

Give short summary on the physical meaning of acceleration, average acceleration and instantaneous acceleration.

Answer to review questions

1. - **S**imilarity:
     They are defined using the ratio of velocity to time. And for constant acceleration motion, the instantaneous acceleration does not vary in value with time and it is equal to average acceleration. Their units are m/s, km/h, mil/s etc

   - **D**eference: Average acceleration gives an information about the motion of the given body based on initial and final velocity. But considering the initial and final velocity of an object in motion, it is difficult to know about its motion in every second whether in motion or stop.
     Instantaneous acceleration varies with time. It is acceleration at any particular moment of time.

2. a) positive acceleration.
   b) negative acceleration and deceleration.

3. $V_o = 0$ $\vec{v} = 15$ m/s west t=1.8 s
   Required:
   $\vec{a_{av}}$ =?
   Solution:
   $a_{av} = \frac{V-V_o}{t} = \frac{15.0\frac{m}{s}-0}{1.8\ s}$ =8.33 m/s^2 west

4. $V_0 = 14\frac{m}{s}$ $V = 0\frac{m}{s}$ t=5.0 s
   Solution:
   $a_{av} = \frac{V-V_o}{t} = \frac{0-14\ m/s}{5\ \ s}$ = -2.8 m/s^2
   The negative in this case indicate the motion the car is deceleration.

2.4 Equations of motion with constant acceleration

1. *This section should fill approximately* **4 period** *of teaching time.*

At the end of this section, students will be able to:

- describe the nature of motion in a straight line;
- derive the equations of motion with constant acceleration;
- use appropriate equations of motion to solve motion-related problems.

Lesson 6: Equations of motion with constant acceleration

Starting Off

In the previous section, the students learned about acceleration. Remind the mathematical expression for average velocity and average acceleration. Then, based on your students' explanation, ask students from their daily experience to give an example of acceleration of constant motion.

Lesson Description

Introduction

Explain to students that they will be exploring about equation of constant acceleration.

Input and Model

Before teaching students about the equation of constant acceleration motion, provide a note for the students. Present the lesson. Help the student while doing activity 2.7. After their feedback. You can then proceed to the topic. Solve the problem related to the topic.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing review questions.

Exercise 2.10: Student's own answer.

Exercise 2.11: Velocity is constant.

Where is next

Encourage students to think about the equation of acceleration constant motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, Show all the equations of constant acceleration motion. Try to summarize the important concept.

Lesson 7: Examples of motion with constant acceleration

Starting Off

In the previous section, the students learned about the equations of uniformly accelerated motion.

Lesson Description

Introduction

Explain to students that they will be doing examples about equation of constant acceleration.

Input and Model

Solve the problem related to the topic.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by asking questions.

Where is next

Encourage students to think about the equation of acceleration constant motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, show all the equations of constant acceleration motion. Try to summarize the important concept.

Lesson 8: Free fall

Starting Off

In the previous section, the students learned about the equations of uniformly accelerated motion. Remind the mathematical expression for uniformly accelerated motion. Then, based on your students' explanation, ask students from their daily experience to give an example of free fall motion.

Lesson Description

Introduction

Explain to students that they will be exploring about free fall.

Input and Model

Before teaching students about the equation of free fall, provide a note for the students. Present the lesson. Help the student while doing activity 2.7 and 2.8. After their feedback. You can then proceed to the topic. Solve the problem related to the topic.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing review questions.

Activity 2.7 Answer Dear teacher, what are your student observations? Can you explain free fall in which air resistance is neglected? If air resistance neglected the two object reach the ground at the same time and similarly free fall.

Activity 2.8 Answer Dear teacher, While velocity of released body speed its acceleration is constant.

Where is next

Encourage students to think about the equation of acceleration constant motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, Show all the equations of constant acceleration motion. Try to summarize the important concept.

Answers to review questions

1. A freely falling body moves under the acceleration due to gravity and therefore, its acceleration is constant. So, it is **a uniformly accelerated motion.**

2. $V_o = 5.6m/s$ $a = 0.6m/s$ $t = 4.0$s required:

   S=?

   V=?

   Using equation of constant acceleration motion

   $S = V_o t + \frac{1}{2}at^2$

   $S = (5.6m/s)(4s) + \frac{1}{2}(0.6m/s^2)(4s^2)$

   $S = 27.2m$

   From $V = V_o + at$ you can get the value of V.

   $V = V_o + at$

   $V = 5.6m/s + (0.6m/s^2(4s)$

   $V = (5.6 + 2.4)\text{m/s}$

$V = 8.0$ m/s

3. $V_0 = 0$ $t = 8.0s$ g $= 9.8$ m/s^2 Required:
   v =? and h =?
   Solution:

a $V = V_0 + gt = 0 + \frac{9.8m}{s} \times 8.0s = 78.4m/s^2$

b $h = \frac{1}{2}gt^2 = 0.5 \times 9.8 \times 64 = 4.9 \times 64m = 313.6\ m$

2.5 Graphical representation of uniformly accelerated motion

*This section should fill approximately **3 periods** of teaching time.*

At the end of this section, students will be able to:

- draw graphs of position-time, velocity-time and acceleration-time graph;
- explain the concept of instantaneous velocity using displacement-time graphs;
- distinguish between instantaneous acceleration and average acceleration using graphical method.

Lesson 9: Position-time graph of uniformly accelerated motion

Starting Off

Start the lesson by asking the students about position -time for the uniform motion from their previous knowledge. Remind distance-time graph of uniform motion.

Lesson Description

Introduction

Introduce the topic: Position-time graph

Input and Model

Dear teacher, provide a short note. Before starting the lesson summarize the graph of uniform motion. And using the motion of the body, draw graphs of position-time graph for uniformly accelerated motion. Show the instantaneous velocity of uniformly accelerated motion using position-time graphs. You need to ask students to do and discuss exercises 2.12 and 2.13. Finally, explain about the slope of Position -time graphs.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask your own oral questions and may use review questions and:

1. What information can you obtain from a position - time graph?

   Exercise 2.12 Answer

   Student's own answer.

   Exercise 2.13 Answer

   Dear teacher, for constant acceleration motion, the s-t graph is a curve like quadratic function graph as shown in the Figure 2.4.

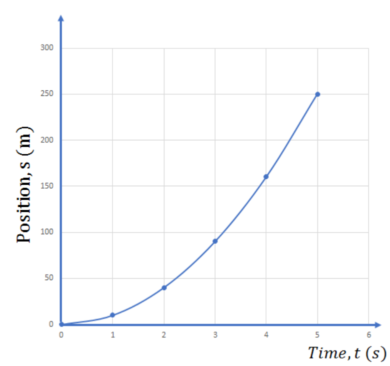


Figure 2.4 Position-time graph.

Where is next

Encourage students to think of about the importance of studying about graphical representation of uniformly accelerated motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concept for them.

Lesson 10: Velocity -time graph of uniformly accelerated motion

Starting Off

Start the lesson by asking the students about velocity -time for the graph for uniform motion from their previous knowledge. Remind velocity-time graph of uniform motion. Encourage your student and introduce the lesson.

Lesson Description

Introduction

Introduce the velocity-time graph for the uniformly accelerated motion.

Input and Model

Dear teacher, provide a short note. And using the motion of the body, draw graphs of velocity - time graph for uniformly accelerated motion. Show the instantaneous acceleration of uniformly accelerated motion using velocity-time graphs. You need to explain about slope and area under of the graph of velocity - time graph.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask your own oral questions and may use review questions and:

1. What information can you obtain from a velocity-time graph?
   Exercise 2.14 Answer
   Acceleration.

Where is next

Encourage students to think of about the importance of studying about graphical representation of uniformly accelerated motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concept for them.

Lesson 11: Acceleration - time graph of uniformly accelerated motion

Starting Off

Start the lesson by asking the students about acceleration - time for the graph for uniform motion from their previous knowledge. Remind acceleration - time graph of uniform motion. Encourage your student and introduce the lesson.

Lesson Description

Introduction

Introduce the acceleration - time graph for the uniformly accelerated motion.

Input and Model

Dear teacher, provide a short note. And using the motion of the body, draw graphs of acceleration - time graph for uniformly accelerated motion. Show the instantaneous acceleration and average acceleration of uniformly accelerated motion are similar using acceleration - time graphs. You need to explain about slope and area under of the graph of acceleration - time graph.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask your own oral questions and may use review questions

1. What information can you obtain from a acceleration - time graph?

Exercise 2.15 Answer

Student's own answer.

Exercise 2.16 Answer

In Uniform Velocity Motion a body will be moving with a constant (unchanging velocity moving in a particular direction and thus acceleration will be zero whereas in Uniform accelerated motion a body will move at constant acceleration and its velocity will keep changing with time at a constant) steady rate.

Activity 2.9 Answer

Based on the given table of the position of an object in the given time, the position- time graph becomes as shown in the Figure 2.5 2.6, the Velocity time graph can be drawn as shown in the 2.7. By taking any arbitrary point on position - time graph you can draw the tangential line and it is shown as in the figure 2.6. Based on the slope of the three tangential line shown in the figure Again from the slope of velocity - time graph values you can draw acceleration - time graph and it is shown as in the figure2.8

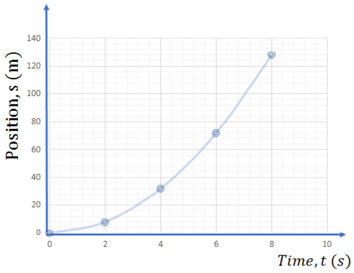


Figure 2.5 postion - time graph for the given table.

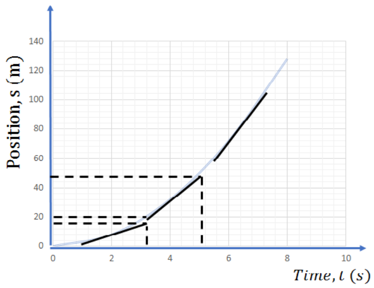


Figure 2.6 Tangent line for postion - time graph of the given table.

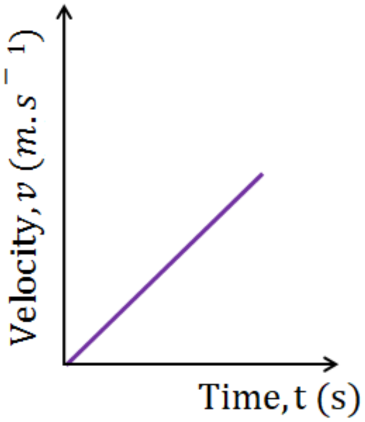
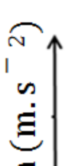


Figure 2.7 Velocity - time graph.



Where is next

Encourage students to think of about the importance of studying about graphical representation of uniformly accelerated motion in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concept for them.

Answers to review questions

1. From velocity-time graph, you can get the following information.
(a)Area under the curve of velocity-time graph is a displacement covered by an object in motion.
(b) The slope of the graph is an acceleration of an object in motion.

If the slope is positive, it is accelerated motion. if slope is negative, it is retarded motion and if slope is zero acceleration is zero.

2. In mathematics, slope is used to describe the steepness and direction of lines. By just looking at the graph of a line, you can learn some things about its slope. The slope of a line is the ratio of the amount that y increases as x increases. A velocity-time graph is the graph of the given motion shows how its velocity changes as it travels in a given time. The slope of the line on a velocity versus time graph is equal to the acceleration of the object. For example: if the object is moving with an acceleration of $+4m/s^2$ (i.e., changing its velocity by 4 m/s per second), then the slope of the line will be +4 m/s/s.

3. $S_1 = Area = 1/2(\Delta V \times \Delta t) = 20\ m \times 1.0\ s = 20 m/s$

$$S_2 = area = 1/2(\Delta V \times \Delta t) = 40\ m \times 2.0\ s = 40\ m/s$$

2.6 Relative velocity in one dimension

This section should fill approximately 1 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- describe the relative velocity in 1-D using frame of reference;
- calculate the relative velocity of two motions in a straight line.

Lesson 12: Relative velocity in one dimension

Starting Off

Start the lesson by asking the students about a frame of reference and what do mean by relative velocity in one dimension.

Lesson Description

Introduction

Starting from your student response, introduce the lesson and give direction that you are going to do. Try to encourage students to give responses to lesson.

Input and Model

Dear teacher, provide a short note. Remind your students about frame of reference. Consider observer on the ground and measuring the speed of the two object moving in similar direction and approaching each other, the relative velocity(v_{AB}) is $v_{AB} = v_A - v_B$ and $v_{AB} = v_A + v_B$ respectively. You need to ask students to do and discuss exercises 2.17. Finally, explain about the relative velocity in one dimension and elaborate using a daily life activities.

Guide Students through Their Practice

While doing the worked example, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask your own oral questions and may use review questions.

Where is next

Students are required to think of about the relative velocity in one dimension. And try to use in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding relative velocity in one dimension. Based on their idea, you need to summarize the important concept. Remind the formulas of relative velocity.

Answers to review questions

1. Speed of motorcycle $v_m = 120km/h$
   Speed of car $v_c = 90km/h$

The relative velocity is defined as, v_{mc} :
$v_m c = v_m \; - \; v_c \; = \; 120 km/h \; - \; 90 km/h$
$v_{mc} = 30 km/h$

2. Solution
   $V_a = 80 km/h$
   $V_t = 60 km/h$
   Required: $V_{at} = v_a + v_t$
   $V_{at} = 80 km/h + 60 km/h$
   $V_{at} = 140 km/h$

3. Time to reach the thief (t)?

$$\overrightarrow{V}_{tp} = \overrightarrow{V}_t - \overrightarrow{V}_p$$
$$\overrightarrow{V}_{tp} = 10 m/s - 9 m/s$$
$$\overrightarrow{V}_{tp} = 1 m/s$$

   This the relative velocity of the thief with respect to the police.

$$V_{tp} = \frac{\Delta s}{\Delta t}$$
$$1 m/s = \frac{100 m}{\Delta t}$$
$$\Delta t = 100 s$$

   So that, Answer: D

Lesson 13: Virtual experiments

Starting Off
Start the lesson by summarizing the important points of the unit.

Lesson Description
Introduction
Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they

already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Answers to end of unit questions and problems

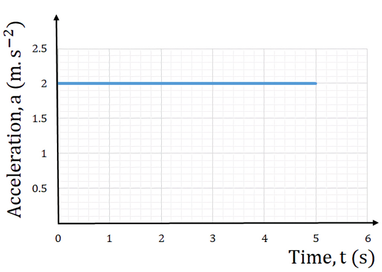


Figure 2.9

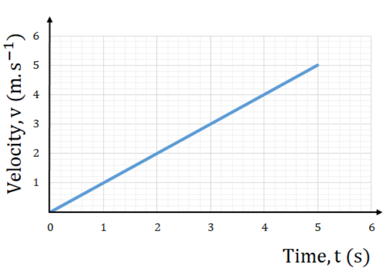


Figure 2.10

1. For constant acceleration motion, acceleration is constant and the interval of acceleration is **zero** in given interval of time. Figure 2.9 shows a-t graph.

2. Acceleration is the time rate of change of velocity, so that can be found from the slope of a tangent to the curve on a velocity-time graph in Figure 2.10. During each interval, the acceleration is **constant** as the straight line segments.

   Velocity increase or decrease with equal interval for equal interval of time.

3. $v_o = 0 \quad a = 2m/s^2 \quad v_1 = 20m/s \quad t_2 = 20s$
   $v_2 = 20m/s$ and constant
   $t_2 = 5s$

   Required: $S = ? \quad v_{av} = ?$
   From constant acceleration equation of motion, you have the following: $t_1 = \dfrac{v - v_o}{a} \quad t_1 = \dfrac{20/m/s - 0}{2m/s^2} \quad t_1 = 10s$
   $s_1 = 1/2at^2$
   $s_1 = 1/2(2m/s^2)(10s)^2 \quad s_1 = 100m$
   $s_2 = v_{av}t$
   $s_2 = (20m/s)(20s) \quad s_2 = 400m$
   $s_3 = v_o t + 1/2at^2$
   $s_3 = (20m/s)(5s) + 1/2(4m/s^2)(5)^2$
   $s_3 = (20m/s)(5s) + 1/2(-4m/s^2)(5)^2 \quad s_3 = 100m - 50m \quad s_3 = 50m$
   $t_{Total} = 35S$
   $s_{total} = s_1 + s_2 + s_3 \quad s_{total} = 400m + 100m + s_3$
   $s_{total} = 550m$
   b) $v_{av} = \dfrac{Total \;\; distance}{Total \text{ `}time}$
   $v_{av} = \dfrac{550m}{35s} \quad v_{av} = 15.7m/s$

   The average velocity during the motion is 15.7m/s

4. t= 15min= 0.25hr
   v_{av} = 12.5km/hr Required:
   Δs =? Solution

   $\Delta s = (v_{av})(t) = (12.5km/hr)(0.25hr) = 3.125$km

   So, he must have ridden 3.125km

5. $V_{0\,=}$ 44m/s

   v = 22m/s

t= 11se

Required:

$s=?$

Solution

S= $(\frac{V_o+V}{2})$t =$(\frac{44m/s+22m/s}{2})$11se = 363m

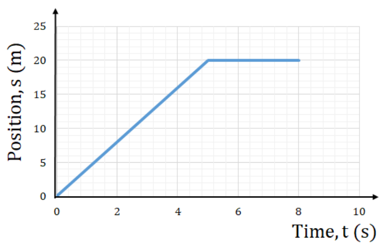


Figure 2.11 Position-time graph of the given data on the table.

6. $v_o = 22$m/s

   $v_f = 14$m/s

   S= 125m

   Required:

   $s=?$ and$a=?$ Solution:

   S= $(\frac{v_o+v}{2})$t

   125m = $(\frac{14m/s+22m/s}{2})$t

   125m = 18t

   t=6.9se

   a= $\frac{v_f-v_0}{t} = \frac{14m/s-22m/s}{6.9s}$ = -1.15m/s^2

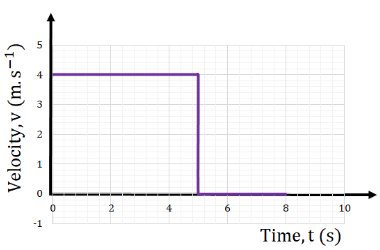


Figure 2.12 Velocity-time graph of the given data on the table.

7. a) Based on the given data table, the graph is shown in the Figure 2.12. b) The Area of velocity- time graph is the displacement. So that, $Area = s = \Delta v \times \Delta t = 4m/s \times 5s = 20m/s$

   c) The slope of v-t graph is represents acceleration,

   $Slope = a = \dfrac{\Delta v}{t - t_o} = 0m/s^2$ which shows it is moving with constant velocity and motion is uniform on straight line surface.

   d) Slope is zero.

8. **A**

9. From the graph on the text book, There is a three straight lines during three time intervals. you find the velocity during each time interval

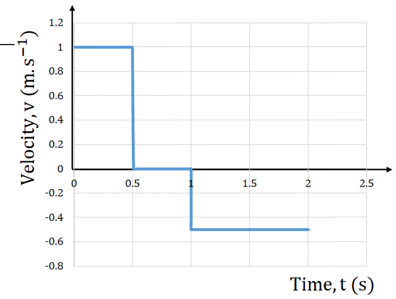


Figure 2.13

by taking the slope of the line using the grid. And it is shown as in the Figure 2.12.

Time interval 0s to 0.5s: v= $\frac{\Delta s}{\Delta t}$ = $\frac{0.5m-0m}{0.5s-0s}$ =1m/s

Time interval 0.5s to 1.0s: v = $\frac{\Delta s}{\Delta t}$ = $\frac{0.5m-0.5m}{10.s-0.5s}$ = 0.0m/s

Time interval 1.0s to 2.0s: v= $\frac{\Delta s}{\Delta t}$ = $\frac{0.0m-0.5m}{2.0s-1.0s}$ = -0.5m/s

Therefore, the graph of the given position- time graph is shown in figure 2.13.

10. Let the direction of Jet be x- direction. Also, let us denote jet with 'A' and hot air with 'B'. Here, v_A=1000km/h
    Required:
    v_B=?
    v_{BA}=-800km/h
    Now, v_{BA}=v_B-v_A
    v_B=v_A+v_{AB} =1000+(-800)=200km/h.
    The speed of the hot air with respect to ground is 200 km/h.

Unit 3

Elasticity and rigid body in static equilibrium

This unit should fill approximately 9 ***periods*** *of teaching time.*

At the end of this unit, students will be able to:

- state elasticity and plasticity of solid materials;
- demonstrate density and specific gravity of materials;
- apply the concept of stress and strain in their daily life activities;
- demonstrate tensile strain and stress using everyday materials;
- identify the physical conditions of static equilibrium;
- apply first and second condition of equilibrium for a body in static equilibrium.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and make them understand why they need to study it. If you could also put in some activities, it would surely add to their interest. So here are some suggestions about how you could teach the elasticity and static equilibrium of a rigid body to your students. Discussion and demonstration at which students observe and ask questions and apply physical concepts in their daily life.You have 7 periods at your disposal for teaching the section.

3.1 Elasticity and plasticity

*This section should fill approximately **1 period** of teaching time.*

At the end of this section, students will be able to:

- define elasticity and plasticity;
- explain the deformation of an object;
- list elastic and plastic from local materials.

Lesson 1: Elasticity and plasticity

Starting Off

Start the topic by asking students prior knowledge about materials stretching due to force is applied and use brainstorming question. Encourage your students.

Lesson Description

Introduction

Introduce about elasticity and plasticity

Input and Model

Explain the physical properties of the materials. Particularly elasticity and plasticity due to the force applied. To do this, try to encourage students to remember what they learnt in their middle school.

Based on the response that you received from the students, try to give short notes on the definition of elasticity and plasticity. Dear teacher, come up with a list of rubber bands. Stretch and release it in front of the students. What do you observe? Again, stretch it using great force; what do you observe? Based on this elaboration: elasticity, plasticity, deformation, elastic and plastic. the lesson. Help the students while they do activities in this section. This is crucial for shaping their knowledge if, in case, they have misconceptions on the concept.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section.

Activity 3.1:

Dear teacher, what are your student observations? When a small force is applied, the spring regains its original shape. But if a large force is applied, the spring is permanently deformed or fractured (broken)

Activity 3.2:

Dear teacher, an object is elastic when it comes back to its original size and shape when the load (applied force) is no longer present. The two materials mentioned should be elastic. While your student plays using these two materials, it continuously regains its shape and they safely play until it becomes permanently deformed.

Were next

You have to encourage the students to start thinking about elastic and plastic in their daily life activity.

Closure

To close the lesson, allow students to describe verbally what they understood about Elasticity and plasticity. After taking their idea, try to summarize the important concepts.

Answers to review questions

1. **Elasticity** is a physical property of a material in which material returns to its original shape after stretched using a force. A material that displays a high degree of elasticity are termed as "elastic."

2. For example: Nail wire, paper, and others. In general Some of the materials in which your class room constructed are plastic.

3. Elastic

4. (a) Force at A is down and force at B is up.

3.2 Density and Specific Gravity

This section should fill approximately 1 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- define density and specific gravity of an object;
- determine the density of an object;
- compare density of unknown object with a standard value.

Lesson 2: Density and specific gravity

Starting Off

Try to start the lesson through asking students prior knowledge about Density and specific gravity. And make clear the about the density of the material by introducing the misconception about the heavier and denser object. Help the student while they conduct activities.

Lesson Description

Introduction

Explain to students that they will be exploring about density and specific gravity.

Input and Model

Provide a note for the students about the definition of density and specific gravity. After you told them the definition of density and specific gravity, you need to ask them, question on the beginning of this section. A students have to have awareness about the word heavier, and denser. Use table 3.1 and discuss the difference between density and specific gravity of solid, liquid and gas. Then do the activity 3.3, I hope you student understand density of a material. For practical application of this physical concept of this section in their daily life do together activity 3.4. If you have a time to solve worked example you can if not give a hint and make it home work.

Guide Students through Their Practice

While doing the three activities of this section, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Activity 3.3 Answer: Dear teacher, what are your student observations? Brass has a greater density than water, whereas wood has a lower density than water due to this brass sink and wood block float.

Activity 3.4 Answer: Dear teacher, based on the instruction given on this activity, try to help your students and summarize the students' activity and results.

Where next

Students need to extend their knowledge of the density and specific gravity for differentiate a material daily used for better usage.

Closure

To close the lesson, allow students to describe verbally the definition of density, specific gravity, formulas of density. Based on their idea, and the physical concept of lesson try to summarize the important concept.

Review questions Answer

1. Given: ρ=1.29kg/m^3

$$V = l \times h \times w = (5.6)(3.6)(2.4)$$

$$required$$

$$m-?$$

$$m = (\rho)(V) = 62kg$$

2. Given:
   $\rho_{substance} = 2.8 \times 10_3 g/cm^3$
   $\rho_{water} = 1.0 \times 10^3 g/cm^3$
   $S.G = \frac{\rho_{substance}}{\rho_{water}}$
   $S.G = 2.8$

3. Given:
   $m_E = 5.98 \times 10^{24}$ kg, $R_E = 6.37 \times 10^6$ m,
   Required: ρ_E =?
   You can calculate the average density of the earth using the given radius and mass. The volume of the Earth is: $V_E = \frac{4}{3}\pi R_E^3 = 1.08 \times 10^{21} ms$ Thus, the average density of the Earth is:
   $\rho_E = \frac{m_E}{V_E}$
   $\rho_E = \frac{5.98\times10^{24} Kg}{1.08\times10^{21} m^3}$
   $\therefore \quad \rho_E = 5.54 \times 10^3 kg/m^3$
   $SG = \frac{\rho_E}{\rho_{water}}$
   $SG = \frac{5.54\times10^3 kg/m^3}{1\times10^3 kg/m^3}$
   $\therefore\ SG = 5.54$

3.3 Stress and Strain

This section should fill approximately ***1 period*** *of teaching time.*

At the end of this section, students will be able to:

- Define stress and strain;
- Apply the formula of stress and strain to solve problems;
- Apply physical concept of stress and strain for their daily life.
- List the deformation you observe in your surroundings.

Lesson 3: Stress and Strain

Starting Off

As usual, try to start the topic by asking students to remind the class about the topics that they learnt in their previous lesson, i.e., about density and specific gravity.

Lesson Description

Introduction

Introduce about the stress and strain.

Input and Model

First you need to start teaching the students using the previous lesson: Elasticity, when you apply the force on rubber band it stretched. Now you are going explain this phenomenon (Stretch, compress and etc) using Stress and strain. After you remind, now define stress and strain, give short note. Based on your explanation give oral question for discussion, motivate student for discussion in their group. Summarize their discussion and lesson.

Guide Students through Their Practice

While student discuss in their group, you are expected to make all participate on the discussion and motivate all to gain knowledge.

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below. **Exercise 3.1 Answer**
Student's own answer.

Exercise 3.1 Answer

Student's own answer.

Activity 3.5 Answer:

Student's own answer.

Where next

Encourage students to appreciate the applications of the stress and strain in their day to day life.

Closure

Give short summary about the stress and strain after you ask your students about the basic concepts regarding the strain and stress.

Answers to review questions

1. C

2. Given $L_o = 4.0m$ $m = 2.0kg$ $\Delta l = 0.24mm$

   $A = \pi r^2 = (3.14)((1 \times 10^{-3})m)^2$

   $A = 3.14 \times 10^{-6} m^2$

   $Tensile \quad stress = \frac{F}{A} = \frac{100N}{3.14 \times 10^-6m^2}$

   $Tensile \quad stress = 3.18 \times 10^7 N/m^2$

3. Given:

   Required:

$Tensile\ stress = ?$

$Tensile\ strain = ?$

$$Tensile\ Stress = \frac{F}{A} = \frac{mg}{A} = \frac{2.0kg \times 9.8\ N/kg}{3.14 \times 10^{-6} m^2} = 6.24 \times 10^6 N/m^2$$

$$Tensile\ Strain = \frac{\Delta L}{L_o} = \frac{0.24\ mm}{4.0m} = 6.0 \times 10^{-5}$$

3.4 Young's Modulus

This section should fill approximately 2 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- define young's modulus;
- apply the formula of young's modulus to solve problems;
- demonstrate the tensile strain and stress using young's modulus of everyday materials.

Lesson 4: Young's Modulus

Starting Off

In the previous section, the students learnt about stress and strain. Dear teacher, can you ask this question. Do you know the relation between stress and strain? Again, use the beginning section question on the text book. And start to introduce the lesson.

Lesson Description

Introduction

Introduce the lesson.

Input and Model

Before teaching about the young's modulus. Ask about physical concept of stress and strain. Introduce the ratio of the stress and strain in elastic range is young's modulus. Based on tensile stress, tensile strain explain young's modulus. You can then proceed to the graph of stress vs strain and discuss on it. Remind the student the young's modulus valid in elastic region, when force is applied on material it deformed.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Where next

Encourage students to think of about the practical applications of young's modulus in their day to day life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concept.

Lesson 5: Examples of Young's Modulus

Starting Off

In the previous section, the students learnt about Young's modulus.

Lesson Description

Introduction

Try to summarize what the students have learnt about the Young's modulus.

Input and Model

Do different examples that uses the applications of Young's modulus.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

Exercise 3.3 Answer

Dear teacher, for Young's modulus equation, if F, A and Y are constant. But the original length of the given material is large and small. What is your students' observation of the change in length of the material? Based on your student observation, summarize this activity.

Exercise 3.4 Answer

Given: $L_o = 1m$, $\Delta L = 3mm$, $D = 1mm$

$A = (\pi D^2)/4 = 7.85 \times 10^{-7} m^2$

$Y = 11 \times 10^{11} N/m^2$

Required $W = mg = ?$

Form Young's modulus formula you can get this the following expression.

$Y = (F_{\perp}/A)(L_o/\Delta L)$

$F = W = mg = Y(L_o/\Delta L)A = 11 \times 10^{11} N/m^2 (3 \times 10^{-3})(7.85 \times 10^{-7} m^2)$

$W = 2.59 \times 10^3$ N

Activity 3.6 Answer

Student's own answer.

Where next

Encourage students to think of about the practical applications of young's modulus in their day to day life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concept.

Answers to review questions

1. Answer: B

2. **a) Strain** is dimensionless quantity that gives the amount of deformation of an object or medium under stress

   b) elastic limit: refers to the maximum value of stress or force for which a material shows elastic behaviors. This is the highest limit before plastic deformation of the material takes place. After reaching its elastic limit, a material or metal becomes deformed with the exertion of more force or stress. Elastic limit marks the end of elastic behavior and the beginning of a material's plastic behavior. Creating stresses beyond the elastic limit results in fracture for most brittle materials.

   c) Young's modulus: For a stress is sufficiently low, the stress causes the deformation is directly proportional to the strain. The proportionality constant in this relation is called the elastic modulus (Young's modulus) and mathematically:

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

3. $m = 200kg$

   $L_o = 4m$

   $A = 2 \times 10^{-5} m^2$

   $Y = 8 \times 10^{10} N/m^2$

   $Required = ?$

   $DeltaL = ?$

   where Y is Young's modulus, A - cross section area, L length of the wire, F force, ΔL is increase in length.

   In our case force equals weight: F = mg.

   Therefore, stretch of the wire equals:

$$\Delta L = \frac{mg}{A}\frac{L}{Y}$$

$$\Delta L = \frac{(200kg)(9.8N/kg)(4m)}{(2\times10^{-5}m^2)(8\times10^{11}n/m^2)}$$

$$\Delta L = 4.9\times10^{-4}m$$

3.5 Static equilibrium

*This section should fill approximately 3 **period** of teaching time.*

At the end of this section, students will be able to:

- define static equilibrium of rigid body;
- state the first and second conditions of equilibrium;
- apply the first and second conditions for equilibrium to solve problems.

Lesson 6: Static equilibrium

Starting Off

Try to start the lesson by asking the students about effect of the force applied on an object and rigid body in balance. Encourage your students for the daily lesson.

Lesson Description

Introduction

Based on the students response, define the static equilibrium, Use the practical example to make practical and relate with their daily life experience of the students.

Input and Model Define static equilibrium, give an example of rigid body in balance. Fo example, When the students are sitting with respect the building on the chair. They are at rest. So that the net force ($\overrightarrow{F}_{net} = m\overrightarrow{a}$) and net torque ($\overrightarrow{\tau}_{net} = I\overrightarrow{\alpha}$) is zero but there are non-zero force action on them. Define net force and net torque responses and explain their meaning while it is zero and make clear about static equilibrium. While the students are doing exercise 3.3 and activity 3.5 encourage them and summarize.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below. List static equilibrium bodies in your surrounding.

Where next

Students are required to think of about the static equilibrium of the rigid body.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding the static equilibrium of the rigid body. Based on their idea, you need to summarize the important concept for them.

Lesson 7: First conditions of equilibrium

Starting Off

Start the lesson by asking the students about effect of the force applied on an object, newton's law of motion, net force from their knowledge. Remind them about inertial frame of reference. Take local material and explain about first condition of equilibrium.

Lesson Description

Introduction

Explain to students that they will be exploring about first condition of equilibrium.

Input and Model

Explain the topic based on material prepared. While the force is acting on the rigid body to say it is in static equilibrium the two condition of equilibrium should be satisfied: The first condition of equilibrium says:
$\sum \vec{F} = 0$ when:
$\sum \overrightarrow{F}_x = 0$
$\sum \overrightarrow{F}_y = 0$
Try to relate the lesson with student daily life activity.
Solve the problems that are related to first condition of equilibrium to elaborate the lesson.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below. Explain first condition of equilibrium.

Where next

Students are required to think of about the first condition of equilibrium and relate the physical definition in their daily life.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding the first condition equilibrium of the rigid body. Based on their idea, you need to summarize the important concept for them.

Lesson 8: Second condition of equilibrium

Starting Off

Try to start the lesson by asking the students about second condition of equilibrium of a rigid body in balance. Encourage your students for the daily lesson.

Lesson Description

Introduction

Based on the students response,explain second condition of equilibrium, Use the practical example to make practical and relate with their daily life experience of the students.

Input and Model

Define second condition of , give an example of rigid body in balance. Fo example, When the students are sitting with respect the building on the chair. They are at rest. So that the net force ($\vec{F}_{net} = m\vec{a}$) and net torque ($\vec{\tau}_{net} = I\vec{\alpha}$) is zero but there are non-zero force action on them. Define net force and net torque responses and explain their meaning while it is zero and make clear about static equilibrium. While the students are doing exercise 3.3 and activity 3.5 encourage them and summarize.The second condition of equilibrium :

$\tau_{net} = 0$. For example, the two children shown in Figure 3.3 are balanced on a seesaw of negligible mass. The first child has a mass of 26.0 kg and sits 1.60 m from the pivot and the second child has a mass of 32.0 kg .

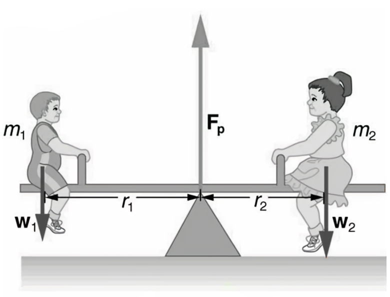


Figure 3.1

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below. Explain the second condition of equilibrium and give an example your surrounding.

Where next

Students are required to think of about the second condition of equilibrium of the rigid body, first condition of equilibrium and second condition of the equilibrium of an object. And try to apply it in their daily life activity.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding the static equilibrium of the rigid body. Based on their idea, you need to summarize the important concept for them.

Exercise 3.5

Student's own answer.

Exercise 3.6

Student's own answer.

Exercise 3.7 Answer

Solution

Given:

$\tau = 1800$ N.m $\quad r = 4.0$ m $\quad g = 9.8$N/kg Required $m = ?$

Her torque is her weight times the distance r between the diver and the left support post.

$\tau = F_{\perp}.r$

$$m = \frac{\tau}{(g)(r)} = \frac{1800N.m}{(9.8N/kg)(4m)} = 45.9kg$$

Activity 3.8

Students own answer.

Activity 3.9 Answer

Dear teacher, the mass of the meter stick is equal to the mass of the rock. Since the meter stick is uniform, its center of mass is at the 50 cm mark. You can treat the stick as though its entire mass is concentrated at the center of mass. The meter stick's mass at the 50 cm mark (25 cm from the pivot) balances the rock at the 0 mark (also 25 cm from the pivot), so the masses must be equal.

Answers to review questions

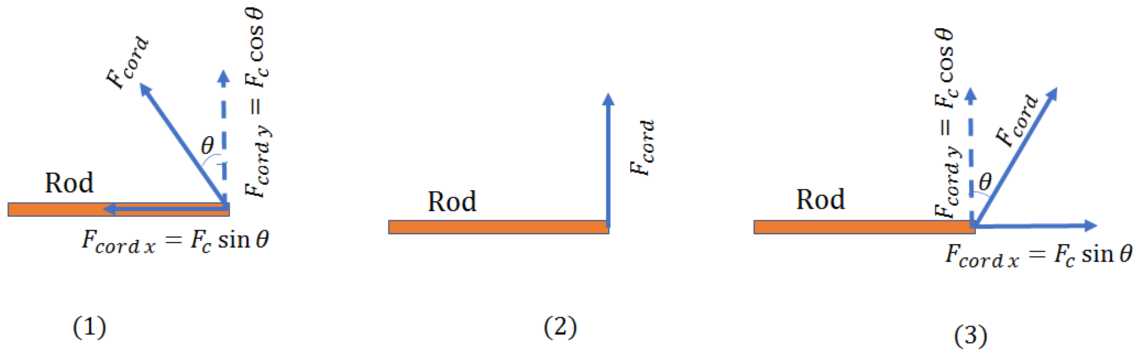


Figure 3.2 The forces and its components applied on the rods.

1. For example, your school building, reference books on the shelf and so on.

2. To answer this question, draw the free body diagram for the given three cord applying force on the rods and t is shown as in the Figure 3.2. As shown in the Figure 3.2: a) The vertical force of a cord shown in the Figure 3.2(2) is greater than the vertical force in (1)and (3). b) The horizontal force of a cord of (1) and (3) is grater than the horizontal force of a cord (2).

3. Answer:

   $m_{1=26\ kg}$

   $m_{2=32kg}$

   $r_1 = 1.60$ m

   Required

   $r_{2=?}$

   Solution

   $\tau = (r)(mg)$

   $\tau_{net=0}$

   $\tau_{1=\tau_2}$

   $(m_1 g)(r_1) = (m_2 g)(r_2)$

   $r2 = (1.60m)26.0kg/32.0kg = 1.30m$

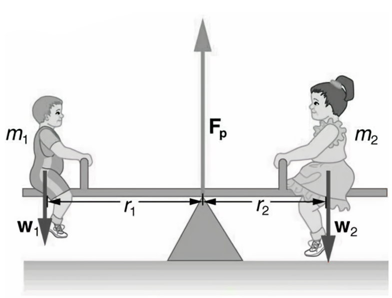


Figure 3.3 The two children in balance.

Entering known values gives

$f_p = m_1 g + m_{2g}$

$Fp = (26.0kg)(9.80m/s2) + (32.0kg)(9.80m/s2) = 568.4N.$

Lesson 9: Virtual experiment

Starting Off

Start the lesson by summarizing the important points of the unit.

Lesson Description

Introduction

Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Answers to end of unit questions and problems

1. Drawing free body diagram. Free body diagram of the given problem shown as in the Figure 3.4

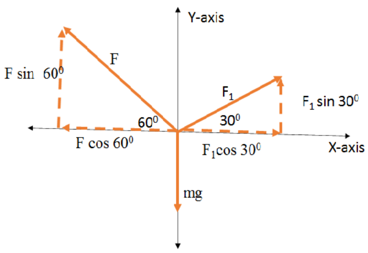


Figure 3.4 Free body diagram for the given cart in equilibrium.

The forces F and F_1 can be resolved.

$F_x = Fcos60^o = 0.5F$

$F_y = Fsin60^o = 0.86F$

$F_{1x} = F_1 cos30^o = (20N)(0.86) = 17.2N$

$F_{1y} = F_1 sin30^o = (20N)(0.5) = 10N$

Applying first condition pf equilibrium.

$\sum F_x = 0$

$F_{1x} + F_x = 17.2N + (-0.5F) = 0$

$0.5F = 17.2N$

$F = 34.4N$

$\sum F_y = 0$

$F_y + F_{1y} + (-W) = 0$

$Fsin60^o + F_1 sin30^o - W = 0$

$0.86F + 10N = W$

Substituting the $F = 34.4N$ you can get the magnitude of weight. $(0.86)(34.4N) + 10N = W$

$W = 39.6N$

2 a) Drawing a free body diagram. And it is Shown in the Figure 3.5

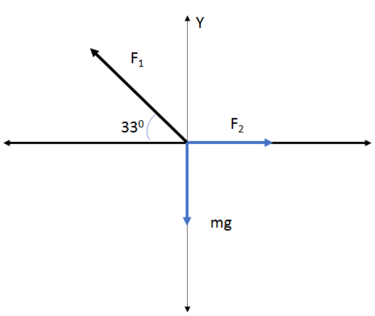


Figure 3.5 Free body diagram.

b)F_1 due have two components; $F_{1x} = F_1 cos330$ and$F_{1y} = F_1 sin330$ c) applying the first condition of equilibrium.

$\sum F_x = 0$

$F_2 - F_1 cos33^o = 0$

$F_2 = F_1 cos33^o$

$F_2 = 0.83F_1$

and $\sum F_y = 0$

$F_1 sin33^o - mg = 0$

$F_1 = \frac{mg}{sin33^o} = \frac{1862}{0.54} = 3448N$

For $F_2 = 0.83F_1$, If you substitute the value of $F_1 = 3448N$ you get the following result.

$F_2 = (0.83)(3448N) = 2861.9N$

3. Given:

$A = 0.1cm^2 = 1 \times 10^{-4}m^2$

$Y = 2 \times 10^{11}N/m^2$

While the forces is applied the length is doubled, so that: $\Delta L = L - L_o = 2L_o = L_o = L_o$ Using Young's Modulus (Y) formula:

$Y = (\frac{F}{A})(\frac{L_o}{\Delta L})$

$Y = (2 \times 10^{11N/m^2})(1 \times 10^{-4}m^2)$

$F = 2 \times 10^6 N$

4. D

While you apply equal forces on two different material and have similar cross sectional, the stress becomes the same. But they do have different strain.

5. A

a)Figure shows the two force at different place applied cause for net torque to be zero. b) applying second condition of the equilibrium:

$\tau_{net} = 0$

$\tau_{1=\tau_2}$

$(F)(r_1) = (W)(r_2)$

$(5N)(2cm) = (W)(5cm)$

$W = 2N$

6. Given:

$L_o = 4m$

$D = 1mm,\ A = \pi \times r^2 = (3.14)0.5 \times 10^{-6}m^2) = 7.85 \times 10^{-7}m^2$

$m = 4kg, Y = 1.378 \times 10^{10}N/m^2$

Required:

$\Delta L = (\frac{F}{A})(\frac{L_o}{Y}) = (\frac{(9.8)(16)}{(7.85)(1.378)(10^4)}) = 1.5mm$

$\therefore \Delta L = 1.5mm$

7. Given: $L_2 = 2L_1, D_1 = 2D_2, r_1 = 2r_2$

$F_1 = F_2 = mg,\ Y_2 = Y_1$

Required:
$\dfrac{\Delta L_1}{\Delta L_2}$ =?
Solution:

$$Y = \frac{(F)L_{01}}{(A_1)\Delta L_1} = \frac{(F)L_{02}}{A}\Delta L_2$$

From both side when F canceled and it becomes:

$$\frac{L_{01}}{A_1\frac{\Delta L_1}{den}} = \frac{L_{02}}{A_2\Delta L_2}$$

and substitute the given values,

$\frac{\Delta L_1}{\Delta L_2} = (\frac{1}{2})((\frac{r_2}{r_2})^2)$

$\frac{\Delta L_1}{\Delta L_2} = (\frac{1}{2})(\frac{1}{4}) = \frac{1}{8}$

$\therefore \frac{\Delta L_1}{\Delta L_2} = \frac{1}{8}$

Unit 4

Static and Current Electricity

This unit should fill approximately 21 periods of teaching time.

At the end of this unit, students will be able to:

- understand the basic properties of electric charge;
- produce charges in different charging process and explain the charging process;
- have a conceptual understanding of Coulomb's law and the factors which effect electrical force;
- understand the concept of an electric field qualitatively and quantitatively;
- understand the concept of electric field lines;
- understand the relationship among voltage, current and resistance;
- describe arrangement of resistors in a combination circuit and its practical implications;
- apply the concept of electricity in solving problems in their real-life situations.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and let them understand why they need to study it. If you could also put in some activities or games, it would surely add to their interest. So here are some suggestions about how you could teach the static and current electricity unit to your students. You have 20 periods at your disposal for teaching this unit.

4.1 Charges in Nature

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- distinguish between the two types of electric charge;
- show that the total electric charge in an isolated system is conserved;
- use conservation of charge to calculate quantities of charge transferred between objects.

Lesson 1: Charges in Nature

Starting Off

Start the topic by asking students prior knowledge about an electric charge through encouraging students to relate the concepts of an atom that they learnt in chemistry. This helps you to know the students level of understanding. This is crucial for shaping their knowledge if in case they have misconceptions on the concept.

Lesson Description

Introduction

Explain to students that they will be exploring about an electric charge. To do this, try to encourage students to remember what they learnt in their middle school about charges.

Input and Model

Based on the response that you received from the students, try to give short notes on the meaning of a charge. You have to also teach them about the two different types of charges: positive and negative. You can ask your students' questions like the one there in exercise 4.1 and 4.2 to help them to understand about a positively charged object or a negatively charged object.

Then tell them about the SI section of charge, i.e., about Coulomb. After that you can proceed to teaching about the law of conservation of charge. Encourage the students, after making them discuss in groups, to give you an example for conservation of charge.

Then after, you can teach them about the quantization of electric charge. You have to help students understand charge is always found to be an integral multiple of e. Students have to understand the existence of a charge in discrete packets rather than in continuous amount. Whenever a physical quantity possesses discrete values instead of continuous values, then the quantity is said to be quantized. You must ensure students understanding of this concept before asking students to do exercise 4.2. They can do the activity in groups or individually.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What are the different types of charges that exist in nature?
- When do we say a body is charged negatively?
- What does the laws of the charge says?

- What does it mean by quantization of a charge?

Where next

You have to encourage the students to start thinking about the importance of charges in our day to day life.

Closure

To close the lesson, allow students to describe verbally what they understood about electric charges. After taking their idea, try to summarize the important concepts behind charge.

Answers to review questions

1. Positive and negative charges.
2. A body becomes negatively charged if it gains electrons.
3. Electric charges can neither be created nor destroyed, but can be transferred from one material to the other.
4. Whenever a physical quantity possesses discrete values instead of continuous values, then the quantity is said to be quantized. Therefore, we say that charge is quantized.
5. Charge is a scalar quantity. Charge is transferrable; it transfers from one body to another. Like charges repel each other and unlike charges attract each other. Charge is always associated with mass.

4.2 Methods of Charging a Body

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- demonstrate different charging processes;
- explain the results of different charging processes.

Lesson 2: Methods of Charging a Body

Starting Off

Start the topic by activating students' prior knowledge about charging through asking questions. This helps you to gauge the students' level of understanding. This is crucial for shaping their knowledge if in case they have misconceptions on the concept.

Lesson Description

Introduction

Explain to the students that they will be exploring about methods of charging a body. To do this, try to encourage students to recall what they learnt in the previous lesson about a charge.

Input and Model

Based on the response that you have obtained from students', try to give short notes on the meaning of charging. You can then ask students to give you a response for activity 4.1 after discussing in groups.

Afterwards, try to proceed to discussing the three different methods of charging a body. Help students to differentiate between each types of charging methods. The figures indicated in their textbook help them to clearly understand each method of charging. So encourage them to study these diagrams in groups until they understand it. Finally, ask them to give you real life examples for each type of charging methods, discussing in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. State the three methods of charging a body.
2. Describe how objects (insulators) can be charged by contact or rubbing.

Where next

You have to encourage students to start thinking or study about the practical applications and importance of different types of charging.

Closure

To close the lesson, allow students to describe each of the three different types of charging methods. After taking their idea, try to summarize the important concepts regarding methods of charging.

Answers to review questions

1. Rubbing, induction and conduction are the three different types of charging a body.
2. Charging by conduction involves the contact of a charged object to a neutral object while charging by rubbing occurs when two different neutral materials are rubbed together or come in contact (touch) and electric charges are transferred from one object to the other.

4.3 The Electroscope

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the function of an electroscope;
- use simple electroscope to detect or identify charges;
- construct simple electroscope from locally available materials.

Lesson 3: The Electroscope

Starting Off

Start the topic by asking students about an electroscope if in case they know it. You can do this by asking questions like those found in exercise 4.4.

Lesson Description

Introduction

Explain to students that they will be exploring about electroscope.

Input and Model

As majority of the students might be new to this device, it is better if you start your discussion by showing an electroscope to the students. This enables you to show each parts of the electroscope one by one. If there is no electroscope in your school, try to make a simple electroscope using easily available materials. If you fail to do this, try to show a video about the functions of an electroscope. Towards the end of the class, you need to ask your students to make a simple electroscope using easily available materials. This is clearly indicated in Activity 4.2 of the Students' Book.

Then proceed to explaining about the purposes of an electroscope. Then try to demonstrate for the students the things that happen when a charged body is brought near the electroscope. Students have to understand the reasons behind the diverging and collapse of the leaves of the electroscope. After the demonstration, you have to create the opportunity for the students to discuss the phenomenon they observed.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What is an electroscope used for?
- How can you tell if an electroscope is charged?
- When do the leaves of an electroscope converge and diverge?

Where next

You have to encourage students to start thinking about the importance of studying about an electroscope.

Closure

To close the lesson, allow students to describe verbally what they understood about an electroscope. After taking their idea, try to summarize what an electroscope is and its function.

Answers to review questions

1. An electroscope is a device that is used to detect the sign and amount of charge on a body.
2. It can be known by looking at the leaves of the electroscope. The leaves collapse or diverge when a charged object is placed near the electroscope.

4.4 Electrical Discharge

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- express the nature of electric discharge;
- describe how lightning happens;
- list the importance of grounding.

Lesson 4: Electrical Discharge

Starting Off

You need to start the topic by tapping students' prior knowledge about how to charge a body that they learnt in previous lessons.

Lesson Description

Introduction

After taking the students response, inform the students that they will be exploring about electrical discharge. To do this, try to encourage students to answer the questions in exercise 4.5.

Input and Model

Based on the response that you get from the students, try to explain for the students the definition of discharging, i.e., about the process of removing electric charges from a charged body. Then proceed to teaching students about some phenomena like lighting that happens due to discharging. To do this, you can ask students to discuss in groups, answer the question in exercise 4.6.

After taking their response, you need to help students understand how lightning is formed. They can study carefully the diagram indicated in figure 4.5 so as to understand the formation of these phenomenon.

Then after, you can proceed to discussing mechanisms that are used to save people from lightning accident. You can start these by asking students to do activity 4.10. You need to inform them about grounding as one way of avoiding the damage caused by electric discharges. Also, try to ask the students about the experience of the people in their local area on the remedial mechanisms for a person that was stroke by lightning. This is the question that was indicated in Activity 4.4 of Students' Book.

You need to tell them that burying some part of the person under the ground is an example of grounding. You can also tell them the importance of lightning rods placed at the top of buildings and towers by relating it to grounding. You have to also discuss the measures that should be taken by an individual in order not to be struck by lightning. After discussing in groups, students can add ways that they know for protecting themselves from lightning. This is the question that is indicated in exercise 4.7.

In addition, you have to discuss the reason why people do not get struck while they are inside a car or in an airplane.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

- Explain the terms charging and discharging.
- Explain what causes the lightning that is associated with a thunderstorm.
- What is grounding and how is it useful?

Where next

You have to encourage the students to start thinking about the importance of electric discharge in their day to day life.

Closure

To close the lesson, allow students to describe verbally what they have understood about electric discharge. After taking their idea, try to summarize the important concepts behind an electric discharge and lightning phenomenon.

Answers to review questions

1. Charging is the process of adding a charge on a body while discharging is the process of removing electric charges from a charged body.

2. Lightning is a very large electrical discharge caused by induction.

3. The process of providing a pathway into the Earth to drain excess charge is called grounding.

4.5 Coulomb's Law of Electrostatics

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- state coulomb's laws of electrostatics;
- use coulomb's law to find the magnitude of electric force between two objects.

Lesson 5: Coulomb's Law of Electrostatics

Starting Off

Start the topic by activating students' prior knowledge about electric force through asking questions like those found in exercise 4.8 as the students were familiar with what an electric charge is. This helps you to gauge the students' level of understanding.

Lesson Description

Introduction

Explain to students that they will be exploring about electric force or Coulomb's law. To do this, try to take into consideration the students' answers to the questions in exercise 4.8.

Input and Model

Depending on the students' response, try to explain the factors on which the electrostatic force between two charges depends , i.e., the electrostatic force between the two charges is proportional to the product of the charges and is inversely proportional to the square of their distance apart.

From this, define the expression that is used to calculate the magnetic force between two charged particles. i.e.,

$$F = k\frac{q_1 q_2}{r^2}$$

Then discuss the unit of force, i.e., Newton and the direction of the electrostatic force between two charged particles. Make sure that students have understood that the electrostatic force of repulsion or attraction is along the line joining the two charges.

Thereafter, you need to encourage students to solve a problem as an example of the application of Coulomb's law. While the students are doing the task in groups, you have to assist them to come to the right answer.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions like:

- What are the factors on which an electrostatic force depends?
- How can we determine the direction of the electrostatic force between two charges? etc

Where next

Students have to extend the knowledge they obtained here in solving more advanced problems.

Closure

To close the lesson, allow students to describe verbally what they understood about Coulomb's law. After taking their idea, try to summarize the important concepts regarding Coulombs law.

Answers to review questions

1. The two charges attract each other.
2. $\boldsymbol{F} = k\frac{q_1 q_2}{r^2} = \frac{(9\times10^9 Nm^2/C^2)(2\times10^{-6}C)(-4\times10^{-3}C)}{(0.3m)^2} = -800N$

The minus sign shows that the force is an attraction force.

4.6 The Electric Field

This section should fill approximately 2 periods of teaching time.

At the end of this section, students will be able to:

- state the meaning of an electric field;
- distinguish the elements that determine the strength of the electric field strength at a given location;
- show electric field lines diagrammatically;
- calculate the strength of an electric field.

Lesson 6: The Electric Field

Starting Off

Start the topic by activating the students' prior knowledge about electric field through asking questions like those found in exercise 4.9. This helps you to gauge the students' level of understanding. This is crucial for shaping their knowledge if in case they have misconceptions on the concept.

Lesson Description

Introduction

Explain to the students that they will be exploring about electric field. You can use a football field as an analogy for teaching about it.

Input and Model

Depending on the response that you receive from the students, try to give short notes on the meaning of an electric field. For visualizing an electric field, you can use electric field lines. You have to inform the students to study the properties of electric field lines that are indicated in their textbook. They can study these properties by discussing in groups. Students have to also study carefully the electric field line patterns indicated in Figure 4.7 and 4.8.

Furthermore, you have to define the expression that is used to solve the value for an electric field strength, i.e.,

$$E = \frac{F}{q}$$

You can give an example for the students to do as an application of this formula.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions like those listed below:

- What is an electric field?
- What are electric field lines?
- Calculate the magnitude of the electric field 2.00 m from a point charge of 5.00 mC.

Where next

Students have to start thinking about the importance of electric field in their day to day lives.

Closure

To close the lesson, allow students to describe verbally what they have understood about electric field. After taking their idea, try to summarize the important concepts behind an electric field.

Lesson 7: The Electric Field continued

Starting Off

Start the topic by asking students to recall the important points that they learnt in the last session, i.e., about the definition of an electric field, electric field lines, the expression relating electric field strength, electric force and charge.

Lesson Description

Introduction

Tell the students that they are going to continue discussing electric field, i.e., an electric field strength at a point **p** a distance r from a charge.

Input and Model

In the previous section, you defined an expression for **E**, i.e.,

$$E = \frac{F}{q}$$

Starting from this expression, you need to also derive the expression for electric field strength at a point P a distance r from a charge

$$\boldsymbol{E} = \frac{\boldsymbol{F}}{q_o} = \frac{k\frac{q_o q}{r^2}}{q_o} = k\frac{q}{r^2}$$

But before deriving this equation, you need to define a test charge in a way that the students easily understand. In addition to this, you have to give the correct answer or feedback for exercise 4.10 after receiving their response from the groups.

You have to encourage the students as well to do an example in groups as an application of the expressions for the electric field strength.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What is the magnitude and direction of the force exerted on a 3.50 μC charge by a 250 N/C electric field that points due east?

Where next

Students have to start thinking about the applications of these formulae in other problems, for instance, the electric field of a number of point charges.

Closure

Before closing the session, give chance for the students to describe the important points that they got from the lesson. After taking their ideas, try to summarize the important concepts related to the electric field and the equations that are used to calculate the electric field strength.

Answers to review questions

1. Electric field lines are imaginary lines that are used to describe an electric field.
2. $F = Eq = 250N/C \times 3.5 \times 10^{-6}C = 8.75 \times 10^{-4}C$
3. $E = k\frac{q}{r^2} = 9 \times 10^9 Nm^2/C^2 \frac{5.0\times10^{-3}C}{(2.0\ m)^2} \approx 11.25 \times 10^6 N/C$

4.7 Electric circuits

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- define what electric circuit is;
- describe the components of a simple circuit;
- sketch electric circuit diagram.

Lesson 8: Electric circuits

Starting Off

Try to start the topic from students' everyday experiences. That is by asking brainstorming questions like those found at the start of the sub topic, i.e., activity 4.5.

Lesson Description

Introduction

Explain to students that they will be exploring about electric circuit.

Input and Model

Based on the responses that you get from the students, you can explain to the students about an electric circuit, through the use of different mechanisms. You can encourage the students to closely look at the figure indicated in Figure 4.10. This helps students to have a clear picture of what an electric circuit is.

Students have to understand the constituent parts of an electric circuit like a source of potential difference and electrical energy, such as a battery, and a load like a bulb or group of bulbs. You also need to help them understand the meaning of important terms like a load and circuit diagram.

You have to encourage students to answer the questions in activity 4.5 after they have discussion in groups. Based on the response that you receive from the students, try to explain to them the reason why the bulb does not glow. They can clearly understand this difference by closely watching

Figure 4.11. By showing the differences between closed and open circuit, you can help your students to understand the concept of an electric circuit.

You have to also encourage students to tell you devices that work using an electric circuit.

Teacher, you have to encourage the students to study the schematic diagram symbols of the different components of a circuit so that they can understand what it means when they look it in in circuits.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.,

- What does an electric circuit mean?
- What is the name for the unbroken path that current follows?
- What are the differences between open and closed electric circuits?

Where next

You have to encourage the students to start thinking about the importance of electric circuits in every part of the electrical appliances that they use in their home.

Closure

To close the lesson, allow students to describe verbally what they have understood about magnet. After taking their idea, try to summarize the important concepts behind a magnet.

Answers to review questions

1. An electric circuit is a path through which charges can flow.

2. Open circuit

3. In an open circuit, there is no charge flow and thus there is no current. On the other hand, in closed circuit, charge flows through the circuit and thus there is a current.

4.8 Current, Voltage and Ohm's law

This section should fill approximately 4 periods of teaching time.

At the end of this section, students will be able to:

- define current, voltage and resistance;
- state Ohm's law;
- calculate current and solve problems involving Ohm's law.

Lesson 9: Current

Starting Off

Start the topic by probing students' prior knowledge about an electric charge that flows through a circuit as they got some insight about it while discussing electric circuit. This helps you to assess the students' level of understanding.

Lesson Description

Introduction

Explain to students that they will be exploring first about an electric current. To do this, try to encourage students to recall what they learnt in their previous lesson.

Input and Model

Through taking the water circuit that the students are familiar with as an analogy, you can move to your discussions about an electric circuit. Thus, tell the students to discuss in groups and answer the questions in exercise 4.11. Based on the answers that you got from the students, try to give short notes on the meaning of an electric current flowing through a circuit. You have to inform them about the conventional direction of current, i.e., the direction of flow of positive charges.

After this you can proceed to defining the expression which enables us to calculate an electric current, i.e.,

$$I = \frac{\Delta Q}{\Delta t}$$

The students have to have awareness about the unit of current, the ampere and the instrument that is used to measure current, i.e., the ammeter. Try to give the students a chance to understand the concept of an electric current by relating it with the flow of water. They can do this by discussing in groups.

As an application of the above formula, you need to give one example like the one found in the Students' Book that they can do in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What is the term for the flow of electric charge per section time?
- What is the direction of an electric current? etc

Where next

Students have to extend the knowledge they obtained from this section into other scenarios.

Closure

To close the lesson, allow students to describe verbally what they understood about an electric current. After taking their idea, try to summarize the important concepts behind an electric current.

Lesson 10: Voltage

Starting Off

Start the topic by probing students' prior knowledge about voltage or potential difference through asking questions like "what makes the charges to flow in an electric circuit?". This is the question that is indicated in exercise 4.13. This helps you to assess the students' preexisting knowledge about the topic.

Lesson Description

Introduction

Explain to students that they will be exploring about voltage or potential difference.

Input and Model

After taking students' response to the activity given to them, try to give them a chance to understand the concept of potential difference by relating it with the flow of water as an analogy. They can do this by discussing in groups. Based on the discussion you made with the water circuit analogy, try to give short notes on what a voltage or potential difference means.

After this you can proceed to defining the expression which enables us to calculate potential difference between two points, i.e.,

$$\Delta V = \frac{W}{Q}$$

The students have to have awareness about the unit of potential difference, the ampere and the instrument that is used to measure current, i.e., the voltmeter.

You have to use real life examples for teaching the potential difference, for instance the reason why a bird is not harmed when sitting on an electric wire. This is a question that is indicated in exercise 4.14. You can use the conceptual change text for teaching this concept.

Try to ask the students, to extend the knowledge they got here to other real life situations, for instance you can consider the situation indicated in Activity 4.6.

As an application of the above formula, you need to give one example like the one found in the Students' Book that they can do in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions like:

- What is a potential difference?
- Why is the bird not caught when sitting in an electric wire? etc

Where next

Students have to be encouraged to use the concept that they got here to other real life scenarios like the one in Activity 4.6.

Closure

To close the lesson, allow students to describe verbally what they have understood about potential difference. After taking their idea, try to summarize the important concepts behind voltage or potential difference.

Lesson 11: Ohm's law

Starting Off

Start the topic by probing students' prior knowledge about the topic of investigation if in case they have some insights through asking questions like those found in exercise 4.15. This helps you to assess the students' prior knowledge about the topic of investigation.

Lesson Description

Introduction

Explain to the students that they will be exploring about Ohm's law.

Input and Model

Based on the answers that you get from the students to the questions exercise 4.15, try to give short notes on the relationship that exists between the current *I*, flowing in a metallic wire and the potential difference across its terminals. This is usually known as Ohm's law.

From the relationship between voltage and current, try to derive the expression for resistance R, i.e., $\frac{\Delta V}{I} = constant = R$

After this try to proceed to defining what is resistance including its unit, Ohm. You can use real life examples like the water in a pipe so as to make the students understand the concept very well. This is similar with question that indicated in exercise 4.15. You have to help the students to understand this analogy.

In order to check the learners understanding about the relationship between voltage and current, ask the students to come up with their response of exercise 4.16 after discussing in groups. If you are sure that students understood the relationship between these variables, try to discuss this relationship graphically. You have to help students to differentiate between Ohmic and non ohmic materials.

As an application of the above formula, you need to give one example as a classwork like the one found in the Students' Book that they can do in groups. You have to also give a home work for the students.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What is Ohm's law?
- Use Ohm's law to calculate values for potential difference, current and resistance in theoretical circuits and a range of relevant applications.

Where next

Students need to extend the knowledge they got here in electrical circuits.

Closure

To close the lesson, allow students to describe verbally what they understood about Ohm's law. After taking their idea, try to summarize the important concepts behind Ohm's law for them.

Lesson 12: Resistance of a conductor

Starting Off

Start the topic by asking students whether they did the assignment that was given to them last session. You have to also ask students about the topic that they learnt in last session, i.e., about Ohm's law.

Lesson Description

Introduction

Explain to students that they will be exploring about resistivity.

Input and Model

You can start this lesson through teaching students about the motion of charges inside a conductor. You can then proceed to discussing the factors through which the resistance of a conductor depends, i.e., you have to tell them that the resistance is proportional to the conductor's length, and inversely proportional to its cross sectional area *A*.

From this relationship, derive the expression for resistance of a conductor, i.e., $R = \frac{l}{A}$.

Try to define what resistivity means including its section in the above expression. In order to check whether the students understood these concept or not, try to ask students to give you a response for exercise 4.16 after they discussed in groups.

Then after proceed to the discussion of the differences between resistivity and conductivity. Students need to understand that good electric conductors have very low resistivities and Good insulators have very high resistivities.

As an application of the above formula, you need to give one example as a classwork like the one found in the Students' Book that they can do in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

- What is resistivity?
- What are the factors through which the resistivity of a conductor depends?

Where next

Students need to extend the knowledge they got here in electrical circuits.

Closure

To close the lesson, allow students to describe verbally what they have understood about resistivity. After taking their idea, try to summarize the important concepts behind the factors on which the resistance of a conductor depends.

Answers to review questions

1. Electric current
2. Ohm's law
3. One volt is the potential difference between two points in a current carrying conductor when 1 Joule of work is done to move a charge of 1 coulomb from one point to the other.
4. The resistance of a conductor depends on the length, cross sectional area and nature of the conductor.
5. Current flow more easily through a thick wire and hardly through a thin wire as the resistance is indirectly proportional to the cross-sectional area of a wire.
6. The amount of current flowing through the electrical component is reduced by half.

4.9 Combination of Resistors in a Circuit

This section should fill approximately 3 periods of teaching time.

At the end of this section, students will be able to:

- draw a diagram that shows series and parallel connection of resistors;
- describe what happens to the current and potential difference when the resistors are connected in series and in parallel;
- calculate the equivalent resistance for a circuit of resistors in series, or in parallel;
- calculate the current in and potential difference across resistors connected in series and in parallel.

Lesson 13: Resistors in series

Starting Off

Start the topic by activating students' prior knowledge about Ohm's law as well as combination of resistors. This helps you to assess the students' level of understanding. This is crucial for shaping their knowledge if in case they have misconceptions on the concept.

Lesson Description

Introduction

Explain to the students that they will be exploring about resistors in series. To do this, ask the students: 'What if you wanted to watch TV and had to turn on all the lights, a refrigerator, and every other electrical appliance in the house to do so?'

Input and Model

Based on the response that you get from the students, tell them that it is an example for a series combination of circuits. Then, try to take a response for exercise 4.19 after they discuss in groups. You can then continue discussing what a series circuit is, i.e., a series circuit is a circuit that has only one path for the electric current to follow. Students have to closely watch and understand Figure 4.16 as it helps them to understand what a series circuit is all about. You can explain this concept to the students by taking the example there in their textbook about string of lights. You can also explain the scenario by taking students' answer to the questions in exercise 4.20.

Following this, you can proceed to giving feedback to exercise 4.21 after checking students' answers. You need to explain why the current remains the same throughout a circuit that is connected in series. Furthermore, you have to explain for the students why the total potential difference is the sum of the potential differences across each of the resistors.

On the other hand, through the use of Ohm's law, try to encourage the students to derive the expression for equivalent resistance.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

- How many paths does a series circuit have?
- What happens to the current when the resistors are combined in series?
- What happens to the potential difference when resistors are combined in series?

Where next

The students should have to extend the knowledge that they obtained here in solving different problems.

Closure

To close the lesson, allow students to describe verbally what they have understood about a series combination of resistors. After taking their idea, try to summarize the important concepts behind series combination of resistors.

Lesson 14: Resistors in parallel

Starting Off

Start the topic by activating the students' prior knowledge about series combination of resistors. This helps you to assess the students' level of understanding.

Lesson Description

Introduction

Explain to the students that they will be exploring about resistors in parallel. To do this, try to ask students to answer the questions in exercise 4.20.

Input and Model

Based on the response that you have received from the students, tell them that a wiring arrangement that provides alternative pathways for the movement of a charge is a parallel arrangement. Students have to closely watch and understand Figure 4.17 as it helps them to understand what a parallel circuit is all about. Students need to have awareness about the existence of more than one path in a parallel combination. You can take the case of a decorative light as an example for this. The bulbs of the decorative light set that we use in our home are arranged in parallel with each other. Thus, if one path is broken, electrons continue to flow through the other paths.

Then, try to take students' response to exercise 4.23 after they discuss in groups. Having corrected the answers you get from the students, you can then continue discussing why the total current in a parallel combination is the sum of the currents each of the resistors. Furthermore, you have to explain for the students why the total potential difference is the same throughout a circuit that is connected in parallel.

As before, through the use of Ohm's law, try to encourage students to derive the expression for equivalent resistance.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

- How many paths does a parallel circuit have?
- What happens to the current when the resistors are combined in parallel?
- What happens to the potential difference when resistors are combined in parallel?

Where next

The students should have to extend the knowledge that they obtained here in solving different problems.

Closure

To close the lesson, allow students to describe verbally what they have understood about a parallel combination of resistors. After taking their idea, try to summarize the important concepts behind parallel combination of resistors.

Lesson 15: Examples on resistors combination

Starting Off

Start the topic by activating students' prior knowledge about series and parallel combination of resistors through asking different questions. This helps them to recall the important points of the previous two lessons.

Lesson Description

Introduction

Explain to the students that they will be going to solve some examples of the series and parallel combination of resistors. To do this, try to encourage students to recall what they learnt in the last two sessions.

Input and Model

Start the lesson by reminding the students the expressions that you derived in the last two sections for each of the series and parallel combination of resistors. After that try to proceed to solving one of the examples (together with the students) done on the Student's Text Book or any other similar example.

While solving the problem, it is good if you use the Minnesota Assessment of Problem Solving Skill rubric rather than using the old strategy. The rubric identifies five general problem-solving processes and defines the criteria to attain a score in each: organizing problem information into a Useful Description, selecting appropriate principles (Physics Approach), applying those principles to the specific conditions in the problem (Specific Application of Physics), using Mathematical Procedures appropriately, and displaying evidence of an organized reasoning pattern (Logical Progression).

After doing the first example, try to give a similar example as a class work for the students to do in the class. They can do the class work in groups. You need to give them homework, too.

Guide Students through Their Practice

While solving the problems, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. From a drawing provided a) three series and b) three parallel connections of resistors. Calculate the equivalent resistance of the combination.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts about series and parallel combination of resistors.

Answers to review questions

1. Parallel circuit

2. (a) $R_{eq} = R_1 + R_2 + R_3 = 4.0\Omega + 8.0\Omega + 12.0\Omega = 24.0\Omega$

   (b) $I = \frac{\Delta V}{R_{eq}} = \frac{24V}{24\Omega} = 1.0A$

   (c) $I = I_1 = I_2 = I_3 = 1.0A$

3. The equivalent resistance of n resistors connected in parallel is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} = \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

In our problem, the resulting resistance of the 5 pieces connected in parallel is $\frac{1}{R_{eq}} = 200\Omega$ and since the 5 pieces are identical, their resistance R is identical, so we can rewrite as

$$\frac{1}{R_{eq}} = \frac{1}{2} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{5}{R}$$

From which we find $R = 5 \times 2\Omega = 10\Omega$ So, each piece of wire has a resistance of 10Ω. Before the wire was cut, the five pieces were connected as they were in series. The equivalent resistance of a series of n resistors is given by $R_{eq} = R + R + R + R + R = 5R = 5 \times 10 = 50\Omega$. So if we apply it in our case, we have therefore, the resistance of the original wire was 50Ω.

4. If headlights were wired in series, when one light goes out, both would go out. Wiring headlights in parallel means that when one bulb goes out, the other stays lit.

4.10 Voltmeter and Ammeter Connection in a Circuit

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- list the devices used for measuring current and voltage;
- use voltmeter and ammeter to measure the voltage and current in an electric circuit, respectively;
- explain why an ammeter is connected in series and voltmeter is connected in parallel.

Lesson 16: Voltmeter and Ammeter Connection in a Circuit

Starting Off

You have to start this section by reminding students about the use of the devices: Voltmeter and Ammeter as they learnt in the previous sections. You can do this through asking questions.

Lesson Description

Introduction

This subtopic is about the connection of ammeters and voltmeters in a circuit. To teach students about this, try to encourage students to tell the things that they remember.

Input and Model

Try to start the topic by discussing the analog and digital meters. Then proceed to your discussion of a voltmeter connection in a circuit as they learnt about the use of this device in the previous sections.

Students are familiar with a voltmeter as they learnt about its use in the previous section. If possible, try to show the actual device to the students. But before discussing the reason behind the parallel connection of voltmeter, try to take students responses through asking questions. After taking their response, you can guide the students towards the correct reasoning for the parallel connection of voltmeter in a circuit. You also need to tell them the thing that happens on the voltmeter when it is connected in series.

Then, you can do the same to teach about an ammeter. As before, if possible, try to show the actual device to the students. But before discussing the reason behind the series connection of ammeter, try to check students' answers by asking questions in exercise. Afterwards, you can give feedback to shape the students' reasoning for the series connection of ammeter in a circuit. You need to also tell them the thing that happens on the ammeter when it is connected in parallel.

Furthermore, it is also good if you teach the students about multimeter, an instrument that can measure multiple electrical properties like voltage, current, or resistance. Again it is better if you teach the students by showing the actual device.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. Explain why a voltmeter is placed in parallel with a resistor.
2. Explain why an ammeter is placed in series with a resistor.
3. What will happen if I connect an ammeter in parallel and a voltmeter in a series circuit?

Where next

Students have to use the theoretical knowledge that they get from this section into practical applications, for instance while doing the project work that is there at the end of this section.

Closure

To close the lesson, allow students to describe verbally what they understood about ammeter and voltmeter connection in a circuit. After taking their idea, try to summarize the important concepts about why an ammeter is connected in series and voltmeter in parallel.

Answers to review questions

1. A parallel connection is used because objects in parallel experience the same potential difference.
2. A series connection is used because objects in series have the same current passing through them.
3. If an ammeter is connected in parallel, it would draw most of the current and would get damaged. Hence, it must be connected in series. If a voltmeter is connected in series, it would increase the equivalence resistance of the circuit to nearly infinite and no current would flow through the circuit. Hence, it should be connected in parallel.

4. By accidentally leaving the multimeter in voltmeter mode, you would not measure current (the particles that carry charge in the circuit) but rather the voltage (potential electromotive force) of the circuit. The voltmeter would apply a voltage to a resistance.

4.11 Electrical Safety in General and Local context

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- state the safety measures to be taken to protect us from electrical accidents or shocks.

Lesson 17: Electrical Safety in General and Local context

Starting Off

Start the topic by activating students' prior knowledge about safety issues related to electric through asking questions like those found in exercise 4.24. This helps you to assess the students' level of understanding regarding safety issues.

Lesson Description

Introduction

Explain to the students that they will be exploring about electrical safety in the general and local contexts.

Input and Model

Brainstorm the dangers of electrical power lines in general, the variations of main supply and related safety precautions as applied to the local context.

Based on the response that you get from the students, try to give short notes on how an individual experiences an electric shock. Students have to have awareness why a person can be electrocuted by touching a live wire while in contact with ground. You need to tell them as such a hazard is often due to frayed insulation that exposes the conducting wire. The ground contact might be made by touching a water pipe (which is normally at ground potential) or by standing on the ground with wet feet because impure water is a good conductor. Tell them to avoid such situations at all costs.

Then proceed to discussing the factors that determine the damage caused to a human body by an electric shock. This is indicated in exercise 4.25. Taking the students' answers to the questions into consideration, you need to inform them that the magnitude of the current, the length of time it acts, and the part of the body through which it passes are the factors that determine the degree of damage to the body.

You need to teach the students about the additional safety measures like case ground. Help the students understand this concept through reading and closely looking at the diagrams indicated in Figure 4.24. Furthermore, try to create awareness among students about special power outlets called ground-fault interrupters (GFIs) which are now being used in kitchens, bathrooms, basements, and other hazardous areas of new houses.

Also, try to also encourage students to read in groups, and understand the tips used to present electrical accident or shocks that are listed in the Students' Text Book.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions similar to those given at the end of this section like

1. the things that determine the damage caused to the human body by an electric shock.

Where next

In their everyday life, the students should have sufficient knowledge to protect themselves and others from electrical shocks or accidents.

Closure

To close the lesson, allow students to describe verbally what they have understood about electrical safety. After taking their idea, try to summarize the important concepts related electrical safety.

Answers to review questions

1. Many variables determine what injuries may occur, if any. These variables include the type of current (AC or DC), the amount of current (determined by the voltage of the source and the resistance of the tissues involved), and the pathway the electricity takes through the body.

2. We are often advised not to flick electric switches with wet hands; dry your hand first. Not only might water drip into the switch and cause a shock, but also the resistance of your body is lower when you are wet.

4.12 Electric Projects

This section should fill approximately 3 periods of teaching time.

At the end of this section, students will be able to:

- draw an electric circuit diagram consisting of battery, connecting wires, resistors, switch, bulb, using their symbols.
- construct an electric circuit using wires, resistors, switch and bulb.

Lesson 18: Electric Project 4.1 (A series lamp circuit)

Starting Off

In order for the students to perform the electric project works, it is good to remind them what they already learnt about series circuits. To do this you can ask different questions that can help them to recall the concepts that they learnt before. In addition to this, you can also ask your students to tell you a project that they have undertaken, if any. This is the question that is indicated in exercise 4.26.

Lesson Description

Introduction

Explain to students that they will be doing electric project 4.1: a series lamp circuit. For doing this, try to encourage students to remember what they have already learnt in this section.

Input and Model

In this project, students are expected to do a project related to a series lamp circuit. Before doing this, you need to revise some important concepts related to series circuit. Students have to properly understand how a current goes from one lamp and then to the other in a series circuit. The lamps are strung together end to end. You have to also tell them the drawback of series connections, i.e., if one component fails in a way that results in an open circuit, the entire circuit is broken and none of the components will work. So, if either one of the lamps in the series circuit burns out, neither lamp will work. That's because current must flow through both lamps for the circuit to be complete.

In groups, students are expected to examine the diagram shown in Figure 4.25 before starting doing the project. They have to construct and draw electric circuit consisting of source, connecting wires, resistors, switch, bulb, using their symbols. Try to encourage the students to ask things that are not clear to them.

Thereafter, you can ask the students to start doing the projects in their group. Make sure that every member of the groups has come up with the necessary materials for doing the projects. After checking for the availability of the equipment's, inform the students to start doing the projects by following all the necessary steps listed in their textbook.

After completing the projects, students have to show their results to another group.

Guide Students through Their Practice

During the entire project, you as a teacher facilitator students' learning (i.e. student centered instruction). Most tasks should be completed by students after you give them simple directions, or facilitate questions and answer to enhance student learning.

Check for Understanding

To assess students' learning, you may ask them different questions like:

1. Why are the lamps dim when the two lamps light?
2. What will happen to the circuit when one of the lamps is removed? etc

Where next

After the class, students should be able to apply the knowledge that they have got here into other simple electrical projects, for instance when the lamps are connected in parallel.

Closure

To close the lesson, allow students to describe verbally what they have understood from this simple electrical project. After taking their idea, try to summarize the important concepts regarding the knowledge that the students need to get from the project. Don't forget to inform students to come up with the necessary materials that help them to do electric project

4.2.

Lesson 19: Electric Project 4.2 (A parallel Lamp Circuit)

Starting Off

In order for the students to perform the electric project works, it is good to remind them what they already learnt about parallel circuits. To do this you can ask different questions that can help them to recall the concepts that they learnt before. In addition to this, try to remind them about the project they did in the last session.

Lesson Description

Introduction

Explain to the students that they will be doing electric project 1: a parallel lamp circuit. For doing this, try to encourage students to recall what they already learnt in this unit.

Input and Model

In this project, students are expected to do a project related to a parallel lamp circuit. Before doing this, you need to revise some important concepts related to parallel circuit. Students have to properly understand a parallel circuit as an arrangement that avoids the if-one-fails-they-all-fail nature of series connections. In a parallel connection, the components do not depend on each other for their connection to the battery. Thus, if one lamp burns out, the other will continue to burn.

In their groups, students are expected to understand the diagram shown in Figure 4.26 before starting doing the project. They have to construct and draw electric circuit consisting of source, connecting wires, resistors, switch, bulb, using their symbols. Try to encourage the students to ask things that were not clear to them.

Thereafter, you can ask the students to start doing the projects in their group. Make sure that every one of the groups has to come up with the necessary materials for doing the projects. After checking for the availability of the equipment, inform the students to start doing the projects by following all the necessary steps listed in their textbook.

After completing the projects, students have to show their results to another group.

Guide Students through Their Practice

During the entire project, you serve as a facilitator of student learning (i.e. student centered instruction). Most tasks should be completed by students after you give simple directions, or asking and answering questions to enhance student learning.

Check for Understanding

To assess students' learning, you may ask them different questions like:

1. What happens to the two lamps light when they are connected in parallel? it brighter or dimmer? Compare it with what you obtained in project 4.1.
2. What happens to the circuit when one of the lamps is removed? etc

Where next

After the class, students should be able to apply the knowledge that they got here, like the one that uses the series and parallel combinations, into other electrical projects.

Closure

To close the lesson, allow students to describe verbally what they have understood from this simple electrical project. After taking their idea, try to summarize the important concepts regarding the knowledge that the students need to get from the project.

Lesson 20: Electric Project 4.3

Starting Off

In order for the students to perform the electric project works, it is good to remind them what they already learnt about circuits. To do this, you can ask different questions that can help them to recall the concepts that they learnt before.

Lesson Description

Introduction

Explain to the students that they will be doing electric project 4.3: electric house project. As usual, for doing this, try to encourage students to recall what they already learnt in this unit.

Input and Model

In this project, students are expected to do a project related to electric house project. Before doing this, you need to revise some important concepts related to series and parallel circuits. Furthermore, help the students to recall the two electric projects that they did in the previous lessons. This is because students are expected to use both the series and parallel circuits while doing this project.

In their groups, students need to construct a model house using available materials. The house will be wired with 4 different circuits as it is outlined in the Students' Text Book. Try to encourage the students to ask things that were not clear to them.

Subsequently, you can ask the students to start doing the projects in their group. Make sure that every one of the groups has come up with the necessary materials for doing the projects. After checking for the availability of the equipment, inform the students to start doing the projects by following all the necessary steps listed in their textbook.
After completing the projects, students have to show their results to another group.

Guide Students through Their Practice

During the entire project, you serve as a facilitator of students' learning (i.e. student centered instruction). Most tasks should be completed by students after simple directions, or facilitated questions to enhance student learning.

Check for Understanding

To assess students' learning, you may ask them different questions like:

1. Do you understand how the series and parallel circuits are connected in your house? etc

Where next

After the class, students should be able to extend the knowledge that they got here into other simpler real life electrical circuits.

Closure

To close the lesson, allow students to describe verbally what they have understood from this simple electrical project. After taking their idea, try to summarize the important concepts regarding the knowledge that the students need to get from the project.

Lesson 21: Virtual experiments

Starting Off

Start the lesson by summarizing the important points of the unit.

Lesson Description

Introduction

Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Response to end of unit questions and problems

1. A balloon is charged by rubbing it with hair. It is then brought near some bits of paper. The charged balloon attracts the paper bits, lifting them up off the table. This demonstrates the attraction between charged objects and neutral objects.
2. This is because the metal shell around you would divert charge away
3. The electrostatic force between the two charges is proportional to the product of the charges and is inversely proportional to the square of their distance apart.
4. The electroscope consists of a glass container with a metal rod inside which has 2 thin pieces of gold foil attached. The other end of the metal rod has a metal plate attached to it outside the glass container. You can refer to Figure 4.4 in the Students' Book to look at the labelling.
5. Electric charges can neither be created nor destroyed, but can be transferred from one material to the other.
6. An uncharged object can be charged in different ways: charging by friction, charging by conduction and charging by induction.
7. Avoid high places and open fields; stay away from tall objects such as

trees, flag poles, or light towers, and avoid objects that conduct current such as bodies of water, metal fences, picnic shelters, and metal bleachers.

$$8. F = k\frac{q_1 q_2}{r^2} = \frac{\left(9\times10^9 Nm^2/C^2\right)\left(2\times10^{-6}C\right)\left(-4\times10^{-9}C\right)}{0.2m^2} = -6.0\times10^{-4}N$$

9.

$$F = k\frac{q_1 q_2}{r^2}$$

$$1.2\times10^{-9}N = \frac{\left(9\times10^9\frac{(Nm^2)}{C^2}\right)(q)(2q)}{0.2m^2}$$

$$q = 1.03\times10^{-11}C \quad and \quad 2q = 2.06\times10^{-11}C$$

10. 0.51 m

11. These conductors are made of metal and are connected to metal cables that conduct electric charge into the ground if the rod is struck by lightning.

12. Current flows in a loop [which means the circuit is closed]. A bird sitting on a transmission line does not complete the circuit. If the same bird keeps one leg on one line and another leg (or any part of its body) on another line (or the neutral points), then it will get roasted.

13. It must be connected in parallel with the circuit.

14. Like electric current, water current can carry energy to do work. They are different because water current carries water and electric current carries electricity.

15. The current is doubled

16. Given, diameter, d=0.5 mm

resistivity, ρ=1.6×10^{-8} Ωm

Resistance, R=10 Ω

Let the length of wire be l.

$$A = \frac{\pi d^2}{4}$$

$$R = \frac{\rho l}{A} = \frac{\rho l}{\left(\frac{\pi d^2}{4}\right)}$$

$$\longrightarrow l = \frac{R\pi d^2}{4\rho} = \frac{10 \times 3.14 \times \left(0.5 \times 10^{-3}\right)^{-2}}{4 \times 1.6 \times 10^{-8}} = 122.7m$$

$$R \propto \frac{1}{d^2}$$

If the diameter is doubled, resistance will be one-fourth.

Hence, new resistance =2.5Ω

17. Aluminium should have to have the larger diameter.

18. After simple plot, the value for the resistance equals the value for the slope and thus it is equal to 3.3 Ω.

19.

$$R = \frac{\Delta V}{I} = \frac{12V}{2.5A} = 4.8\Omega$$

20. For resistors in series,

$$R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5 = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4\Omega$$

By ohm's Law:

$$V = IR_{eq} \longrightarrow 9 = 13.4I$$

$$\longrightarrow I = 0.67A$$

When resistors are connected in series, current is same in all the resistors.

Hence, current in 12 Ω resistor =0.67 A.

21.Since $R_{eq} = \frac{\Delta V}{I} = \frac{220V}{5A} = 44\Omega$. So in order to get an equivalent resistance of 44 Ω, the number of 176 Ω resistances needs to be 4.

22. If resistor are connected n series 6Ω+6Ω+6Ω=18Ω. This is not correct. When they are connected in parallel, 1/(1/6+1/6+1/6)=2. This is also wrong.

(i) When they are connected in parallel

Two 6Ω resistors are connected in parallel. Resistance=1/(1/6+1/6)=3Ω

If 3rd resistor of 6ω and 3ω are connected in series, it becomes 6Ω+3Ω=9Ω

(ii)When they are connected in series Resistance=6Ω+6Ω =12Ω

If 3rd resistor 6Ω and is connected to 12Ω in parallel, total resistance =4Ω

23. This is because a series circuit is a circuit that has only one path for the electric current to follow. If this path is broken, then the current no longer

flow and all the devices in the circuit stop working.

24. They are inversely proportional to each other.

25. Copper and aluminium are generally used for electrical transmission lines. This is because they have very low resistivity.

26. When the skin is significantly dried, the resistance of the body for electric current increases vastly and offers a high resistance to the current entering the body. On the other hand, when the body or skin surface is partly or fully wet, the salts go into the ion form and participate largely in the flow of current as due to lowering of the resistance drastically. Hence, it is advised to not flick electric switches with wet hands, and to dry the hands first. Also , when we throw water on electric fire, the electricity causing fire get transferred to the person's hand holding the water bucket or jug etc. with the help of stream of water thrown at the fire, causing shock hazards.

27. The liquid present on the skin rapidly breaks down contains some ions that makes conduction more easily and hence lowering the resistance significantly. Whereas, in the case of a dry skin such ions are absent thus, making the resistance of the body very high. Blood also contains ions like bicarbonate ions and also the body fluids like lymph contain ions and hence effectively they have low resistance and can conduct electricity easily.

28. The severity of a shock to the body depends on the magnitude of the current, the length of time it acts, and the part of the body through which it passes.

29. The fuses or circuit breakers work on the principle of heating effect of electric current. Heat generated in the circuit is depend on the amount of current flowing, the resistance of the wire used for use or time of flow of current.

30. When an electric heater is plugged in, or turned on, some of that very fast, hot electricity transfers from the outlet into the light. A rapid draw on available power thus occurs.

31. Possibly. A fuse is designed so that if there is a problem, then the fuse blows. By putting in a higher voltage fuse, it takes more to blow that fuse, which could result in the wires getting hotter/melting/starting on

fire. Unless you change the wiring, just leave the voltage of fuses alone and replace a 5v with a 5v.

Unit 5

Magnetism

This unit should fill approximately 9 periods of teaching time.

At the end of this unit, students will be able to:

- understand the nature and characteristics of magnets;
- understand what is meant by the magnetic field;
- understand the concepts related to magnetic force;
- solve problems related to magnetism;
- appreciate simple applications of magnetism in your everyday life.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and let them understand why they need to study it. If you could also put in some activities or games, it would surely add to their interest. So here are some suggestions about how you could teach the Magnetism unit to your students. You have 8 periods at your disposal for teaching the Magnetism Unit.

5.1 Magnet

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- identify various types of magnets based on their physical shapes;
- describe the properties of magnets.

Lesson 1: Magnet

Starting Off

Start the topic by probing students' prior knowledge about magnet through asking questions like those found in exercise 5.1. This helps you to gauge the students' level of understanding. This is crucial for shaping their knowledge if in case they have misconceptions on the concept.

Lesson Description

Introduction

Explain to students that they will be exploring about magnet. To do this, try to encourage students to remember what they learnt in their middle school.

Input and Model

Based on the response you get from the students, try to give short notes on the meaning of a magnet by starting from the historical perspective. You have to also inform them about the commonly known shapes of magnets: bar magnet, horseshoe magnet, cylindrical magnet, circular magnet, rectangular magnet. You can ask your students' questions like the one there in exercise — to discuss on the types of magnets that they are familiar with or have observed so far.

Also, ask them to list the names of devices (that have a magnet inside them) they know. To do this, you can give them a chance to discuss on it.

After that try to help students to understand the three different types of magnets: Permanent magnet, temporary magnet and electromagnet. Encourage the students, after discussing in groups, to give you an example for each type of magnet.

Thereafter, you can teach them about some of the important properties of a magnet. You have to teach these through demonstration by making use of a bar magnet or any other available magnet. Tell students to closely study the diagram indicated in Figure 5.2. After doing all these activities, you can explain to the students about some of the uses of magnets. Encourage students to tell you other applications of a magnet that they know.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. Define magnet and list its properties.
2. What happens with the properties of magnet when it is broken into two pieces?
3. State the rule for magnetic attraction and repulsion.
4. Describe how a temporary magnet differs from a permanent magnet.
5. What are magnetic poles?
6. If you break a magnet into two, would you have isolated north and south poles? Explain.

Where next

You have to encourage the students to start thinking about the importance of magnets in different devices that they have listed earlier.

Closure

To close the lesson, allow students to describe verbally what they have understood about magnet. After taking their idea, try to summarize the important concepts about a magnet.

Answers to review questions

1. A magnet is a material or object that produces a magnetic field which is responsible for a force that pulls or attracts other materials. You can find the list of properties of a magnet in the Students' Book.
2. The properties would remain the same even if we break the magnet.
3. Like poles repel each other and unlike poles attract each other.
4. Permanent magnets are magnets that do not lose their magnetic property once they are magnetized while temporary magnets are those that lose their magnetic property when the magnet field is removed.
5. Magnetic pole is a region at each end of a magnet where the external magnetic field is the strongest.
6. No, magnetic pole always exists in pair.

5.2 Magnetic Field

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe what a magnetic field is;
- state the properties of magnetic lines of force;
- draw magnetic field lines around magnets

Lesson 2: Magnetic Field

Starting Off

Start the lesson by probing students' prior knowledge about magnetic field. You can help them relate it with what they already know, i.e., the electric field. So allow them to discuss exercise 5.2 and come up with the definition of the concepts of a magnetic field.

Lesson Description

Introduction

Explain to the students that they will be exploring about magnetic field.

Input and Model

Provide a note for the students about the definition of a magnetic field. After you tell them the definition of a magnetic field, you need to ask them to do exercise 5.3. Students be familiar with the magnetic compass, a device used to detect magnetic field. You have to also tell them about the visual tools used to represent magnetic fields. Students have to also understand the properties of the magnetic field lines listed in their textbook. To help them understand these concepts, you need to encourage students to do Activity 5.1 and exercise 5.4. To do these you can use different teaching methods like group discussion or conceptual change text.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by utilizing questions/prompts like those listed below.

1. Draw a small bar magnet and show the magnetic field lines as they appear around the magnet. Use arrows to show the direction of the field lines.
2. Draw the magnetic field between two like magnetic poles and then between two unlike magnetic poles. Show the directions of the fields.
3. Determine where the field around a magnet is the strongest and where it is the weakest.
4. Explain the magnetic field using the concept for magnetic field lines.
5. Write the properties of magnetic lines of force.

Where next

Students need to extend their knowledge of magnetic field to other devices that use its applications.

Closure

To close the lesson, allow students to describe verbally the meaning of magnetic field as well as the lines that are used to describe magnetic field. Based on their idea, try to summarize the important concept.

Answers to review questions

1.

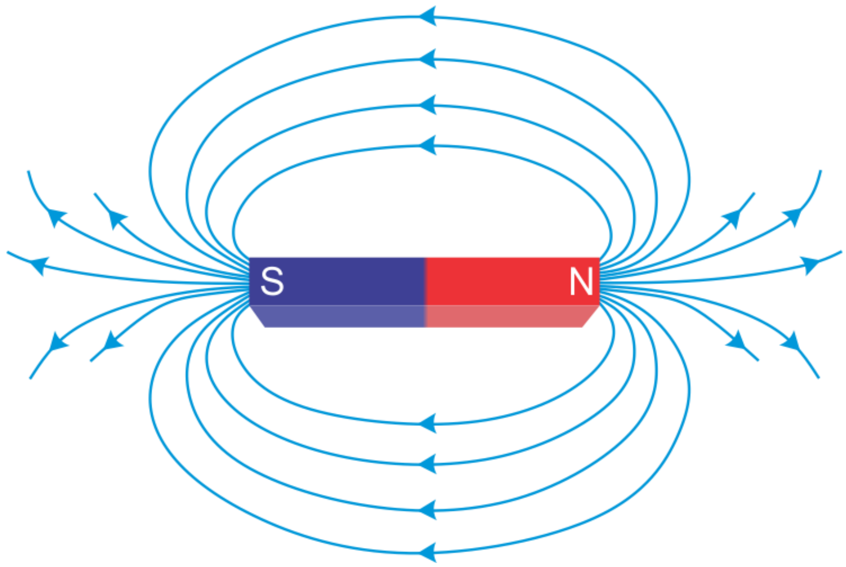


Figure 5.1

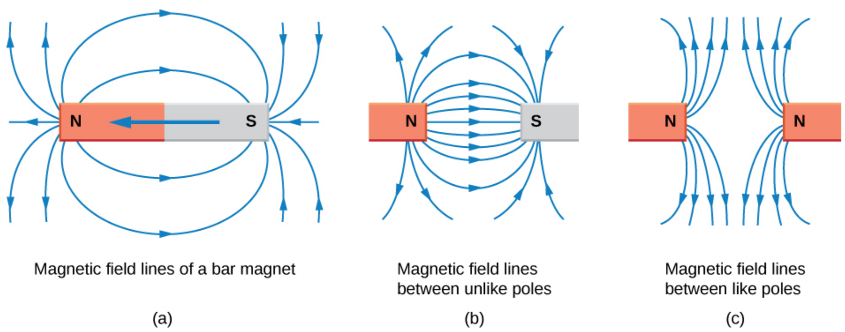
2. 

Figure 5.2

3. The magnetic field is stronger near the poles of a magnet and weaker somewhere in between the magnet.

4. Magnetic field lines are used to describe magnetic field.

5. The properties of the magnetic field lines are those listed in Students' Book.

5.3 The compass and the earth's magnetic field

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the earth's magnetic field;
- explain the origin of the Earth's magnetic field and its importance for the life on Earth.

Lesson 3: The compass and the earth's magnetic field

Starting Off

As usual, try to start the topic by asking students to remind the class about the topics that they learnt in their previous lesson, i.e., about magnetic field.

Lesson Description

Introduction

Explain to students that they will be studying about the compass and earth's magnetic field.

Input and Model

First you need to start teaching the students about the Earth's magnetic field. You can start by asking students responses of exercise 5.5 5.7 after making them to discuss in groups. Based on the students' responses, you can continue explaining the concepts behind the Earth's magnetic field. You can do this by letting students closely observe the diagram indicated in Figure 5.4.

You can then proceed to teaching the concepts behind a compass. As before, you can start by taking students' responses for exercise 5.5. Based on the students' response, you can explain what a compass is all about including its purpose.

To help students to understand what a compass is, you have to bring and show them the actual compass in the classroom. Relate your discussions of a compass with the Earth's magnetic field.

Guide Students through Their Practice

While students are exploring check their understanding by using questions/prompts like those listed below.

1. What does it mean by theEarth's magnetic field?
2. What is a geographic north pole?
3. What is a compass? What purpose does it serve? etc

Where next

Encourage students to appreciate the applications of the Earth's magnetic field and compass in their day to day life.

Closure

Give a short summary about the Earth's magnetic field and compass after asking students about the basic concepts regarding the topics they have learnt.

Answers to review questions

1. Evidence for these geomagnetic reversals can be found in basalts, sediment cores taken from the ocean floors, and seafloor magnetic anomalies. Reversals occur nearly randomly in time, with intervals between reversals ranging from less than 0.1 million years to as much as 50 million years.
2. A compass needle points north because the north pole of the magnet inside it is attracted to the south pole of the Earth's built-in magnet. Since unlike poles attract, the thing your compass is being attracted to must be a magnetic south pole.

5.4 Magnetic field of a current carrying conductor

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the factors through which a magnetic field due to current carrying conductor depends on;
- Calculate the magnetic field of a current-carrying conductor.

Lesson 4: Magnetic field of a current carrying conductor

Starting Off

In the previous section, students learnt about magnetic field. So as usual, try to start the topic by activating students' prior knowledge about magnetic field.

Lesson Description

Introduction

Explain to the students that they will be exploring about magnetic field of a current carrying conductor. To do this, try to encourage students to do exercise 5.7 discussing in groups.

Input and Model

Before teaching students about the magnetic field around a current carrying conductor, remind students about how a charge produces an electric field. Then proceed to explaining about how moving charges produce magnetic fields which are proportional to the current and hence a current carrying conductor produces magnetic effect around it. You can do these by letting students discuss in groups.

You can then proceed to the factors on which the magnetic field of a current carrying conductor depends. This helps you to define the equation that enables you to calculate **B**, i.e., $\boldsymbol{B} = \frac{\mu_o I}{2\pi r}$. You need to also show students how to use the right hand rule that is used for determining the direction of the magnetic field. If students understand the right hand rule, then, ask the them to do Activity 5.2. After checking their answers, try to summarize the characteristics of the magnetic field that is produced due to a current carrying conductor. You can also give them opportunities for solving one problem as an application for the formula of the magnetic field. They can solve the problem in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by questions/prompts like those listed below.

1. Why does a current carrying conductor experience a force when it is placed in a magnetic field?
2. What are the factors on which a magnetic field due to current carrying conductor depends?

Where next

Encourage students to think of the practical applications of magnetic field around a current carrying conductor in their day to day life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concepts.

Answers to review questions

1. This is because a moving charge can produce a magnetic field

2. It depends on the current and distance r from the wire.

5.5 Magnetic force on a moving charge

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the effects of magnetic fields on moving charges;
- determine the magnitude and direction of a magnetic force on a moving charge.

Lesson 5: Magnetic force on a moving charge

Starting Off

Start the lesson by asking the students things that they know about magnetic force. They can relate the concept of electric force as an analogy for magnetic force.

Lesson Description

Introduction

Explain to the students that they will be exploring about magnetic force on a moving charge. To do this, try to encourage students to do in groups.

Input and Model

You can start teaching the topic by checking students' answers for exercise 5.8 after they discuss on it. The students' answer should be related to the fact that all magnetism is caused by current, the flow of charge. *Magnetic fields exert forces on moving charges,* and so they exert forces on other magnets, all of which have moving charges.

You can then proceed to the equation that enables you to calculate the magnitude of the magnetic force F on a charge q moving at a speed v in a magnetic field of strength $\boldsymbol{B}$:

$$F = qv\boldsymbol{B}sin\theta$$

You need to also show students how to use the right hand rule that is used for determining the direction of the magnetic force. Try to encourage the students to practice the rule until they correctly understand how to use it. You can also give them opportunities for solving a problem like the one shown in the textbook as an application of the formula of the magnetic force on a moving charge. They can solve the problem by discussing in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts like those listed below.

1. Is it possible for the magnetic force on a charge moving in a magnetic field to be zero?

Where next

Encourage students to think about the importance of studying about magnetic force around a moving charge in their day to day life.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the important concepts.

Answers to review questions

1. Yes; you can consider the case in the example solved in the Students' Book.

2. The magnitude of the magnetic force can be calculated by $F = qvB = (1.6 \times 10^{-19})(7.5 \times 10^{6})(1 \times 10^{-5}) = 1.2 \times 10^{-19}$.

5.6 Magnetic force on a current carrying conductor

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- state the relationship between magnetic force, current and magnetic field;
- calculate the magnetic force on a current carrying conductor in a magnetic field;
- determine the direction in which a current carrying wire experiences a force in an external magnetic field.

Lesson 6: Magnetic force on a current carrying conductor

Starting Off

Start the lesson by asking the students things that they know about magnetic force and the magnetic force around a moving charge.

Lesson Description

Introduction

Explain to the students that they will be exploring about magnetic force on a current carrying conductor. To do this, try to encourage students to do exercise 5.9 in groups.

Input and Model

You can start teaching the topic by checking students' answers to exercise 5.9 after they made a discussion on it. The students' answer should be related to the fact that a current-carrying wire experiences a force in the presence of a magnetic field.

You can then proceed to the equation that enables you to calculate the magnitude of the magnetic force F on a conductor carrying current I in a magnetic field of strength $\boldsymbol{B}$:

$$F = Il\boldsymbol{B}sin\theta$$

You need to also show students how to use the right hand rule that is used for determining the direction of the magnetic force. Try to encourage the students to practice the rule until they correctly know how to use it. You can also give them opportunities for solving one problem like the one shown in the textbook as an application for the formula of the magnetic force on a current carrying conductor. They can solve the problem by discussing in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts like those listed below.

1. Explain the force acting on current carrying conductor in a magnetic field.
2. List the factors that affect the size of the force experienced by a current-carrying wire.
3. Describe how to use the right-hand rule to determine the direction of a magnetic field around a straight current-carrying wire.

4. A wire 625 m long is in a 0.40 T magnetic field. A 1.8 N force acts on the wire. What current is in the wire?

Where next

Students are required to think about devices that work based on the application of magnetic force around a current carrying conductor.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding the magnetic force around a current carrying conductor. Based on their idea, you need to summarize the important concept.

Answers to review questions

1. A current carrying conductor produces a magnetic field around it, i.e., it behaves like a magnet and exerts a force when a magnet is placed in its magnetic field. Similarly, a magnet also exerts equal and opposite force on the current carrying conductor.

2. The force on a current carrying conductor depends on the magnitude of the magnetic field strength, current and the distance r from the wire.

3. According to the right hand rule, you need to point the fingers of your right hand in the direction of B. Point your thumb in the direction of the conventional current in the wire. The palm of your hand then faces or pushes in the direction of the force acting in the wire.

4. $Since\ F = ILB,\ I = \frac{F}{LB} = \frac{1.8N}{625m \times 0.4T} = 0.0072A$

5.7 Magnetic force between two parallel current carrying conductors

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the effects of the magnetic force between two conductors.
- explain how parallel wires carrying currents can attract or repel each other.

Lesson 7: Magnetic force between two parallel current carrying conductors

Starting Off

Explain to students that they will be exploring about magnetic force between two parallel current carrying conductors.

Lesson Description

Introduction

Explain to students that they will be exploring about magnetic force between two parallel current carrying conductor.

Input and Model

You can start teaching the topic by taking students' responses for exercise 5.10 after they made a discussion on it. The students' answer should be related to the fact that a force acts between the wires if two wires carrying a current that are placed parallel to each other as their magnetic fields interact. The magnitude of the force acting on each wire is equal but the directions are opposite.

You need to consider two cases for two parallel current carrying conductors, i.e., when the conductors carry currents in the same direction and when they carry in opposite directions.

You have to encourage students to apply the right hand rule that they learnt previously so as to find the direction of the force between the wires. This enables students to find answer for Activity 5.3. They can do this in groups. The students' response should be in agreement with the following statement if the two conductors carry current in the same direction, the wires attract each other. If the two wires carry currents in opposite directions, they repel each other'. Figure 5.9 clearly shows the attractive force between two conductors carrying current in the same direction and a repulsive force between two conductors carrying currents in opposite directions.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts like those listed below.

1. Two parallel wires carrying currents in the same direction attract each other. Why?
2. Is the force between the hot and neutral lines hung from power poles attractive or repulsive? Why?

Where next

Students are required to think of the forces that exist between two parallel high voltage transmission wires.

Closure

To close the lesson, give students a chance to summarize the important concepts regarding the attractive or repulsive forces between two parallel current carrying conductors. Based on their idea, you need to summarize the important concepts.

Answers to review questions

1. If you have two current-carrying, parallel wires with magnetic fields circling around them in the same direction, they attract each other;

at the point which their respective magnetic fields intersect, they are traveling in opposite directions, and opposites attract.

2. The hot wire is the wire through which some current is flowing, whereas a neutral wire is a wire with zero current.

5.8 Applications of magnetic forces and fields

This section should fill approximately 1 ***period*** *of teaching time.*

At the end of this section, students will be able to:

- describe some applications of magnetism.

Lesson 8: Applications of magnetic forces and fields

Starting Off

Start the lesson by asking students the things that they know about the applications of magnetic force and fields.

Lesson Description

Introduction

Explain to the students that they will be exploring about applications of magnetic force and fields.

Input and Model

You can start teaching the topic by taking students to try to think of devices that work using the application of electric and magnetic fields. Taking students' responses into consideration, you can start discussing the devices that work using the application of magnetic field and magnetic force. While doing this, you have to let the students participate making use of different mechanisms.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts that are related to the applications of magnetic and electric fields.

Where next

Students are expected to transfer the knowledge they have got here to other familiar situations.

Closure

To close the lesson, give students a chance to summarize the important concepts that they have understood about the applications of magnetic fields and forces. Based on their response, you need to summarize the important concept for them.

Lesson 9: Virtual experiments

Starting Off

Start the lesson by summarizing the important points of the unit.

Lesson Description

Introduction

Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Answer to review question

The most important applications of magnetism are:

1. Health and Medicine.
2. In the Home.
3. Computers and Electronics.
4. Electric Power and Other Industries.
5. Compasses and Navigation.

Answers to end of unit questions and problems

1. A magnet is a material or object that produces a magnetic field which is responsible for the force that pulls or attracts other materials. Magnets attract objects made of iron or steel, such as nails and paper clips.
2. Magnets can influence our everyday life in many different ways. For instance, magnets are used in medicine. Equipment such as MRI machines use magnets to operate. In addition to medical devices, magnets are used in the treatment of cancer.

3. A magnetic field is a region in space where a magnet or object made of magnetic material will experience a non-contact force.

4. Both are non-contact forces.

5. Even if the magnet is cut into tiny pieces, each piece will still have *both* a N and a S pole. These magnetic poles *always* occur in pairs.

6. Like poles of magnets repel each other

7. Unlike poles attract each other.

8. You can refer to Figure 5.3 in Students' Book.

9. A compass is an instrument which is used to find the direction of a magnetic field. Therefore, when in the presence of a magnetic field, the needle is able to line up in the same direction as the field.

10. In the picture below, you can see a representation of the Earth's magnetic field which is very similar to the magnetic field of a giant bar magnet like the one on the right of the picture. So the Earth has two sets of north poles and south poles: **geographic poles** and **magnetic poles**.

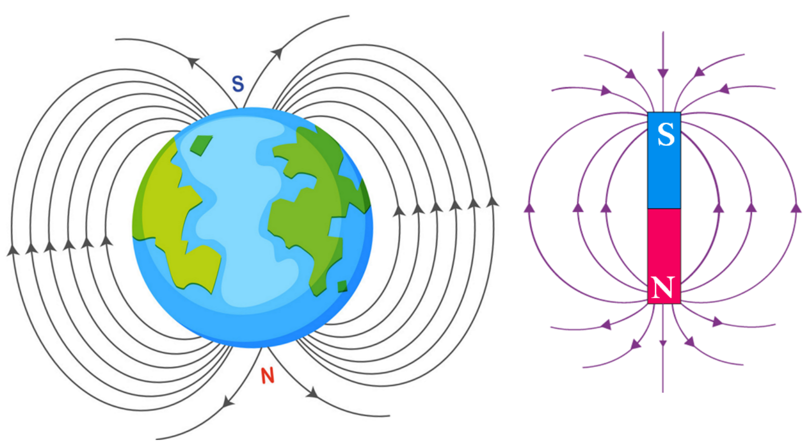


Figure 5.3

11. The geographic north pole, which is the point through which the Earth's rotation axis goes, is about 11.5^o away from the direction of the magnetic north pole (which is where a compass will point).

However, the magnetic poles shift slightly all the time. Another interesting thing to note is that if we think of the Earth as a big bar magnet, and we know that magnetic field lines always point from north to south, then the compass tells us that what we call the magnetic north pole is actually the south pole of the bar magnet.

12. You can refer to Figure 5.4 on the Students' Book.

13. $L = 0.5m, \quad I = 8.0A, \quad F = 0.4N, \quad B = ?$

$$\text{F= ILB}$$
$$\text{B}=\frac{\text{F}}{\text{IL}}=\frac{0.40\text{N}}{8.0\text{A}\times 0.5\text{m}}=0.1\text{T}$$

14. $L = 0.5m, \quad I = 8.0A, \quad B = 0.6T, \quad F = ?$

$$F = ILB = 8A \times 0.5m \times 0.6T = N$$

15. $I = 25A, r = 10cm$

$$B = \frac{\mu_0 I}{2\pi r} = \frac{(4\pi \times 10^{-7} \frac{Tm}{A}) \times (25A)}{2\pi \times (0.01m)} = 1.5 \times 10^{-11} T$$

The direction of the magnetic field can be obtained using the right hand rule.

16. $q = 1.6 \times 10^{-19}C, v = 8.75 \times 10^5 m/s, B = 0.75T$ and $\theta = 90^o$. The magnitude of the force is obtained by

$$\mathbf{F} = qvBsin\theta = (1.6\times10^{-19}C)(8.75\times10^5 m/s)(0.75T)sin90^o = 1.05\times10^{-13}N$$

The direction is perpendicular to the plane containing v and **B**.

Unit 6

Electromagnetic wave and geometrical optics

This unit should fill approximately 21 periods of teaching time.

At the end of this unit, students will be able to:

- understand the concept of Electromagnetic waves;
- understand the properties and transmission of light in various media and their applications;
- investigate the properties of light through experimentation and illustration using diagrams and optical instruments;
- predict the behavior of light through the use of ray diagrams;
- appreciate the contributions of optics in our day to day life.

Dear teacher, you would agree that a good way of introducing any concept in physics is to relate it to your students' everyday experiences and let them understand why they need to study it. If you could also put in some activities or games, it would surely add to their interest. So here are some suggestions about how you could teach the EM wave and geometrical optics unit to your students. You have 20 periods at your disposal for teaching the EM wave and geometrical optics Unit.

6.1 Electromagnetic Waves

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- describe the propagation of Electromagnetic (EM) waves;
- state sources of EM waves.

Lesson 1: Electromagnetic Waves

Starting Off

Try to start the topic by probing students' prior knowledge about wave through asking different questions like those found in Activity 6.1 and exercise 6.1. Then, try to shape their knowledge if in case they have misconceptions on the content. After that try to ask the students about the different types of waves that they have learnt in grade 9.

Lesson Description

Introduction

Explain to the students that they will be exploring about waves, particularly EM waves. To do this, try to encourage students to remember what they learnt in grade 9.

Input and Model

After reminding the students about the definition of wave, ask them to do exercise 6.1. Based on their response, try to remind students about the differences between electromagnetic and mechanical waves. Try to give short notes on the different types of waves: mechanical wave and EM wave. You have to also inform them about the differences between transverse and longitudinal waves. As the focus of the topic is on EM waves, try to discuss it by giving special attention. Introduce light and radio frequency waves as types of electromagnetic waves. In doing so, you can use different teaching strategies like discussion.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students learning, you may ask them different questions similar to those given at the end of this section, i.e.

1. Explain how an EM wave propagates, with the aid of a diagram.
2. Do EM waves need a medium to travel through?
3. Describe the properties of electromagnetic waves.

Where next

You have to encourage students to transfer the concepts that they have learnt here into other related topics, for our case to light wave as light is one type of EM wave.

Closure

To close the lesson, allow students to describe verbally what they have understood about the EM waves. After taking their idea, try to summarize the important concept.

Answers to review questions

1. Since EM wave is a transverse wave, it propagates in a way indicated in Figure 6.1 of the Students' Book.
2. EM waves can travel both in a material medium and in vacuum.
3. Just like the other waves, EM waves are expressed by terms like frequency and wavelength.

6.2 EM Spectrum

*This section should fill approximately 2 period**s** of teaching time.*

At the end of this section, students will be able to:

- describe what an EM spectrum is;
- describe and explain the differences and similarities of the EM spectrum;
- describe the uses and dangers of EM spectrum.

Lesson 2: EM Spectrum

Starting Off

Start the lesson through probing students' prior knowledge about EM waves that they learnt in the previous lesson. You can do this by asking students to do exercise 6.2.

Lesson Description

Introduction

Explain to students that they will be exploring about EM spectrum.

Input and Model

Provide a note for the students about EM spectrum. Tell them to list the constituents of the spectrum. Before going to the detailed discussion on each of the different types of the spectrum, try to give a chance for the students to study, in groups, the diagram indicated in Figure 6.2. If they properly understand the diagram, they can see the relationships between frequency, energy and wavelength. To do this, you can also

1. make a display of the EM spectrum and discuss the relationship between frequency and energy or wave length and energy.
2. Use a cardboard, white paper or piece of flat wood or white painted part of the classroom to scale the different frequencies of EMW. On

one side will be frequency, on the other side will be wavelength.

3. Brainstorm in groups safety concerns of high energy electromagnetic waves(EM) and present to the class.

Following this, you can move to discussing the parts of the EM spectrum one by one up to the visible light.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts like those listed below.

1. List one source of electromagnetic waves.

2. Arrange the following types of EM radiation in order of increasing frequency: infrared, X-rays, ultraviolet, visible, gamma.

Where next

Try to help students to understand the importance of studying the EM spectrum parts.

Closure

To close the lesson, allow students to describe verbally what they have understood about the EM spectrum. Based on their idea, try to summarize the important concepts.

Lesson 3: EM spectrum Continued

Starting Off

As usual, try to start the topic by asking questions to remind the students about the topics that they learnt in their previous lesson.

Lesson Description

Introduction

Explain to the students that they will be exploring about the remaining part of the EM spectrum, i.e., by starting from the visible light.

Input and Model

Try to give some notes on the remaining parts of the spectrum. This encourages students to participate in discussions by forming different groups through raising different interesting scenarios like the uses of some of the parts of EM spectrum. You can repeat the teaching aids you used in the previous lesson.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What does it mean by visible light?
2. What are the contributions of EM waves to human society?

Where next

Encourage students to appreciate the applications of the EM spectrum in their day to day life.

Closure

Give short summary about the EM spectrum.

Answers to review questions

1. The sun
2. infrared, visible, ultraviolet X-rays, gamma.

3. Examples of some uses of electromagnetic waves

Category	**Uses**
gamma rays	used to kill the bacteria in marshmallows
X-rays	used to image bone structures
ultraviolet light	bees can see into the ultraviolet because flowers stand out more clearly at this frequency
visible light	used by humans to observe the world
Infrared	night vision, heat sensors, laser metal cutting
microwave	microwave ovens, radar
radio waves	radio, television broadcasts

4. Gamma rays can destroy living cells, produce gene mutations, and cause cancer as they penetrate about anything. X-rays damage or destroy living tissues and organisms. UV radiation induces the production of more melanin, causing tanning of the skin.

6.3 Light as a wave

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- illustrate the propagation of light;
- describe the medium of propagation of light;
- describe the speed of light waves.

Lesson 4: Light as a wave

Starting Off

In the previous section, students learnt that light is a form of EM wave. So, as usual, try to start the topic by activating students' prior knowledge about EM waves.

Lesson Description

Introduction

Explain to the students that they will be exploring about light: medium of light propagation, speed of light and direction of propagation of light. To do this, try to encourage students to do exercise 6.3, 6.4 and 6.5 in groups after discussing in class.

Input and Model

Provide students with the definition of light in relation to EM wave. You have to also help them understand about the medium of light propagation, speed of light and direction of propagation of light. You can do these by letting students participate in groups.

You have to also teach the students about the speed of EM waves. It is also good if you show the relationship between speed of light, wavelength and frequency. You help them understand these relationships through doing the example there on their textbook.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What is light?
2. What are the mediums of propagation of light?
3. What is a light ray? etc

Where next

Encourage students to think about the importance of light in their day to day life as almost everything is impossible without light.

Closure

To close the lesson, give students a chance to summarize the important concepts of the lesson. Based on their idea, try to summarize the key concepts.

Answers to review questions

1. Light rays are not real. In physics we use the idea of a light ray to indicate the direction in which light travels. In geometrical optics, we represent light rays with straight arrows to show how light propagates.

2. You can pass a knitting needle through the holes to confirm if they are in a straight line. Now place a burning candle in front of the board C and look through the pinhole in board A. The flame will be clearly visible. This shows that light travels in a straight line.

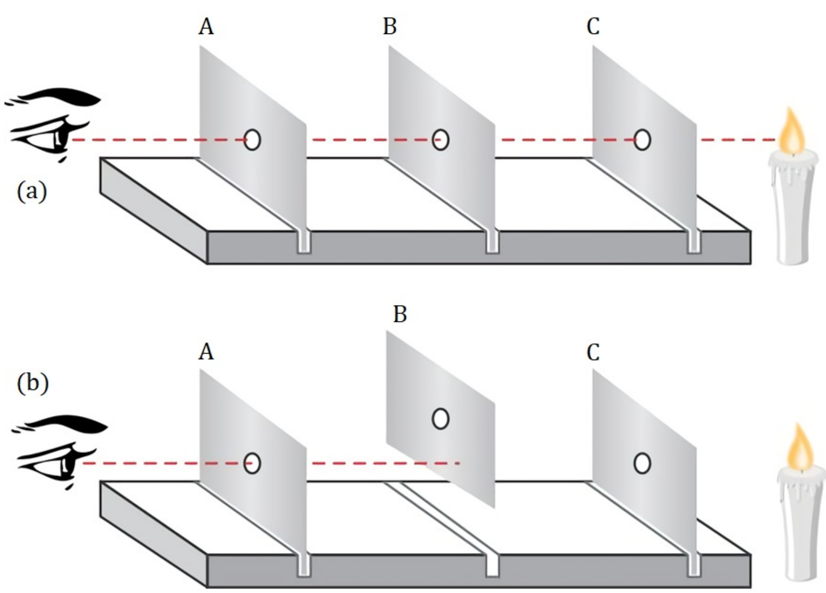


Figure 6.1

3. Electromagnetic waves are produced by accelerating charged particle. When the charge moves with acceleration, both the magnetic and electric fields change continuously. This change produces electromagnetic waves. Accelerated charge is the source of energy of these waves. You can refer to the diagram found in students textbook.

4. EM waves can travel both in a material medium and in vacuum. So, necessarily, they do not need a material medium for their propagation.

5. Light is an EM wave. It travels with a speed of 3.00×10^8 m/s in a vacuum and is represented by letter c.

6. $f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 m/s}{400 \times 10^9 m} = 7.5 \times 10^{-4}$

6.4 Laws of reflection & Refraction

This section should fill approximately 4 periods of teaching time.

At the end of this section, students will be able to:

- state laws of reflection and refraction;
- solve problems based on the laws of reflection and refraction;
- identify area of application of these laws in your locality and/or elsewhere.

Lesson 5: Reflection

Starting Off

Start the lesson by asking the students things that they know about reflection. Try to receive students' response regarding exercise 6.7 as it enables you to probe students' prior knowledge about the topic.

Lesson Description

Introduction

Explain to the students that they will be exploring how light is reflected off a mirror to predict the Law of Reflection. Show students the general set up using a flashlight, mirror, and construction paper. Do not turn on the flashlight when modelling the set up so that students may explore the path of the light in their own groups. With a mirror resting flat on a table, hold a flashlight at an angle pointing down toward the mirror. Explain that the light will reflect upward off the mirror and they will need to use a piece of construction paper to catch the light above the mirror.

Input and Model

Provide students with the vocabulary they need for this activity so they may take notes:

Angle of incidence: The angle formed by a ray of light that travels toward a surface and a line perpendicular to the surface. (Demonstrate the angle using a flashlight and an object, such as a string, that forms a line perpendicular to the mirror.)

Angle of reflection: The angle formed by a ray of light that travels away from the surface and a line perpendicular to the surface. (Do not demonstrate this angle because it will be the task of the students' to determine it.)

Normal line: The imaginary line perpendicular to the surface of reflection. (Demonstrate the normal line using an object, such as a string, perpendicular to the mirror's surface.)

Law of Reflection: (Explain that students will determine the Law of Reflection based on their exploration.)

After defining the important terms, teach the students about the two laws of reflection. In addition to these, try to also ask the students to give you a response for exercise 6.8. Depending on their response, discuss with the students the two different types of reflection.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using the following questions/prompts:

1. Did you instinctively know where to hold the paper in order to catch the light?
2. What is the relationship between how you hold the flashlight and where the light goes?
3. What role does the mirror play?
4. Use your finger to outline the angle of incidence.
5. Use your finger to outline the angle of reflection.
6. Use your finger to outline the normal line.
7. Use the vocabulary you learned today to describe how the light is reflected.

Using their understanding of the Law of Reflection, students should work independently to construct and label a diagram of the light's path using a compass and straightedge. Diagrams should include a depiction of the following: flashlight, mirror, construction paper, angle of incidence, normal line, angle of reflection, and an indication of the congruent angles.

Closure

To close the lesson, allow students to describe verbally what they predict the Law of Reflection to be. Encourage students to use the vocabulary presented in the lesson. Once a few students have had an opportunity to state the Law of Reflection in their own words, allow them to update their notes.

Where next

Tell them about the applications of laws of reflection on the formation of images.

Lesson 6: Refraction

Starting Off

As usual, try to start the topic by activating students' prior knowledge about refraction through asking the questions in exercise 6.8.

Lesson Description

Introduction

Explain to the students that they will be exploring about refraction of light rays. To do this, try to encourage students to do Activity 6.2 at home or in class by forming different groups. Remind them to note how a ray of light changes its direction as it goes from one medium to another.

Input and Model

Depending on the students' response, try to explain what refraction is all about. You need to ask students to do exercise 6.9. Afterwards, you need to discuss why a ray bends towards or away from the line.

Then you can proceed to teaching the laws of refraction (Snell's law) and giving the definition of the term refractive index.

After deriving Snell's law, you can give them an example as application of Snell's law. The students can do the example individually or in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What causes light to bend?
2. When does a ray bend towards the normal?
3. What is a refractive index?

Where next

Tell them about the applications of laws of reflection on the formation of lenses.

Closure

To close the lesson, allow students to describe verbally what they predict the Law of refraction to be. Based on their idea, try to summarize the important concepts.

Lesson 7: Total Internal reflection

Starting Off

As usual, try to start the topic by activating students' prior knowledge about refraction as they going to learn about the applications of the laws of refraction.

Lesson Description

Introduction

Explain to students that they will be exploring about total internal reflection. To do this, try to encourage students to do exercise 6.12 at home or in class by forming different groups. Remind them to note how a ray of light changes its direction as it goes from one medium to another.

Input and Model

Provide students with what happens when a ray of light travels from an optically denser to an optically rarer medium, say from glass to air or from water to air. Students have to be aware about the bending of a ray away from the normal. This means that the angle of refraction is greater than the angle of incidence. Then after try to encourage the students to do exercise 6.12.

Their answer leads you to your discussions of the two conditions that need to be satisfied for total internal reflection to occur. You can give students a chance to discuss in groups the diagram indicated in Figure 6.10. After making sure that the students have understood the concept, you can proceed to deriving the expression for critical angle.

In addition to these, you need to explain some of the practical applications of total internal reflection to the students. This includes optical fibre and endoscopy.

You have to also do one example for the students using the formula you derived. They can do the example with students individually or in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What is total internal reflection?
2. What is the condition that needs to be satisfied for total internal reflection to occur?
3. What are the practical applications of total internal reflection? etc

Where next

Encourage students list other things that work using the applications of total internal reflection.

Closure

To close the lesson, allow students to describe the concept about total internal reflection. Based on their idea, try to summarize the important concepts. For their next lesson, encourage students to come to class having done Activity 6.3 of section 6.2.

Lesson 8: Dispersion by a glass prism

Starting Off

As before, try to start the topic by probing students' prior knowledge about refraction as they are going to learn about the applications of the laws of refraction.

Lesson Description

Introduction

Explain to the students that they will be exploring about dispersion by glass prism. To do this, try to encourage students to do exercise 6.13 in class by forming different groups.

Input and Model

Provide students with what a glass prism is all about. Students have to have awareness about the things that happens when a ray of light passes through a prism. Then after, try to encourage the students to do Activity 6.3 that they had been informed to do at home. If students failed to get a glass prism, you might teach them to observe a video on the dispersion of light through a glass prism.

After the activity or after the demonstration, encourage the students to carefully look at the seven colours: Violet, Indigo, Blue, Green, Yellow, Orange and Red shown in Figure 6.12.

You can extend their knowledge to understand about the formation of a rainbow in the sky.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. Why is a prism selected to disperse white light ray?
2. What are the orders of the colors after white light is dispersed by a prism?
3. Which one has a larger wavelength? etc

Where next

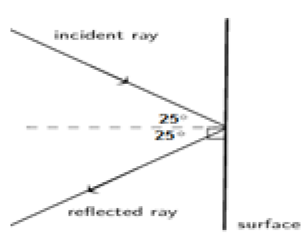
Students have to be encouraged to think of other phenomena that are formed after dispersion.

Closure

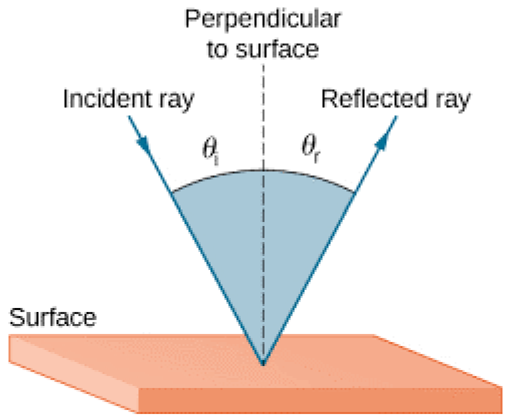
To close the lesson, allow students to describe the concept behind dispersion by a glass prism. Based on their idea, try to summarize the important concepts.

Answers to review questions

1.



2.



3. Light reflects from a smooth surface at the same angle as it hits the surface. For a smooth surface, reflected light rays travel in the same direction. This is called specular reflection. For a rough surface, reflected light rays scatter in all directions.
4. According to Snell's law, the ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given color and for the given pair of media.
5. The refractive index (n) of a material is the ratio of the speed of light in different media and gives an indication of how difficult it is for light to get through the material.
6.

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$n_a sin30^o = n_d sin\theta_2$$

$$1 \times 0.5 = 2.42 sin\theta_2$$

$$sin\theta_2 = \frac{0.5}{2.42}$$

$$\theta_2 = sin^-1(0.2) = 11.5^o$$

7. The light ray bends towards the normal. As water is optically denser than air, a ray of light entering from air into the water will bend towards the normal. The light ray will bend towards the normal because air is a rarer medium and water is a denser medium.
8. We know from the definition of refractive index, that the speed of light is higher in a medium with the lower refractive index. So, the light travels

fastest in water relative to kerosene and turpentine. ... Speed of light—-> water> kerosene> turpentine.

9.

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$n_s sin\theta_1 = n_w sin 69^o$$

$$3.88 \times sin\theta_1 = 1.33 \times 0.93$$

$$sin\theta_1 = 0.32$$

$$\theta_1 = sin^- 1(0.32) = 18.7^o$$

10. The conditions for total internal reflection are the the light is traveling from an optically denser medium (higher refractive index) to an optically less dense medium (lower refractive index) and that the angle of incidence is greater than the critical angle.

11. The critical angle is the angle of incidence where the angle of refraction is 90^o. The light must travel from an optically more dense medium to an optically less dense medium. When the angle of incidence is equal to the critical angle, the angle of refraction is equal to 90^o.

12. Diamond sparkle because of total internal reflection. Total internal reflection is a phenomenon that occurs at the boundary between two mediums, such that if the incident angle in the first medium is greater than the critical angle, then all the light is reflected into that medium. Along with total internal reflection, the following are the three other factors that determine the sparkling of the diamond: Reflection, Refraction and Dispersion.

13. Diamond (index of refraction is about 3) is less optically dense than silicon (index of refraction is about 4) and so total internal reflection cannot occur.

14. The shorter wavelengths of light undergo the most refraction. Thus, violet is refracted the most and red light is refracted the least. The fact that the various component colors of white light refract different amounts leads to the phenomenon of dispersion.

6.5 Mirrors and Lenses

This section should fill approximately 7 periods of teaching time.

At the end of this section, students will be able to:

- apply the laws of reflection and refraction;
- describe image formation as a consequence of reflection and refraction;
- perform calculations based on the law of reflection and refraction;
- distinguish between real and virtual images.

Lesson 9: Mirrors and Lenses

Starting Off

As usual, try to start the topic by probing students' prior knowledge about mirror in general and plane mirror in particular through asking students responses regarding exercise 6.14.

Lesson Description

Introduction

Explain to the students that they will be exploring about plane mirror and its image formation.

Input and Model

Provide students with what a plane mirror is all about and then proceed to teaching about the type of image produced by a plane mirror. To do this, try to encourage students to do exercise 6.15. After doing Activity 6.4 in groups, students have to show their response through diagrams like the one shown in Figure 6.14.

1. discuss in small group reflection of light from plane surfaces.

2. trace the path of a ray reflected from the surface of a plane mirror using optical pins and measure angle of incidence and angle of reflection.

3. discuss the characteristics of image formed in the plane mirror.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What is a plane mirror?

2. What type of image is formed by a plane mirror?

3. Why is a diverging mirror used as a driving mirror?

4. Use optical diagram to locate the image of a point object in a plane mirror.

5. Find the number of images formed by an object placed between two plane mirrors inclined at 30 0. Etc

Where next

Students should have to start thinking about the type of image and the number of images produced by two plane mirrors that are:

1. parallel to each other

2. Placed at angle with each other

Closure

To close the lesson, allow students to describe verbally about the type of image that is produced by a plane mirror. Based on their idea, try to summarize the important concepts.

Lesson 10: Spherical Mirror

Starting Off

As usual, try to start the lesson by probing students' prior knowledge about spherical mirror.

Lesson Description

Introduction

Explain to students that they will be exploring about spherical mirror.

Input and Model

Provide students with the definition of what a spherical mirror is and then proceed to teaching through the two different types of spherical mirrors: Concave and convex. You have to help them to differentiate these two different types of mirrors. Before you move further on spherical mirrors, you need to help students understand the meaning of a few terms like principal axis, center of curvature, radius of curvature. These terms are commonly used in discussions of spherical mirrors.

To help them understand these concepts, try to encourage students to think of doing Activity — that they were informed to do at home last time. Try to discuss with them what they noticed. Help them try to understand this observation with the help of a ray diagram.

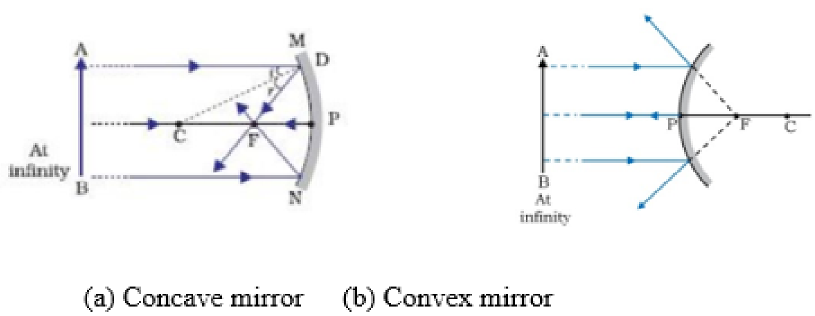


Figure 6.2

You have to also tell them the relationship between the radius of curvature R, and focal length f, of a spherical mirror.
After doing all these things, try to move to discussing the four important rays used for forming images in a spherical mirror. These rays are:

1. A ray parallel to the principal axis
2. A ray passing through the principal focus
3. A ray passing through the center of curvature
4. A ray incident obliquely to the principal axis, towards a point P (pole of the mirror)

The students have to understand the importance of the intersection of at least two of the reflected rays for the formation of the images in a spherical mirror. Thus, any two of the following rays can be considered for locating the image.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What is a spherical mirror?
2. What are the important terms that we use in spherical mirrors?
3. What type of ray is used to form images in spherical mirrors?

Where next

Students have to start thinking about how to form images in a concave and convex mirror through the use of the rays they learnt now.

Closure

To close the lesson, allow students to describe what a spherical mirror is all about, the important terms and the rays used to form images in spherical mirrors. Based on their ideas, try to summarize the important concepts.

Lesson 11: Image formation by Concave and convex Mirror

Starting Off

Try to start the topic by asking students to recall the important rays used for forming images in spherical mirrors as they are going to use it in their today's lesson. If they forget, try to remind them about the rays used to form images.

Lesson Description

Introduction

Explain to students that they will be exploring about formation of image by a concave and convex mirror one by one.

Input and Model

To help students understand the types of image formed by concave mirrors, try to encourage students, in groups, to do exercise 6.16.

Inform them to compare the result they obtained from their activity with the summary of the properties of the image shown in Table 6.3. After that, tell them to do Activity 6.5.

You need to repeat the same procedure to teach about the types of image formed by a convex mirror. In addition to these, you have to teach them about the uses of concave as well as convex mirrors.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What are the types of images formed by a concave mirror?
2. What are the types of images formed by a convex mirror?
3. What are some of the functions of concave as well as convex mirrors?

Where next

Encourage students to think of ways that help them to apply the knowledge that they got here to other real world applications like optical instruments that use a mirror.

Closure

To close the lesson, allow students to describe verbally about the type of images formed by concave and convex mirrors. Based on their ideas, try to summarize the important concepts.

Lesson 12: Mirror Equation

Starting Off

As usual, try to start the topic by giving chance for the students tell the class about the properties of images that are formed by a concave and convex mirror that they learnt in their previous session.

Lesson Description

Introduction

Explain to students that they will be exploring about Mirror formula and magnification. To do this, try to encourage students to study Figure 6.21 in groups as it enables them to understand the sign convention that we use in mirror equation.

Input and Model

Provide students some note on the sign convention that you use while using the mirror formula. After that proceed to showing the relationships between object distance, image distance and focal length, i.e., the equation

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

You have to also teach them the meaning of magnification and the equation that is used to find the magnification

$$m=\frac{h'}{h}=-\frac{v}{u}$$

Thereafter, you have to give them different questions to solve like those found in the Students' Book so as to let students understand the applications of these equations. Students can solve the problems individually or in groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those found at the end of the section on mirror. You can also ask students to compare converging and diverging mirrors in terms of:

1. (a) Image formation

   (b) Magnification

Where next

Students have to extend their knowledge of mirror equation and magnification in other situations like optical instruments.

Closure

Try to summarize the important concepts about the mirror and magnification formulae by giving due emphasis on the importance of sign convention.

Lesson 13: Lens

Starting Off

It is expected from the teacher to start the lesson through creating rooms for the students to recall what they learnt in the previous section, i.e., about refraction. It is also good if you try to collect students pre-existing knowledge on lenses by asking different questions like those found in exercise 6.18 and 6.19 as it lets you give remedy if there is a misconception.

Lesson Description

Introduction

Explain to the students that they will be exploring about lens.

Input and Model

Provide students with the definition of what a lens is and then proceed to teaching through the two different types of lens: Concave and convex. You have to help them to differentiate these two different types of lens. Before you move further on lens, you need to help students to understand the meaning of a few terms like principal axis, the two centers of curvatures, and radius of curvature. These terms are commonly used in discussions of lens.

To help them to understand these concepts, try to encourage students to think of their responses to exercise 6.20. To answer these questions, you may encourage the students to think of Activity 6.7 that they were informed to do at home last time. Try to discuss with them what they noticed. Help them to try to understand this observation with the help of a ray diagram.

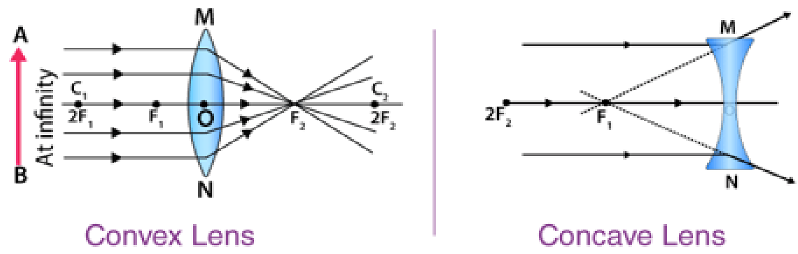


Figure 6.3

You have to also tell them the relationship between the radius of curvature R, and the two focal lengths, of a lens.

After doing all these things, try to move to discussing the four important rays used for forming images in a lens. These rays are:

1. A ray parallel to the principal axis
2. A ray passing through the principal focus
3. A ray of light passing through the optical center of a lens

The students have to understand the importance of the intersection of at least two of the reflected rays for the formation of the image in a lens. Thus, any two of the following rays can be considered for locating the image.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What is a lens?
2. What are the important terms that we use in lens?
3. What type of ray is used to form images in lens?

Where next

Students have to start thinking about how to form images in a concave and convex lens through the use of the rays they learnt now.

Closure

To close the lesson, allow students to describe what a lens is all about, the important terms and the rays used to form images in lens. Based on their ideas, try to summarize the important concepts.

Lesson 14: Image formation by Concave and convex Lens

Starting Off

Try to start the topic by asking students to recall the important rays used for forming images in lens as they are going to use it in their today's lesson. If they forget, try to remind them about the rays used to form images.

Lesson Description

Introduction

Explain to the students that they will be exploring about formation of image by a concave and convex lens one by one.

Input and Model

To help students to understand the types of image formed by concave lens, try to encourage students, in groups, to give response to question 6.21 after doing Activity 6.8 that they were asked to perform at home.

Inform them to compare the result they obtained from their activity with the summary of the properties of the image shown in Table 6.5. After that, inform them to do Activity 6.8. You can also create rooms for the students to:

1. describe the images formed by concave and convex lenses.
2. use ray diagrams to locate positions of images formed by converging and diverging lenses.

3. conduct experiments to determine the focal length of a converging lens.

4. Brainstorm in groups safety concerns in using mirrors and lenses and present it to the class.

You need to repeat the same procedure to teach about the types of image formed by a convex lens. In addition to these, you have to teach them about the uses of concave as well as convex lens.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What are the types of images formed by a concave lens?

2. What are the types of images formed by a convex lens?

3. What are some of the functions of concave as well as convex lenses?

Where next

Students should understand about the type of image formed by any optical instruments that use a lens.

Closure

To close the lesson, allow students to describe verbally about the type of images formed by concave and convex lenses. Based on their ideas, try to summarize the important concepts.

Lesson 15: Lens Equation

Starting Off

As usual, try to start the topic by giving chance for the students about the properties of images that are formed by concave and convex lenses that they learnt in their previous session.

Lesson Description

Introduction

Explain to the students that they will be exploring about Lens formula and magnification. To do this, try to encourage students to study the sign convention for lenses in groups as it enables them to understand the sign convention that we use in lens equation.

Input and Model

Provide students some noted on the sign convention that you use while using the lens formula. After that proceed to showing the relationships between object distance, image distance and focal length, i.e., the equation

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

You have to also teach them the meaning of magnification and the equation that is used to find the magnification

$$m=\frac{h'}{h}=\frac{v}{u}$$

Afterwards, you have to give them different questions to solve like those found in the text so as to help students to understand the applications of these equations. Students can solve the problems individually or in groups.

Try to also teach the students about the power of a lens (including its importance) and the relation it has with focal length.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those found at the end of the section on lens. You can also ask students questions like:
Compare converging and diverging lenses in terms of:

1. (a) Image formation
   (b) Magnification

Where next

Students have to extend their knowledge of lens equation and magnification in other situations like optical instruments.

Closure

Try to summarize the important concepts about the lens and magnification formulas by giving due emphasis on the importance of sign convention.

Answers to review questions

1. The image that is formed by a plane mirror is: virtual, same distance behind the mirror as the object is in front of the mirror, laterally inverted, same size as the object and upright.
2. The image is formed at a distance of 2m from the mirror and 0.5m high.
3. The number of images formed is $\left(\frac{360^o}{\theta} - 1\right) = \frac{360^o}{30^0} - 1$=12-1=11.
4. The principal focus of the concave mirror is the point where the reflected rays are all meeting / intersecting at a point on the principal axis of the mirror.
5. f=R/2=20cm/2=10cm
6. Concave mirror
7. We prefer a convex mirror as a rear-view mirror in vehicles because it gives a wider field of view, which allows the driver to see most of the traffic behind him. Convex mirrors always form a virtual, erect, and diminished image of the objects placed in front of it.
8. Concave mirror

9. $h = 1cm, f = +2cm, u = +4cm$; $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{2} - \frac{1}{4} = \frac{1}{4} \implies v = 4cm$
The image is real. $m = \frac{-v}{u} = \frac{-4}{4} = -1 \implies \frac{h'}{h} = -1$
$\therefore h' = -h = -1cm$

10. $h = 2cm, f = -2cm, u = 4cm$; $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-4} - \frac{1}{4} = \frac{-1}{2} \implies v = -2cm$
The image is virtual. $m = \frac{-v}{u} = \frac{-2}{4} = -0.5 \implies \frac{h'}{h} = -0.5$
$\therefore h' = -0.5h = -1cm$

11. In order to obtain a magnified image, the object should be placed beyond C and F.

12.

Position of the object	**Position of the image**	**Size of the image**	**Nature of the image**
Much further than 2F	Between F_2 and $2F_2$	Diminished	Real and inverted
Just further than 2F	Between F_2 and $2F_2$	Diminished	Real and inverted
At 2F	At $2F_2$	Same size	Real and inverted
Between 2F and F	Beyond $2F_2$	Enlarged	Real and inverted
At F	At infinity	Infinitely large or Highly enlarged	Real and inverted
Between F and O	On the same side of the lens as the object	Enlarged	Virtual and erect

13. $u = 50$mm; $f = 40$mm.
Since the object is placed between F and 2F, the image formed is inverted and enlarged. The sketch is similar to to Figure 6.25 (d). 14. $h = 6cm, h' = 3cm, u = +10cm$; $m = \frac{-v}{u} = \frac{h'}{h} \implies v = \frac{h'}{h} \times u = \frac{-3}{6} \times 10 = -5cm$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{u} = \frac{1}{10} - \frac{1}{5} = \frac{-1}{10} \implies f = -10cm$$

15. $h = 6cm, h^{'} = \frac{h}{3}; \; m = \frac{-v}{u} = \frac{h^{'}}{h} \implies v = \frac{-1}{3} \times u = \frac{-20}{3} = -6.6cm$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{u} = \frac{1}{20} - \frac{3}{20} = \frac{-2}{20} \implies f = -5cm$$

6.6 Human Eye and Optical Instruments

This section should fill approximately 2 periods of teaching time.

At the end of this section, students will be able to:

- describe the human eye in relation to lenses;
- list simple optical instrument in use in your locality;
- explain the physics behind the operation of optical instruments.

Lesson 16: Human Eye and Optical Instruments

Starting Off

Teacher, this section is also about a topic that is most familiar to the students as it is about human eye and optical instruments. This works based on the applications of mirrors and lenses. So it is expected from you to start the lesson by tapping into students' existing knowledge about mirrors and lenses. Try to also identify a misconception that is there with the students.

Lesson Description

Introduction

First try to introduce students to the lesson, i.e., human eye.

Input and Model

Provide students with what a human eye is all about. As the students are very familiar with their eye, try to give them the opportunity to learn by themselves through raising questions like those in exercises 6.22, 6.23 and 6.24. You have to also ask them to discuss in groups the types of lenses that are used to correct human eye image formation in the retina. So teach them in a more participatory approach. While doing this you need to give definitions of some of the important terms like retina, power of accommodation, myopia, hypermetropia and presbyopia.

Guide Students through Their Practice

While students are discussing on the activities, you are expected to guide them to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. What are the parts of a human eye that are responsible for the formation of an image?
2. What does it mean by the word power of accommodation?
3. What types of lenses are used to correct human eye image formation in the retina? etc.

Where next

Tell them about the importance of lenses in restoring human vision.

Closure

Summarize the important concept for students.

Lesson 17: Optical Instruments

Starting Off

As usual, try to start the topic by asking students prior knowledge about optical instruments through asking students responses regarding exercise

6.27.

Lesson Description

Introduction

Tell the students about the lesson topic, i.e., about optical instruments.

Input and Model

Provide students some note with what an optical instrument is. As students are highly familiar with optical instruments try to give them the opportunity to learn the details by themselves by making students to discuss on Activities 6.9, 6.10 and exercises 6.25, 6.26, 6.27 and 6.28. So teach them in a more participatory approach like:

1. Conduct in groups a literature research to find out the use of optical instruments. This could be by going to the library or asking different personnel in the compound or using internet. This could be arranged as a trip or some form of out of class activity. Present the result to the group in the class.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by using questions/prompts like those listed below.

1. What are the uses of optical instruments?

2. What type of image is formed by a simple microscope, compound microscope and telescope?

3. What are the differences between simple and compound microscope: refracting and reflecting?

Where next

Tell students to think about the functions of other optical instruments like camera that they did not learnt in the class.

Closure

To close the lesson, allow students to describe verbally what they learnt about optical instruments. Based on their idea, try to summarize the important concepts.

Answers to review questions

1. Accommodation is the ability of the eye lens to adjust its focal length.
2. Concave lens is used to restore the person's proper vision.
3. For a young adult with normal vision, the near point is about 25 cm. The farthest point up to which the eye can see objects clearly is called the far point of the eye. It is infinity for a normal eye
4. The student has myopia or near-sightedness defect. It can be corrected by a concave lens.
5. Camera, etc
6. A normal eye is unable to clearly see the objects placed closer than 25 cm because the ciliary muscles of eyes are unable to contract beyond a certain limit. If the object is placed at a distance less than 25 cm from the eye, then the object appears blurred and produces strain in the eyes.
7. A magnifying instrument that uses two types of lens to magnify an object with different zoom levels of magnification is called a compound microscope. It consists of two types of lenses viz the objective lens which creates a resolved image and the eyepiece lens which magnifies the object. A magnifying instrument that uses only one lens to magnify objects is called a Simple microscope. Some

examples of the simple microscope are jewelry eyepieces, reading glasses, and pocket magnifiers.

8. The difference between a reflecting telescope and a refracting telescope is that a reflecting telescope has a single or a combination of curved mirrors in order to reflect the light rays and form an image. And a refracting telescope has a lens as its objective lens to form an image.

9. The ability of the lens of the eye to adjust its focal length to clearly focus rays coming from distant as well from near objects on the retina is known as the power of accommodation of the eye. The power (P) of a lens of focal length f is given by the relation

   Power (P) = 1/f

   (i) the focal length of the lens required for correcting distant vision

   Power of the lens (used for correcting distant vision) = – 5.5 D

   Focal length of the lens (f) = 1/P

   f = 1/-5.5

   f = -0.181 m

   The focal length of the lens (for correcting distant vision) is – 0.181 m.

   (ii) the focal length of the lens required for correcting near vision

   Power of the lens (used for correcting near vision) = +1.5 D

   The focal length of the required lens (f) = 1/P

   f = 1/1.5 = +0.667 m

   The focal length of the lens (for correcting near vision) is 0.667 m.

10. Reflecting telescope. It is used to look at a distant object.

6.7 Primary colors of light and human vision

This section should fill approximately 1 period of teaching time.

At the end of this section, you will be able to:

1. list the primary colors of light;
2. describe the relation of primary color and human vision.

Lesson 18: Primary colors of light and human vision

Starting Off

Before starting the lesson, try to probe students' prior knowledge about colours of the visible light that they learnt in the previous sections.

Lesson Description

Introduction

First introduce students to the topic of the lesson, i.e., about the primary colors of light and human vision.

Input and Model

After checking students' response to exercise 6.30, provide them with the definition of the primary colours of light and then proceed to teaching through how a human eye detects colour. You can let students learn the topic through different active learning methods like cooperative learning by prompting some questions.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. List the primary colors of light.
2. What colors do you get when you combine red, blue and green?

3. Explain the relationship between primary color and human vision.
4. What are the two light sensitive cells in the retina?

Where next

Make students to appreciate the role of cones in viewing light. Try to encourage them to think the application of this in more advanced topics.

Closure

To close the lesson, allow students to describe verbally about primary colours of light and human vision. Based on their idea, try to summarize the important concepts.

Answers to review questions

1. Red, green and blue are the primary colors of light.
2. Rods and cones are the two major types of light-sensing cells (photoreceptors) in the retina. Cones are sensitive to colors.

6.8 Color addition of light

This section should fill approximately 1 period of teaching time.

At the end of this section, students will be able to:

- recognize how additive colors affect the color of light;
- add primary colors.

Lesson 19: Color addition of light

Starting Off

As usual, try to start the topic by activating student' prior knowledge about the primary colors of light.

Lesson Description

Introduction

Explain to students that they will be exploring about color addition of light.

Input and Model

After taking students' response to exercise 6.31, provide students with the definition of colour addition and then proceed to the results they obtain when adding two different primary colors of light to get new colors: yellow, magenta and cyan. To do this, try to encourage students to understand Figure 6.34 in class by forming different groups.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

Check for students' understanding while they are exploring by usijng questions/prompts like those listed below.

1. What colors did you get when you add red and blue, red and green, green and blue, red and blue and green?

Where next

Encourage them to think about the practical applications of color addition in their everyday life.

Closure

To close the lesson, allow students to describe verbally what they have understood about color addition including its application. Based on their idea, try to summarize the important concept.

Answers to review questions

1. Red + Green = Yellow, Red+ Blue = Magenta, Blue + Green = Cyan

2. Color television, color computer monitors and on-stage lighting at the theaters use the applications of color addition. A digital projector also works using the additive systems.

6.9 Color subtraction of light using filters

This section should fill approximately 1 period of teaching time.

At the end of this section, you will be able to:

1. describe color subtraction of light using filters.

Lesson 20: Color Subtraction

Starting Off

As usual, try to start the topic by probing students' prior knowledge about color addition. Then, ask students to think of their responses regarding exercise 6.32.

Lesson Description

Introduction

Explain to students that they will be exploring about color subtraction.

Input and Model

Provide students with the definition of color subtraction and then proceed to teaching through the functions of pigments or filter. Then, try to encourage students to study Figures 6.35 and 6.36 in groups. This helps them to understand what color subtraction means.

Guide Students through Their Practice

While doing the activities, you are expected to guide the students to learn by themselves.

Check for Understanding

While they are exploring, check for students' understanding by using questions/prompts like those listed below.

1. Explain color subtraction of light using filters.

Where next

Encourage them to think about the practical applications of color subtraction in their everyday life.

Closure

To close the lesson, allow students to describe verbally what they have understood about color subtraction including its application. Based on their idea, try to summarize the important concept.

Answers to review questions

1. If the pigment is green, then green light must be reflected. Therefore, red and blue light are absorbed.
2. Magenta is produced by combining red and blue.
3. Cyan is produced by combining and blue and green.
4. The object appears red.
5. Yellow light can be thought of as consisting of red light and green light. A blue pigment is capable of absorbing yellow light. That is, blue paper can absorb both red and green primary colors of light (recall that yellow light is a mixture of red and green light). So red and green light shine on the paper; and both the red and the green light are subtracted. There is no color left to be reflected to the eye. Subsequently, the paper appears black.

Lesson 21: Virtual experiments

Starting Off

Start the lesson by summarizing the important points of the unit.

Lesson Description

Introduction

Explain to the students that they will be going to do some selected virtual experiments. To do this, try to encourage students to recall what they already learnt.

Input and Model

Show students how to do the virtual experiments.

Guide Students through Their Practice

While doing the experiments, you are expected to guide the students to learn by themselves.

Check for Understanding

To assess students' learning, you may ask them different questions related to the experiment.

Where next

Students have to use the knowledge that they obtained here in solving other problems.

Closure

Before closing the lesson, try to summarize the important concepts related to the unit as well as the experiment.

Answers to end of unit questions and problems

1. You can draw a ray diagram similar to the one indicated in Figure 6.5 in the Students' Book.
2. The blue light with a wavelength equal to 470.0 nm will have a wavelength of 6.38 x 1014 Hz.
3. X-rays are used by doctors to see the inside parts of a patient. X- Rays are also used in airport security checks, to see inside your luggage. They are also used by astronomers - many objects in the universe emit X-rays, which you can detect using suitable radio telescopes. On the other hand, X-Rays can cause cell damage and cancers. This is why Radiographers in hospitals stand behind a shield when they X-ray their patients

4. Following are the advantages of X-Ray:

1. It is cheaper and simple technique.
2. It has lower radiation compared to CT scan.
3. X-rays are not absorbed very much by air; hence, specimen need not be in an evacuated chamber.
4. It helps to diagnose tumours easily without the need of surgery.
5. X-rays are widely used by radiologists to identify cracks, for infections, to identify level of injury, and to identify abnormal bones.
6. It helps to locate alien objects inside or around bones.

Following are the disadvantages of X-Ray:

1. It does not provide 3D information.
2. Bones can block significant diagnostic data as they absorb the radiation.
3. They do not interact very strongly with lighter elements.
4. Due to its radiation, it mutates cells which causes ionisation. This often leads to cancer.
5. It does not produce the best image but medium quality image.

5. In order of increasing wavelength: Gamma rays, X-ray, UV, Visible, Infrared, Microwave, Radio.
6. Definitely, they obey the laws of reflection.
7. The object should be placed between P and F.
8. The object should be placed at a distance less than 15cm from the concave mirror. The image that is formed is erect, virtual and magnified. You can refer to Figure 6.19 in the Students' Book.
9. a) concave mirror
   b) convex mirror

c) concave mirror

10. The image is formed between the focal point and the optical center. Thus, the object should have to be placed between infinity and the optical center of the lens. You can refer to Figure 6.26 on the students textbook.

11. The object is placed between F and 2F. However, the image that is formed by a convex mirror does not depend on the position of the object. Thus, the image formed is virtual, erect and diminished. You can refer to picture on the student's textbook.

12. The magnification produced by a plane mirror is is +1 which means that the size of the image formed is exactly equal to the size of the object behind the mirror.

13. Radius of curvature (R) = 30 cm

f = R/2 = 30/2 = 15 cm

u = -20 cm, h= 5 cm.

$$Since\ \frac{1}{v}+\frac{1}{u}=\frac{1}{f}\ ,\ \frac{1}{v}=\frac{1}{f}-\frac{1}{u}\ =\frac{1}{15.0}-\frac{1}{(-20.0)}$$

v = 8. 57 cm

Image is virtual and erect and formed behind the mirror.

m = -v/u= h'/h

h'/5= 8.57/20= 0.428

h' = 0.428 x 5 = 2.14cm

Position of Image: Behind the mirror.

Nature of Image: Virtual and Erect.

Size of the Image: Diminished.

14. h=+7cm, u=−27cm, f=−18cm

$$Since\ \frac{1}{v}+\frac{1}{u}=\frac{1}{f}\ ,\ \frac{1}{v}=\frac{1}{18}-\frac{1}{27}$$

v=−54cm

15. Yes it will. Even if half of the convex lens is covered with black paper, the lens will produce a complete image. However, the intensity of the image may be less. It can be observed experimentally by using a lighted candle and a convex lens.

Experiment

1. Take a lighted candle and place it in front of a convex lens mounted on a plane surface.

2. Move the candle along the axis of the plane to obtain the full image on the screen. Once the full image is observed, mark the position of the candle without moving it.

3. Now cover the lower exact half of the lens with a black opaque paper. Do not change the position of the candle.

4. At this point, you will observe a full image of the candle, but you will find that the intensity is reduced. This is because the covered part of the lens does not allow light to pass through it. So the amount of light reaching the screen is reduced.

16. As the object is placed beyond 2F, the image formed is real, inverted and enlarged. You can refer to picture on the student's's textbook.
17. $h' = 4h, v = -15cm; m = \frac{-v}{u} = \frac{h'}{h} \implies u = \frac{-1}{4} \times v = -\frac{-15}{4} = \frac{15}{4}cm$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{u} = \frac{4}{15} - \frac{3}{15} \implies f = 5cm$$

18.The difference is that light color mixing is additive. Pigment color mixing is subtractive. The primary colors of light are red, blue, and green. The primary colors of pigment are red, blue, and yellow. Both can be mixed to make new colors, yes, but so can secondary colors. That's not important. What makes a color primary is that it cannot be mixed using other colors. If you're working with light, you cannot create red, blue, or green by mixing other colors. If you're working with pigment, you cannot create red, blue, or yellow by mixing other colors. That's what makes them primary.
19. An object that appears black is absorbing all colors therefore none of the colors in the spectrum are being reflected.
20. When the lights go off, that is DARK. And there is no color. Color is generated by the reflection of light.

21. We know that magenta is a combination of red and blue primary colours of light. Therefore the object must be reflecting blue and red light and absorb green.

Index

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION