ZIMBABWE

Ministry of Primary and Secondary Education

Combined Science Module Level II Volume 2

Lifelong and Continuing Education

2020

Introduction

High demand for education and training in the 21st century has triggered change or the desire for every education system to evolve and respond to the ever increasing demand for literacy and numeracy as well as high quality products from the education system the world over. Educational institutions have no option but to transform and evolve and fulfil the increasing demand for quality education. Learners also demand an education system that is sensitive to the changing knowledge-based society. This also includes the need to expand and open up spaces for learning enabling learning to take place anywhere or everywhere.

This module comes as a response to the need for the Zimbabwean education system to reach out to all the learners and improve access to quality education. Upon the realisation that formal education is limited to formal pedagogical approaches and restricts access to education, this module provides learners with alternative approaches to acquiring education especially in the sciences. Coping with daily demands of adult life as well as the need to acquire academic qualifications and increasing one`s employability created the need for an open distance learning pathway.

The combined science module will provide you with a learning experience suitable for home learning. The module comes with interactive and exciting approaches to learning where the topics are arranged and designed to provide you with all the tutorials required by the competence based curriculum and sufficient enough depth to guide you for ordinary level combined science public examinations.

Wish you the best in your studies.

Acknowledgements

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How to use this module

As you start this journey of acquiring a qualification in Ordinary Level Combined Science through open distance learning, it is critical that you understand the need to manage your study time and balance it with your day-to-day activities. This module will provide you with the basic material to assist you towards your public examinations in Combined Science.

This module has been subdivided into two volumes, that is, Volume 1 Volume 2. You are advised to study Volume 1 first before going to Volume 2.

TABLE OF CONTENTS

PHYSICS SECTION

UNIT 20 DATA PRESENTATION AND MEASUREMENTS

CONTENTS

INTRODUCTION

It is important to present data or information in an easy way which can be understood by us scientists and others. Data must be clearly presented so that one cannot waste time trying to understand them. After doing our experiments numerical results must be presented in a way that can be read easily so that no time is wasted trying to understand them. There are many ways of presenting data and in this unit we will look at data presentation using pie charts and line graphs. We will also focus on the basic quantities to measure length, mass and time. Accurate measurements must be taken so that the results of the experiments are correct. It is also important to know the international system or SI (systeme international) units of measurement and we are going to discuss some in this unit.

OBJECTIVES

After going through this unit, you should be able to:

- Construct a pie chart
- Interpret and analyse pie charts and line graphs
- Express quantities in the correct SI units
- Derive other SI units from base SI base units

KEY WORDS

Here is a list of some of the new words you are going to meet in this unit:

Base SI unit – any of the seven SI units from which all of the other SI units are obtained.

Chart – a way of presenting data in the form of a picture.

Data –it is a collection of information.

Dependent value – a variable with values which depends on other another variable and is plotted on the y-axis.

Derived SI unit – any SI unit obtained from the base SI unit

Line graph – is a graphical display of data that changes over time

Origin – it is the zero point on the graph where the y-and x-axes are equal to zero.

Pie chart- a method of data presentation which shows data as a percentage of the total data collected

Variable – a value that is likely to change.

TIME: 8 hours

STUDY TIPS

Before you attempt the activity below, identify some of the methods used in data presentation. Also think about their advantages and disadvantages. List methods used in data presentation. State their advantages and disadvantages.

20.1 PIE CHARTS

We hope from the above tips you came up with many methods used in data presentation. These methods are very important in physics as they help us to present data in a much easier way which can be understood by everyone. Let's look at some of the methods of presenting data and we are starting with the Pie Chart.

Pie charts also known as circle chart shows data or information in an easy to read format with varying sizes displaying you how much of one data element exists. The bigger the size the more of that particular data was gathered. They represent data which is classified into different categories and you can easily see which item is the most popular and the least popular. You can use different colours to represent

different slices or categories of the pie charts. Pie charts are not commonly used in physics because they do not show the exact values and quantities. The pie chart below represents the percentage of different gases in exhaled or the air we breathe out.

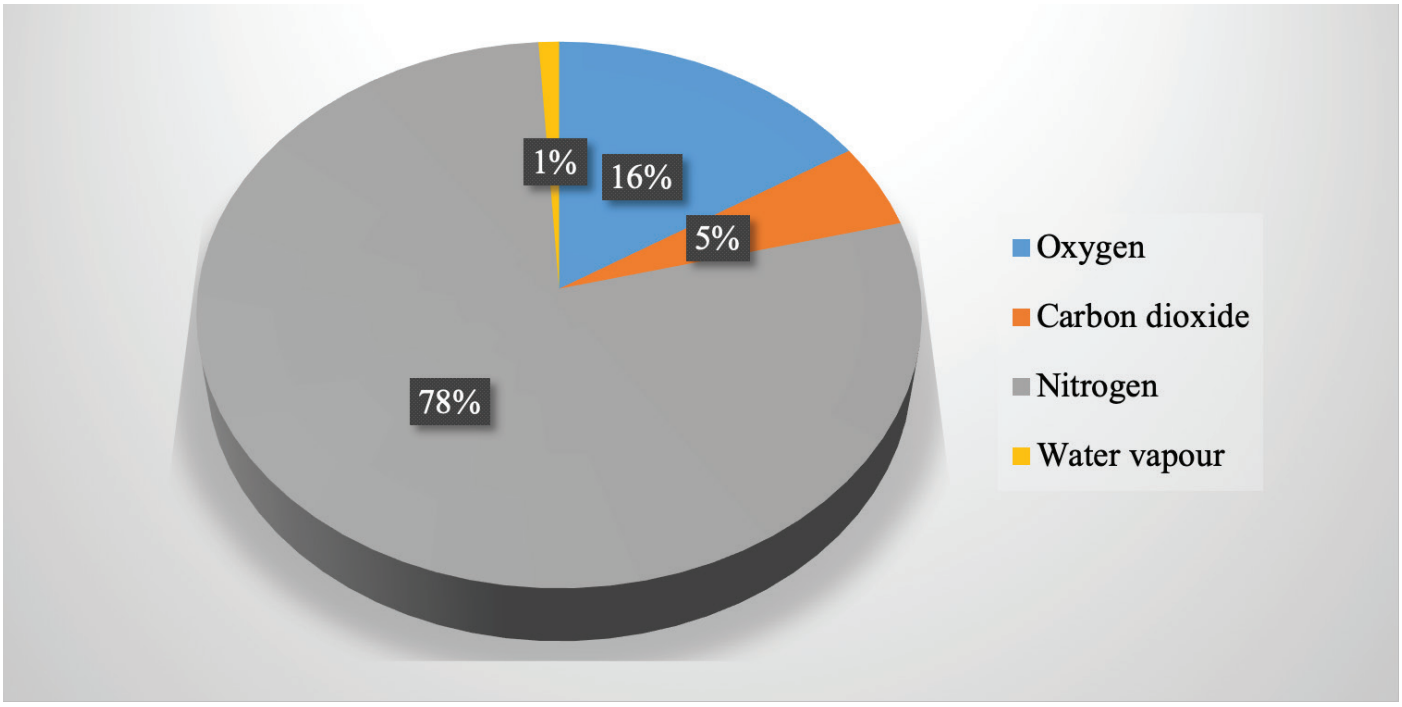


Fig 20.1 A pie chart showing amount of gases in exhaled air

Advantages of pie charts

Pie charts are easy to understand and interpret as compared to other methods of data presentations. They can also summarise large quantities of data.

Disadvantages of pie chart

However, pie charts do not display the exact figures of the quantities but just show proportions. Pie charts also do not show changes of quantities over time.

ACTIVITY 1

Can you try the following activities to see how much you have grasped so far

1.Use the information below to construct a pie chart of the percentage number of people against their favourite type of meat.

Type of meat	Percentage no of people
Chicken	55
Beef	25
Pork	10
Mutton	10

HINT: when constructing a pie chart take note of the following steps;

- Put your data in a table as in table above in activity 2
- Divide each number by the total and express it in percentage by multiplying by 100.
- Determine the number of degrees of each sector by multiplying by 360.

20.2 Line graphs

Line graphs are used in comparing different events or situations and they present data which changes continuously over time. They are made up of the vertical or y-axis and the horizontal or x-axis. They are made up of the independent variables (for example temperature) which are plotted on the horizontal axis and the dependent variable (for example no of days) on the vertical axis. We can also alter the variables and study the effects. The independent variables can be altered and the dependent can be the responding variables. After carrying out an experiment a graph is used to find the relationship between the independent and dependent variables.

The point where the y-axis and the x-axis are equal to zero is called the origin. The information presented by the graph is obtained from the title of the graph and also by looking at the x-axis and the y-axis which are always labelled. Data or information is first provided in a table of results with a set of numbers. The table of results is then used to plot a line graph. If the line graph passes through the y-axis the point is called the y-intercept and if it passes through the x-axis the point is called the x-intercept. The relationship between the two variables being studied is determined by the gradient of the curve. Gradient is the change in value on the y-axis divided by the change in value on the x-axis.

When gradient is positive or negative a straight line graph is formed. In the case of a straight line graph, the variables are directly proportional hence they

increase together. If the straight line graph has a negative gradient it is inversely proportional hence the x-axis values increases as the y-axis decreases and vice versa.

Advantages of line graphs

Line graphs are suitable for presenting complex data. Line graphs can also show changes over time for example distance travelled over a given period of time. Line graphs can also be used to show relationships between two or more variables. Can you think of any disadvantages of line graphs?

Disadvantages of line graphs

Line graphs are difficult to construct as they require a high degree of accuracy.

ACTIVITY 2

Now that you leant more on line graphs answer the question below;

The Data below show the number of days' vs the percentage germination of bean seeds

No of days	Percentage germination
Day1	0%
Day 3	10%
Day 5	45%
Day 6	85%
Day 7	90%
Day 8	95%

(a) Plot a line graph of number of day vs percentage germination.

(b) Answer the following questions using your graph

Use you graph to determine the percentage of seeds that germinated on:

(i) day 2 (ii) day 4

(c) Which day had the highest percentage germination?

REMEMBER: You use your free hand when joining points in a straight line graph. The line must be smooth and each point is joined by a straight line. Remember to label y-axis and the x-axis. Use a suitable scale when constructing a line graph.

20.3 The SI Units

There are three basic quantities we use in physics and these are length, mass and time. The SI Units are used internationally by all scientists so that we use the same units to measure physical quantities. The table below shows the base SI Units used by scientists:

Unit	Symbol	Quantity measured
Metre	M	Length
Second	S	Time
Kilogram	Kg	Mass
Ampere	A	Electric current
Kelvin	K	Temperature
Candela	Cd	Light intensity
Mole	N	Number of particles

There are also other units that are derived from the base SI Units and are called derived SI Units. Below are some of the derived SI Units;

Unit	Symbol	Quantity measured
Square metre	m^2	Area (length×breadth)
Cubic metre	m^3	Volume (breadth× length×height)
Volt	V	Potential difference
Metres/second	m/s (velocity)	Velocity
Newton	N	Force (mass×acceleration)
Joules	J	Work (force ×distance)
Watt	W	Power
Ampere	A	Current

Work is measured in joules and the example below shows how the unit of work is derived from the two base units of force and distance.

Example

A constant of 40N force pulls a cart over a distance of 4m. Calculate the work done.

Work done = force × displacement

40N × 4m

160Nm or 120 J

20.4 Measurements

Taking measurements is very important in all the investigations in science. When doing this remember accuracy is very important in order to make sure that the findings of investigations are reliable. Selecting the correct instrument for measurements is the most important tool towards accurate measurements.

Measuring length

The SI unit used for measuring length is metre (m). Below are some of the instruments used in measuring length. Which instruments do we use to measure length? The choice of instrument to use depends on what is to be measured. Let us look at some instruments below and see how and when do we use them.

Ruler

Can be made up of wood, plastic or Perspex with very small markings of 1mm and large markings of 1cm. Measuring using a ruler requires you to be very close to the object you are measuring. Your eyes must be above the reading so that you can measure correctly. This is the most common instrument you use for example in geometry lessons.

Measuring tape

This piece of material has markings like those of a ruler. It is used to measure objects that are not flat or straight like the circumference of a pipe. Think of what the tailor uses.

Vernier callipers

Used for measuring highly accurate measurements like the diameter of objects such as pipes. A Vernier calliper is made up of two scales, the main scale with markings similar to those of a ruler and a vernier scale with markings in 0,1mm. When taking measurements, you first read from the main scale and then the Vernier scale.

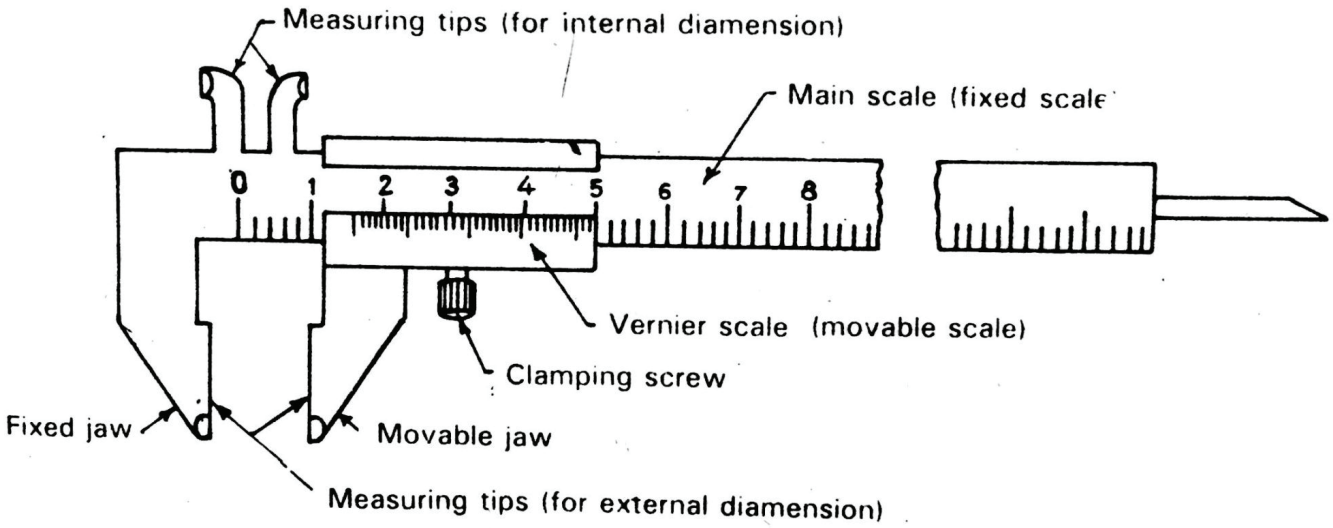
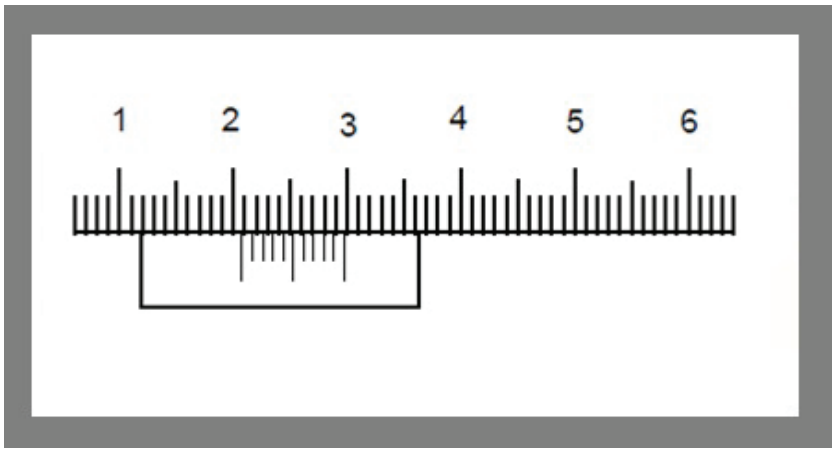


Fig 20.2 showing a Vernier calliper

ACTIVITY 3

In this activity you are going to practise on how to take a reading from a vernier calliper.



Step 1:

Take note of the reading on the main scale to one decimal. In this case it is 2.0

Step 2:

Look for the mark on the Vernier scale that is in line or almost in line with the markings on the main scale. In this case it is the 8^{th} division that appears to be the best choice. So the Vernier scale reading will be 0.08 by multiplying it with fractional part i.e. 0.01.

Step 3:

The add the Vernier scale reading to the main scale to get the answer which in this case is 2.0 + 0.08.

So the answer is 2.08 cm.

Measuring current and voltage

As we saw at the beginning of this unit, voltage and current are physical quantities that can be measured. Voltage is measured by a voltmeter in volts (V). Voltmeters can be analogue that is the moving arm ones or digital. Current is measured using an ammeter which can also be analogue or digital like the voltmeter. Current is measured in amperes (A)

Measuring density

Density is the mass per given volume of matter. The SI unit for density is grams per cubic centimetre (g/cm^3). It can be calculated by dividing the mass of an object by its volume. It can be easily calculated in solid objects that are in perfect shapes

Determining density of different substances

When calculating the density of a liquid, you need to measure its volume and mass first then divide the mass obtained by the volume of the liquid. Do you recall how to measure the volume of an irregular object like a small stone? If not revise your work on measurements in Level 1

1ml of liquid =$1cm^3$ in volume of the liquid

Activity - Experiment3

Aim

To determine the density of different liquids

Apparatus/Materials

Different liquids to measure mass (e.g. water, cooking oil), a balance, two measuring cylinders

Method

Weigh the measuring cylinder and record its mass. The mass must be in grams

Pour 10ml of water into the cylinder. This must be done carefully and accurately.

Measure and record the mass (cylinder plus water) in grams.

Calculate the mass of the water only

Using the mass of water and volume used determine the density of water.

Results

Mass of Measuring Cylinder	
Mass of Measuring cylinder + water	
Mass of water	

Calculation

Density = $\frac{mass}{volume}$

Conclusion

The density of a liquid can be determined by dividing its mass by its volume.

SUMMARY

You have learnt that data presentation is very important in science so that data or information is presented in a way that is easy to understand. We also learnt that there are various methods of data presentation and in this unit we focused more on pie charts and line graphs. Pie charts presents data as a total percentage and classify it into different categories so that the most popular and least popular items can be easily seen. They are not commonly used in physics because they do not show the exact values and quantities.

Line graphs represent data that changes continuously over time. They are used to compare different information. They are made up of the horizontal (x-axis) and the vertical (y-axis). The independent data is plotted on the horizontal axis and the dependant data on the vertical axis. We also learnt that taking measurements is also very important in science and accuracy is vital to make sure the results of the investigations are correct. You need to use the appropriate measuring instruments and the use of SI units is also very important.

Now you can answer the following questions below inorder to assess your understanding. If you face challenges in answering, go back to the unit and read again. Use the spaces provided for answering.

20.4 ASSESSMENT QUESTION

Multiple choice questions

Note: Surround the letter with the correct answer

1. What is data presentation? (1)

   A method of data analysis and interpretation.

   B. A way of presenting data in an understandable way.

   C. The use of pie charts and line graphs.

   D. A method of calculating data on a line graph.

2. The following is a disadvantage of using a pie chart (1)

   A. Exact values are not shown.
   B. Data is presented in a circle divided into sectors.
   C. Suitable for representing complex data.
   D. Can be used to make predictions about results.

3. A straight line graph is said to be directly proportional when; (1)

   A. There are two variables under investigation
   B. It has a negative gradient
   C. It slopes downwards
   D. it has a positive gradient

4. The information displayed by the graph is obtained from; (1)

   A. The title of graph.
   B. The y-intercept.
   C. The two variables being studied
   D. The negative and positive values

5. Vernier callipers measure very small lengths such as; (1)

   A. Current through a conductor.
   B. Diameter of a test tube.
   C. Density possessed by a matter
   D. Density of solid objects

Structured questions

1a) What do you understand by the following terms?

(i) Density (2)

(ii) Independent data (2)

(iii) Dependent data (2)

b) Why do we use line graphs more than pie charts in data presentation? (2)

2a) List two disadvantages of line graphs (2)

b) How do we calculate the density of solid objects with regular shapes (2)

c) how many decimal places can a Vernier calliper measure (1)

d)What is the SI unit for density (1)

Practical question

3) Describe the procedure you would use to determine the density of an irregular object (5)

(b) What is the SI unit for force? (1)

TOTAL = 25 MARKS

UNIT 20-POSSIBLE ANSWERS

1.B

2.A

3.D

4.A

5.B

Structured questions

1a) (i) Density-it is a measure of how much matter is contained in a given volume. (2)

Independent data-variables which are placed on the horizontal axis and can be altered. (2)

(ii) Dependent data– variable with values which depends on other another variable and is plotted on the y-axis. (2)

b) - they can reveal changes over time

- they can represent complex data

- they can show relationships between two or more variables (2)

2a) -Creating an accurate scale can be time consuming

- Difficult to plot decimals

- cannot be visually appealing as compared to pie charts (2)

b) Density (p) = $\frac{\text{Mass of the object}}{\text{Volume of the}}$

c) 2 decimal places. (1)

d) kg/m^3 and g/m^3

Practical question

3) - measure and record the mass of the stone

- fill the measuring cylinder half way with water and record the volume

put the stone into the measuring cylinder gently and record the new volume.

- subtract the second volume reading from the first in order to get the volume of the stone

- repeat the experiment using other objects like a sharpener or a rubber

(b) Pascal (pa)(1)

TOTAL = 25 MARKS

Unit 21: FORCE

CONTENTS

Introduction

Have you ever wondered why objects placed high above ground will always fall towards the ground and not move upwards into space? Well your imagination leads us to this new concept of forces. In this Unit you will learn about weight as a type of force. You will also cover content on Newton's laws of motion and their application is everyday life. Concepts on principle of moments will also be dealt with in this unit.

OBJECTIVES

After going through this unit, you should be able to

- define weight, mass, momentum and inertia
- distinguish between weight and mass
- explain Newton's laws of motion
- describe the concept of pressure
- describe the structures and operations of simple pumps
- describe functions of machines

KEY WORDS

Gravitational force: it is the force that pulls objects downwards. 1 kg is pulled down by a force of 10 N

Motion: anything that is moving is said to be in motion

Resultant force: it is the force that results when two or more forces interact

TIME: 8 hrs

STUDY SKILLS

Make sure you have completely understood the key words mentioned above so that they will help you understand concepts being taught in this unit.

21.1 Mass and weight

When was the last time you measured your weight? I hope it was very recent, now what was your weight.

You have often heard people using the word mass and weight interchangeably but is it always correct to do so. If you said the words mass and weight cannot be used interchangeably then you are correct. Before we proceed can you answer these questions. What is mass and in what units do we measure mass? What is the difference between mass and weight?

Activity 1: Comparing mass and weight

What you need

- Two equal half bricks
- Bucket full of water

What to do

1. Take two equal half bricks and hold them separately one in each hand.
2. State how heavy or light each feels
3. Take one hand and dip it into the bucket of water, whilst you are still holding the half brick
4. How heavy or light does the brick feel when it is immersed in water.

Results

Now complete the results table below

	Out of water	In water
Feeling when holding the half brick (weight)		
Mass	Does not change	Does not change

Expected Results

We hope you noticed that the brick feels light when immersed in water as compared to when held outside the water.

Conclusion

What conclusion do you make from the results obtained from this activity.

Take note: The above experiment clearly shows you that the weight of a substance can change whilst its mass does not.

Information obtained from the activity makes you and me want to compare mass and weight.

Now complete the exercise below that compares mass and weight.

Feature	Mass	Weight
Units		
Type of quantity		Vector
Direction of movement	No direction	

21.2 Newton's laws of motion (1642-1727)

Sir Isaac Newton was a famous British Scientist; he studied the behaviour of moving objects and he came up with three laws of motion.

Newton's first law of motion

Isaac Newton said that, "Every object continues in its state of rest or uniform motion in a straight line unless a resultant force acts on it to change its state."

This law can be broken down into two main aspects.

a) The law tells you that if there is no resultant force acting an object that is at rest, the object will remain at rest forever.

I am sure you have seen large rocks in places around you and these large rocks have never moved since you saw them. This is what the first law implies, it means there never was a large force enough to move the rocks.

Activity 2:

Aim: Testing Newton's first law of motion

Materials

Identify a large rock or building near you.

Method

- Push heavily against the rock or building.
- Observe whether it moved or not.

Results

Did the large rock or building move after you pushed it?

Expected Results

I am sure you discovered that you could not even shake let alone move the rock or building.

Conclusion

Therefore, the rock or building will remain at rest until a larger force (resultant force) acts on it.

b) Secondly, the law implies that for an object moving with constant speed in a given direction, it will continue to do so unless acted upon by a resultant force.

Newton's second law of motion

In order for you to understand Newton's second law of motion, carry out the following activity.

Activity 3

AIM: To observe the speed of movement of differently sized particles when hit by an object supply equal force.

Materials

- Two rock particles, one half the size of the larger one or two plastic balls of the same size.
- Wooden plank.

Method

Place the ball on the floor or a smooth surface on a straight line.

Hit the balls with the plank by pushing it very hard against the balls at the same time.

Observe the speed of movement and the distance covered by each ball.

Results

Now what did you observe?

1) Which ball moved furthest?
2) Which ball travelled at a higher speed upon being hit by the plank?

Conclusion

Therefore, what conclusion can you make from the results of this activity:

I am sure you concluded that the rate at which an object changes its speed is dependent on its mass, if the force is kept constant.

This is what Isaac Newton observed and concluded in his second law of motion which states that, "When a resultant force acts on an object of constant mass, an acceleration will result with the product of its mass and acceleration being equal to the resultant force, the direction of the acceleration being in the same direction as that of the resultant force."

Put mathematically, the law states that;

Force = Mass ×Acceleration

It is therefore necessary for you to know the formula for calculating acceleration.

Acceleration = Change in Velocity/ Time

Question 1

a) A block of mass 500g is pushed on a smooth floor with a force of 200N. Calculate its acceleration. (3)
b) What force might reduce the acceleration of the block. (2)
c) How can the force in (b) above be overcome? (2)
d) Expected answers to question 1

a) Force = mass × acceleration
Acceleration (m/s^2) = Force (N) / Mass (kg)
Acceleration = 200N/ 0.5kg
= $1000m/s^2$

b) The force is friction.

c) Friction can be overcome by lubrication.

Questions

1) A ball of mass 200g is hit by a metal rod with an unknown force. If its acceleration is $10m/s^2$, find the size of the force hitting the ball. (3)
2) A toy car is pushed on a horizontal surface with a force of 150N. If it accelerates at a rate of $2m/s^2$, what is its mass? (3)
3) A car of mass 1000kg takes off from rest and achieves a top speed of 100m/s in 2 seconds. Find the force of the car's engine. (4)

Newton's third law of motion

Activity 4

AIM: To observe action and reaction forces

Apparatus

Balloon

Method

1. Blow air in to a balloon until it is full, close it with your fingers
2. Release the balloon into the air at same time releasing your hold on the opening of the balloon.
3. Observe how the balloon moves

Observation

How did the balloon move?

Conclusion

– What conclusion do you draw from the observation?

Tip:

Your conclusion is the basis of Newton is third law of motion.

– I hope you concluded that the force of air moving out of the balloon forced the balloon to move forward.
– Newton the stated that "for every action there is an equal and opposite reaction"
– It can be noted from the law that:

1) For every force backwards there is a force forward.

2)The two opposing forces are equal.

Application of Newton's laws of motion

Below are some of the applications of the knowledge of Newton's laws of motion.

a) Rockets burn fuels which produce exhaust gases which escape at high pressure from the rocket propelling the rocket upwards.
b) Tyres of cars should have a firm grip so that they are able to provide the needed reaction to stop a moving car when needed.
c) Sport shoes such as spikes have high gripping surfaces so as to provide the much needed grip during the sporting activity.

Research questions

Now find more applications of uses of the laws of motion.

21.3 Momentum and Inertia

A 50kg bag filled with sand and another 50kg filled with grass are placed before you. If you are asked to move them a distance of 2m which is easier to move and why?

I hope you mentioned that the bag filled with grass is easier to move than the one with sand, the reason being the difference in masses of the contents of the bags. This reflects the inertia of the bags. Inertia is the tendency of objects to resist change in their positions of rest.

Inertia is also defined as the reluctance of stationary object to start moving or if moving its reluctance to stop moving. Mass is the quantity which resists change in position of an object.

Examples of situations showing inertia

A rock of mass 5 tonnes resists any force trying to move it, it will only move when a large force such as an earthquake.

A locomotive carrying a large load for example 80 tonnes if it is travelling at a constant speed it will require a large force to increase its speeds or to stop the wagon

What do you think affects inertia?

For the same 50kg bag containing sand, remove half the sand from the bag and then try to move the bag.

RESULTS

Was it easier or more difficult to move the bag?

If you correctly observed it was easier to move the bag with half the contents.

Conclusion

The ease of moving an object depends on its mass.

The activity above has shown you that inertia depends on.

The mass of the object

1. Two objects of masses 5kg each are moving at
a. The first one at 10 m/s
b. The second at 20m/s
a) Which mass (i) or (ii) is easier to stop? (2)
b) Give a reason or your answer in (a) above (3)
c) Define Inertia
d) State the factors that affect the inertia of an object

MOMENTUM

This is the product of mass and velocity of a substance. Momentum has no units.

21.4 Pressure

Have you ever noticed the surface area of the feet of a water duck or the width of a racing car tyre? If you look closely you will notice that both have a large surface area. This is how they distribute their weight on their surfaces of contact. Their weight is distributed evenly over a large area to reduce the pressure they exert of their contact surfaces.

What then is pressure?

Pressure is force per unit area.

$$\text{Pressure} = \frac{\text{Force N}}{\text{Area}}$$

Pressure is measured in Pascal's.

Calculate pressure.

1] What is the pressure on the ground if a force of 200N is applied to the ground using a wooden log of sides 50cm by 20cm

$$\text{Pressure} = \frac{force(200N)}{AREA\ (0.5mx0.2)}$$

Pressure = 200/0.01

= 20 000Pa

2] A block of weight 500N is being pushed in a wheelbarrow, if an area of 0,4m^2 of the wheel of the wheelbarrow is in contact with the ground, Find the pressure exerted on the ground by the wheelbarrow.

Now use the format used in question to find pressure [3}.

3] If the force is not changing, what is the effect of increasing the surface area of contact on the pressure exerted by an object?

Pressure in liquids

This section deals with the pressure exerted by liquids. If you once dived into deep waters during swimming what was the feeling as you sunk deeper into waters? Was there any change in pressure as you sunk deeper or when you moved closer the surface. The answer to the question lies in the activity below:

Activity 5

Aim: to compare the pressure of liquids at different heights.

Apparatus: long water container

Water

Pin

Method

1. Fill the container with water.
2. Mark the container at 10cm intervals as shown on diagram.
3. Use pin to open holes at the marked points.
4. Observe the length of the liquids column coming out of the containers.

Diagram

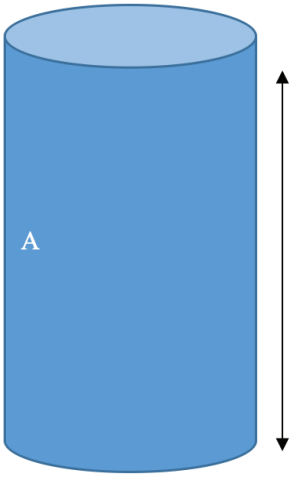


Fig 21.1 pressure of liquids

Results draw diagram showing the movement of water out of the container.

Your results should show a pattern shown on this diagram

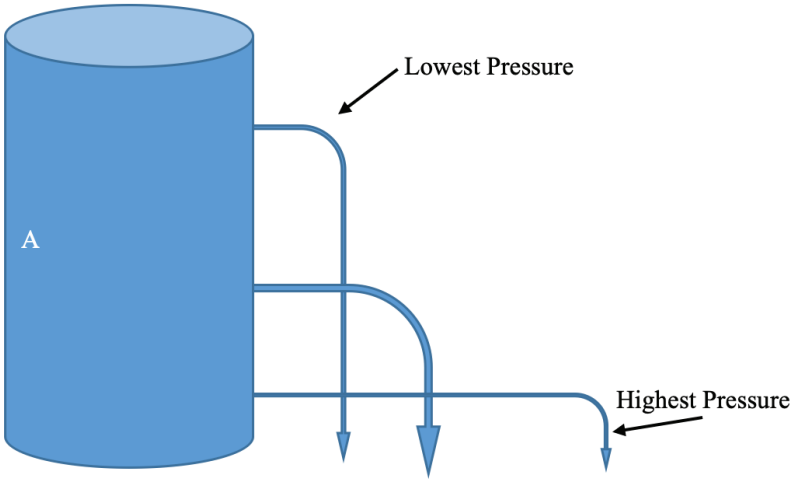


Fig 21.2 pressure of liquids

Use the results of this experiment to answer questions on the next objective.

The effect of depth on liquid pressure

- You have noticed that height or depth can increase or reduce pressure of a liquid from activity B.
- Another important factor is density of the liquid, the larger the density of the liquid the higher the pressure will be.

Formulae for calculating pressure in liquids:

Pressure = density x Gravity X height

TIP

- Force of gravity is always 10N unless stated otherwise.
- Height should be in meters.
- Density should be in kg/m^3.

Practise questions

1. Find the pressure of a liquid column 50cm, if its density is 2kg/m^3.

   Solution

   Pressure = density X gravity X height
   = $2kg/m^3$ X 10N X 0,5m
   = 10Pa

2. a) Now the density of a liquid column exerting a pressure of 200Pa if the liquid column is 1,5m height.[3]

   b) On an overhead water tank, what is the best point to put the outlet pipe. [2]

   c] Give a reason for your answer in above. [2]

   Describe the construction and use of a simple manometer.

   A manometer is used to measure pressure of gas.

   A manometer is a U shaped pipe as is shown on FIG 21.3

   Diagram

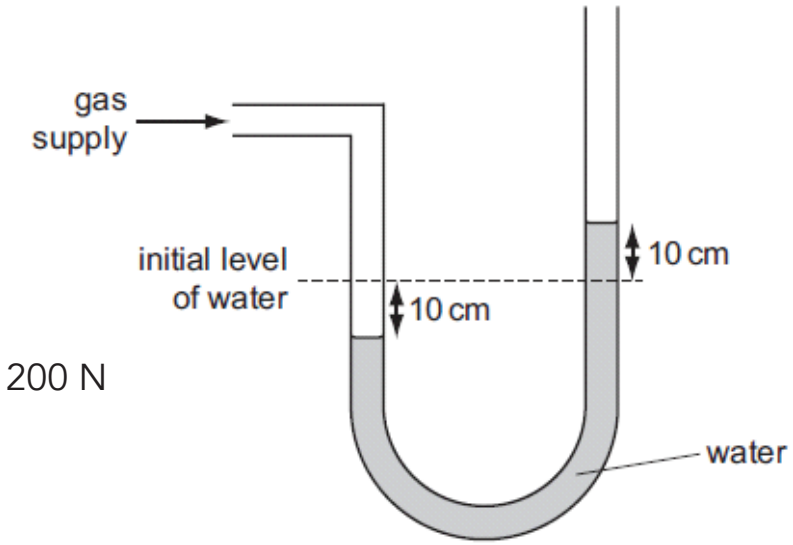


Fig 21.3 manometer

- When a liquid is placed in the U shaped pipe before the gas is connected, it settles by having the same height on both sides of the column. This is so because atmospheric pressure will be equal at all points of the manometer.
- When the gas is connected, the liquid in column a moves down while the liquid in column b moves up.
- Pressure of the gas will be atmospheric pressure + pressure to due to change in height. Pressure = hpg + atmospheric pressure
- Change in height of column b in mainly used.

Questions

Find the pressure of the gas shown on this manometer.

Diagram

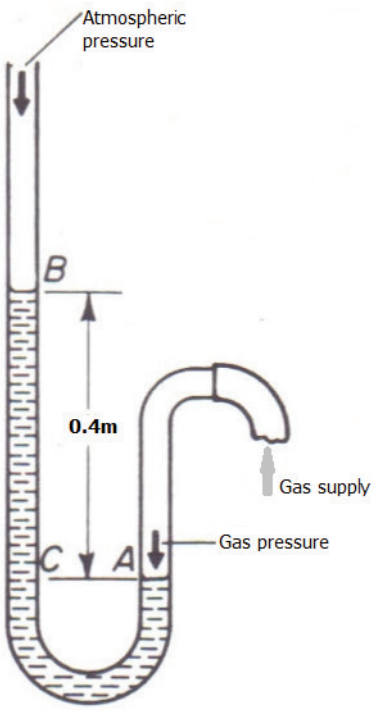


Fig 21.4 pressure of gas

Given that atmospheric pressure is 2Pa and density of liquid is 0,2kg/m^3

Solution

Pressure of gas = atmosphere Pressure + pressure due to change in height

= 2Pa + density X height

= 2Pa + 0/2kgm^3 X0,4m

= 2Pa + 0'8

= 2,8Pa

Operation of simple fluid systems

The following simple fluid systems have improved the lives a man kind a lot, the siphon, the hydraulic jack and car brake systems. The mysteries of the devices will be demystified as their operational frame work is made much clearer and simple.

A siphon

This is a method of draining a liquid from one container to another using the concept of atmospheric pressure.

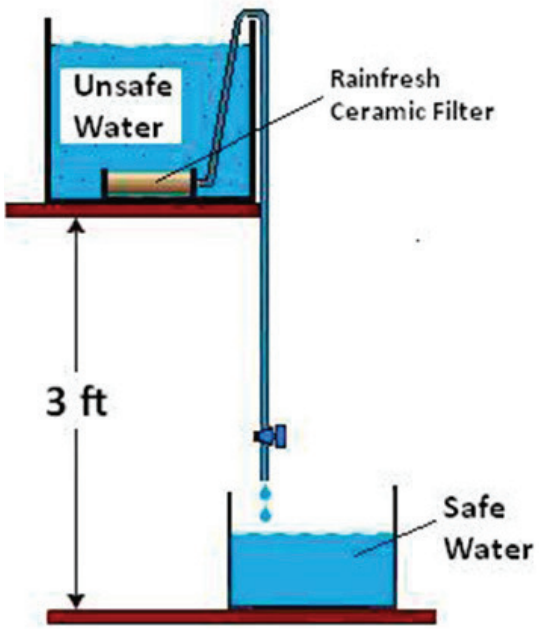


Fig 21.5 shows such a siphon

Activity: 6

Aim: to demonstrate draining a liquid using a siphon.

Material: two water container

Horse pipe

Water

Method:

Now set up apparatus as is shown on fig 19.2

Suck the lower end of the horse pipe in receiving end.

Now observe what happens.

Results

If you correctly carried out the operation you will observe water now freely draining from the supply tank to the receiving end until the supply tank is empty.

Conclusion

Was it possible to use atmospheric pressure to pump liquid. Yes; it is possible to use atmospheric pressure to pump liquids from one container to another.

How it works

Try to explain how the siphon works.

TIP: use the concept of pressure inside the horse pipe.

Well done here is how it works:

1] When you suck air out of the pipe, region of low pressure is created inside the pipe.

2] Atmospheric pressure above water in the supply tank forces water in the supply tank into the pipe so as to balance pressure.

3] The flow of water continues until it is finished up.

Take note:

The supply end of the pipe must be above the receiving end of the pipe for the siphon to work.

Hydraulic Jack

- When people want to remove wheels of their cars, what did they use to lift up their cars so that they can easily change the wheels?
- I hope you mentioned a hydraulic jack as one of the instruments they can use to lift their cars.

First let us define a hydraulic jack:

- It is a device that uses little force to lift heavy loads.

Diagram below shows a hydraulic jack

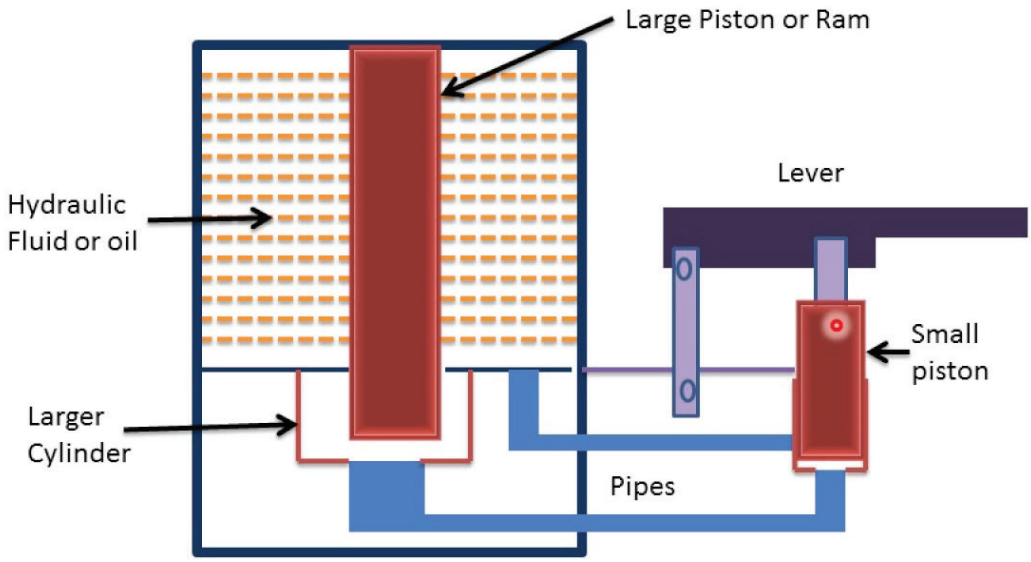


Fig 21.6 hydraulic jack

How it works

Activity 7

Aim: to demonstrate how a hydraulic jack operates.

Materials: hydraulic jack

Heavy load such as car or

Rock boulder

Method:

- Place hydraulic jack under heavy boulder.
- Start to apply force to the input part of the hydraulic jack and observe what happens.

Conclusion

It is possible to use a small force to lift a large load.

Hydraulic fluid cannot be compressed.

- Now a small effort on a small area create a large pressure.
- Pressure created on piston a is transmitted unchanged to piston b.
- At b, the pressure is multiplied by a large area to create a large force.

Question

Calculate the load which the hydraulic jack can lift.

Side A

Force 10N

Area $0,2m^2$

Side B

Area $0,8m^2$

Find force/load

Solution

TIP: follow the following steps when doing these calculations:

a] first find pressure of the hydraulic fluid:

Use formula pressure = $\frac{\text{force}}{\text{Area}}$

Side a pressure = $\frac{10N}{0{,}2m^2}$

= $\underline{50Pa}$

b] Pressure created on side A will move to side b unchanged.

For side b pressure = $\frac{\text{Force}}{\text{Area}}$

Pressure X area = Force

Force = 50pa X $0.8m^2$

Force = $\underline{40N}$

You have now seen how a small effort is used to lift a large load.

CAR BRAKING SYSTEM

Cars need to have effective brake system to help them stop in needy situations. What do you think is the mechanism in cars to help them to stop effectively when needed to.

TIP: car brake system operates on a hydraulic system.

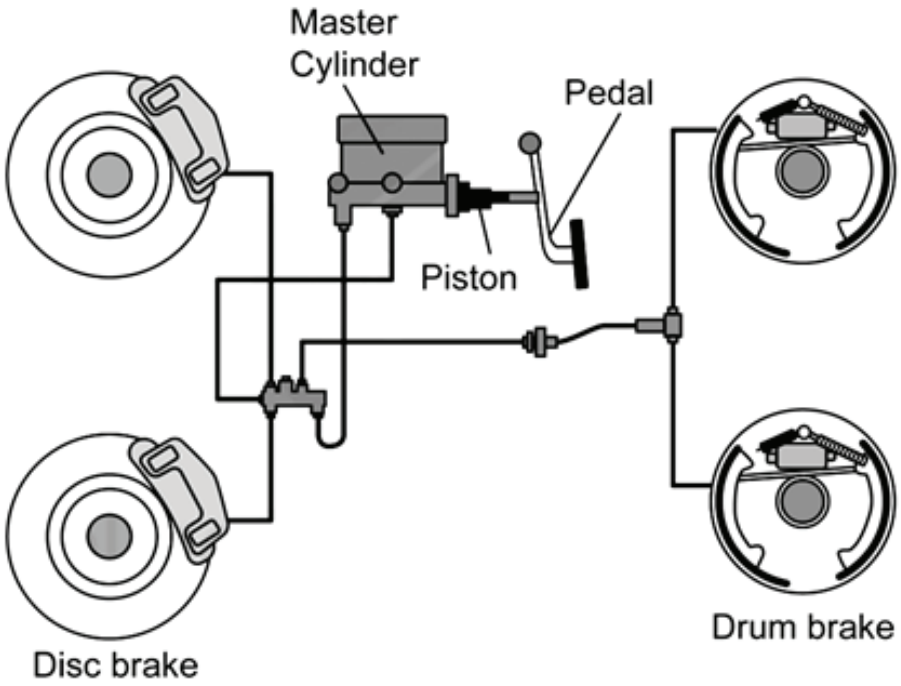


Fig 21.7 showing a car brake system

On stepping on the brake pedal what do you think happens to the pistons in master and slave cylinders.

I hope you noted that on applying force on brake pedal.

a) Piston in master cylinder moves down.
b) A large pressure is created which is transmitted by brake fluid to slave cylinder uncharged.
c) At slave cylinder the piston is pushed out and then presses against wheel drum stopping the car.

On releasing the brake pedal

a) Piston in master cylinder moves back.

b) Pressure inside master cylinder decreases.

c) Brake fluid flows from master cylinder to slave cylinder.

d) Piston in slave cylinder moves back causing brake shoes to release the wheel drum allowing car to move.

Questions

1. Describe the operation of a siphon [3].

2. Outline how a hydraulic jack is used to lift a load.

Describe the Structure, Functions and Operation of simple pumps.

Pumps are a necessary part of our everyday life. They have a wide range of uses including pumping water, fuel and other substances from one point to another. The operation of lift pump, force pump and Blair pump will be dealt with here.

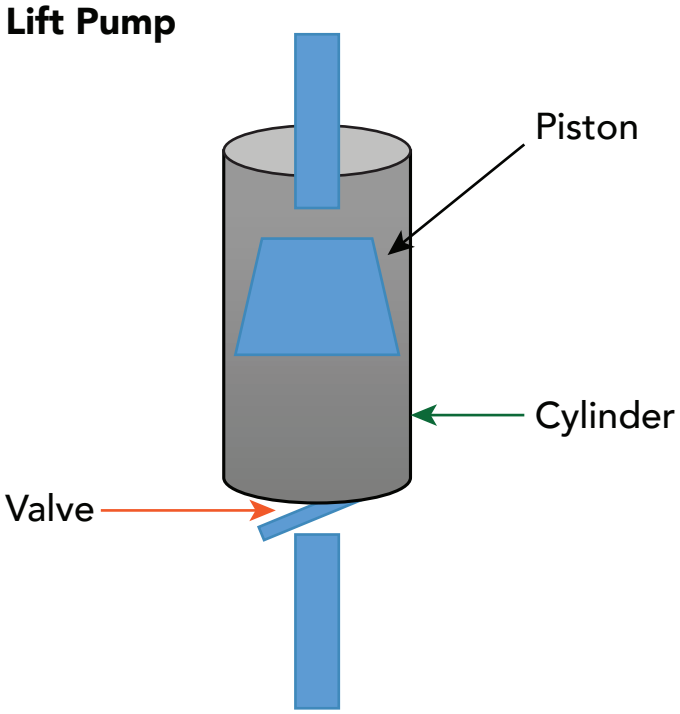


Fig 21.9 lift pump

- When the piston moves up pressure inside the cylinder decreases, atmospheric pressure forces water into the cylinder.
- Values prevent the back flow of water in general.
- Work is done when the piston is moving upwards.

Uses of lift pumps

Used to draw water from wells and other sources below the ground

What do you think are some of the disadvantages of using a lift pump?

.....

.....

.....

.....

I hope you have noted the following disadvantages:

1] Most lift pumps cannot draw water for wells whose depth is above 10m.

2] Lift pumps need to be primed first before use.

The Force Pump

Force pumps which operate in the manner where work is done the piston is moving down.

Question

1] Give an example of a force pump you know.

Answer

I hope you mentioned the bicycle pump as one such example of a force pump

The bicycle pump

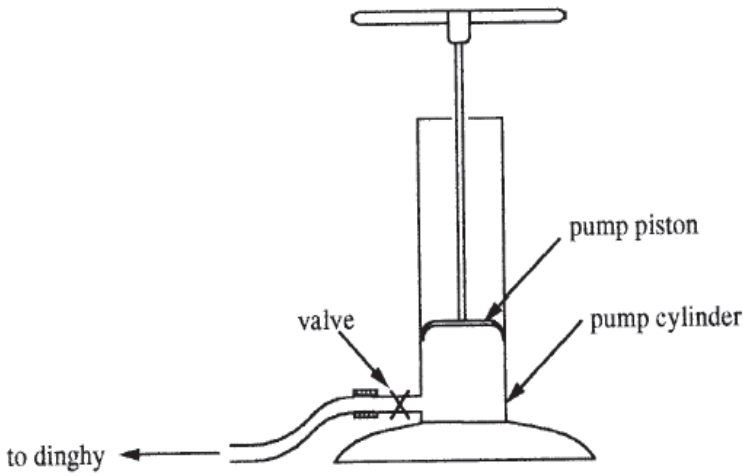


Fig 21.10 the bicycle pump

Activity 8

Aim: to observe the internal parts of a bicycle pump.

Apparatus: **bicycle pump**

Method:

Dismantle the bicycle pump and then state / identify the parts.

Observation:

I hope you managed to identify all of the following parts:

i) Handle
ii) Collapsible ring
iii) Cylinder
iv) Connecting pipe

Blair pump

Simple to react and cheap to maintain

- It combines aspects of both lift and force pump.
- Used to draw water from wells upto a depth of 12m.

How it works

Handle is linked to a piston which moves up and down.

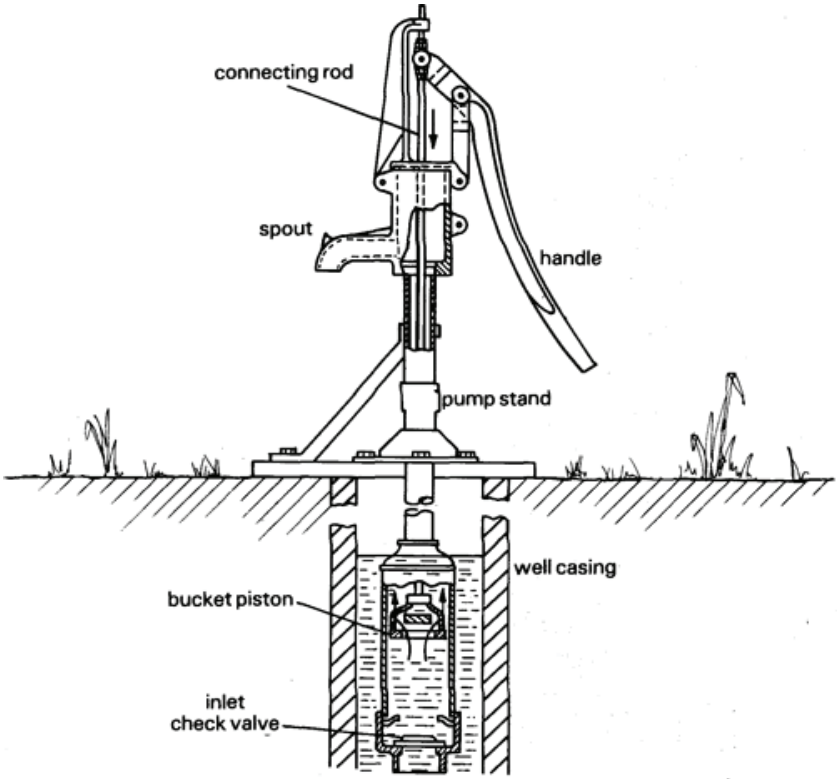


Fig 21.11 blair pump

During upstroke

- Valve at the bottom opens, as the piston moves up.
- Pressure inside cylinder decreases atmospheric pressure forces air into cylinder/ piston valve is closed.

During down stroke

- Valve at the bottom closes.
- Valve at the piston opens.
- Pressure inside cylinder increases forcing water out through the outlet/ spout.

SUMMARY

In this unit you have learnt about the exciting concept of force, you should now be able to define key terms associated with force. You also learnt about pressure due to solids and calculated pressure due to solids, liquid and gases. Interestingly you covered work on the application of atmospheric pressure on everyday life. By now you should also be able to state types of pumps and describing the structure and function of each pump should you have any challenges in understanding any of the concepts covered in this unit, please revisit this whole unit again and also seek information from other sources especially the internet. In the next unit you will learn about machines

21.6 SAMPLE ASSESSMENT QUESTIONS

1) The following is a form of force except
   a) Weight
   b) Gravity
   c) Mass
   d) Friction.

2) What is the effect of increasing the surface area on the pressure exerted if the force is kept constant?
   a) Pressure increases
   b) No change in pressure
   c) Pressure depresses
   d) None of the above

3) What is the pressure of a liquid column of density $2kg/m^3$ and has a height of 2cm.
   a) 400 pa
   b) 100pa
   c) 40pa
   d) 4pa

4) Which instrument is used to measure atmospheric pressure?
   a) Barometer
   b) Manometer
   c) Thermometer
   d) Vacuum pump

5) The bicycle pump in an example of a
   a) Lift pump
   b) Vacuum pump
   c) Force pump
   d) Blair pump

6) Brake fluid is used in hydraulic machine because:
   a) It can be compressed.
   b) It is cheap
   c) It is less dense than water.
   d) It cannot be compressed.

7) The correct formulae for calculating pressure in solids is:
   a) Force divided by area.
   b) Area divided by force
   c) Density divided by area
   d) Pressure divided by force.

8) Define pressure.

9) Name an instrument used to measure pressure in liquids

10) Describes how a manometer is used to measure gas pressure, include diagram if necessary {10}

11) State the formulae for measuring gas pressure using a manometer. [2]

12) Outline how a bicycle pump is used to put pressure into a tube {5}

13) Why are water supply tanks usually built on high areas above the ground [3]

14) State the principle of moments. (2)

15) Why is advisable to apply your effort to the extreme end of a Borehole handle than close to the pivot, when using the borehole to draw water from the ground? [5]

Answers to multiple choice questions

1 C

2C

3C

4A

5C

6D

7A

UNIT 22: MACHINES

CONTENTS

INTRODUCTION

Machines have found their way into each and every sector of our lives. Machines have made life's challenges easier and more interesting to tackle. In this unit you are going to learn about the various types of machines, how these machines help in doing work and calculations involved when dealing with machines. This unit will also cover energy lose in machines and how they can be overcome. We hope you will find this unit very interesting, informative and stimulating to the mind.

OBJECTIVES

After going through this unit should be able to:

- Describe the uses and application of machines.
- Determine mechanical advantage, velocity ratio and efficiency of levers and inclined planes, pulleys and gears.
- Explain energy losses in machines

Describe ways of improving efficiency in machines.

KEY WORDS

- Work –it is the product of force and distance
- Machine-is any device that makes works easier
- Velocity ratio –it is a ratio of the distance moved by an effort in relation to the distance moved by the load.
- Efficiency –it is a percentage ratio of the work output against work input

TIME: 8hours

STUDY SKILLS

- Make sure you have understood the topic on energy so as to maximise understanding of this unit.
- During calculations use a calculator and round off your answer to 2 decimal places.

22.1 MACHINES

Let us start by asking trying to find out what a machine is. Can you state down what you think a machine is? Hopefully you managed to answer the two questions. Think of how you can carry a 50 kg bag of cement. You are most likely going to use a wheel barrow instead of carrying it by your head. The wheel barrow in this case is a machine that is making your work easier.

Simply put a machine is anything that makes your work easier. Machines are designed in such a way as to make doing work easier. Let us now look at various types of machines.

22.2 TYPES OF MACHINES

We have a quite a number machines but in our study we are going to concentrate on levers, pulley systems, inclined plane then gears

22.2.1 The lever

This is one of the simplest type of machines.

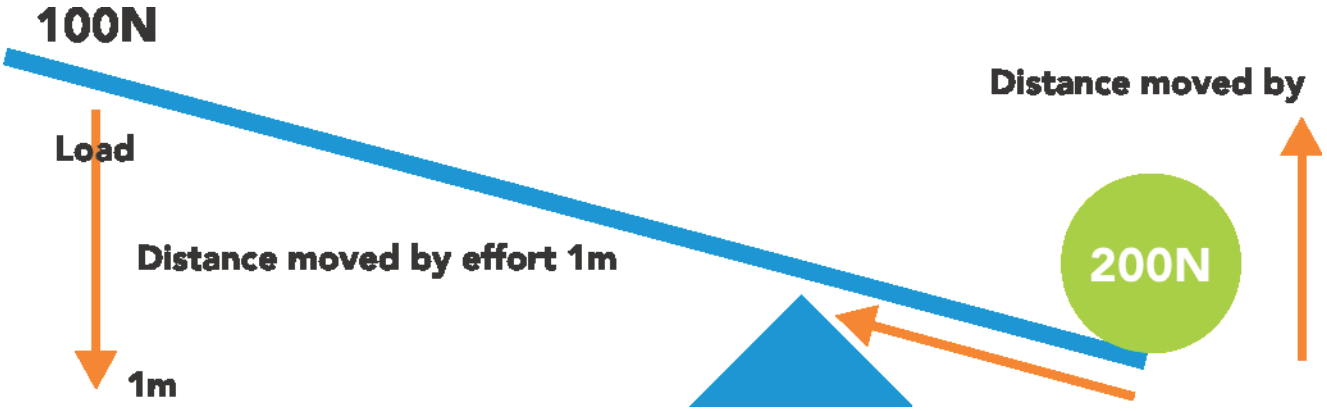


Fig. 22.1 The lever

Mechanical /Advantage of the Lever (M.A)

Ideally a machine should do more for less effort put into it. It should be easier to do work using a machine than without using it.

From the above diagram showing the lever, the mechanical advantage if found by the following method

$$\text{Mechanical advantage} = \frac{\text{load}}{\text{Effort}}$$

$$= \frac{200N}{100N}$$

$$= \underline{2}$$

Velocity Ratio (V.R) of the Lever

This is a ratio of the distance moved by an effort in relation to the distance moved by load.

$$\text{Velocity Ratio} = \frac{\text{Distance moved by effort (M)}}{\text{Distance moved by load (M)}}$$

$$= \frac{1m}{0,5m}$$

$$= \underline{2}$$

22.2 Inclined plane

This type of a machine uses a beam which is inclined against a structure into which a load is to be placed. Fig 23.2 below shows such a machine:

The load is rolled over the inclined plane into the loading bay as shown:

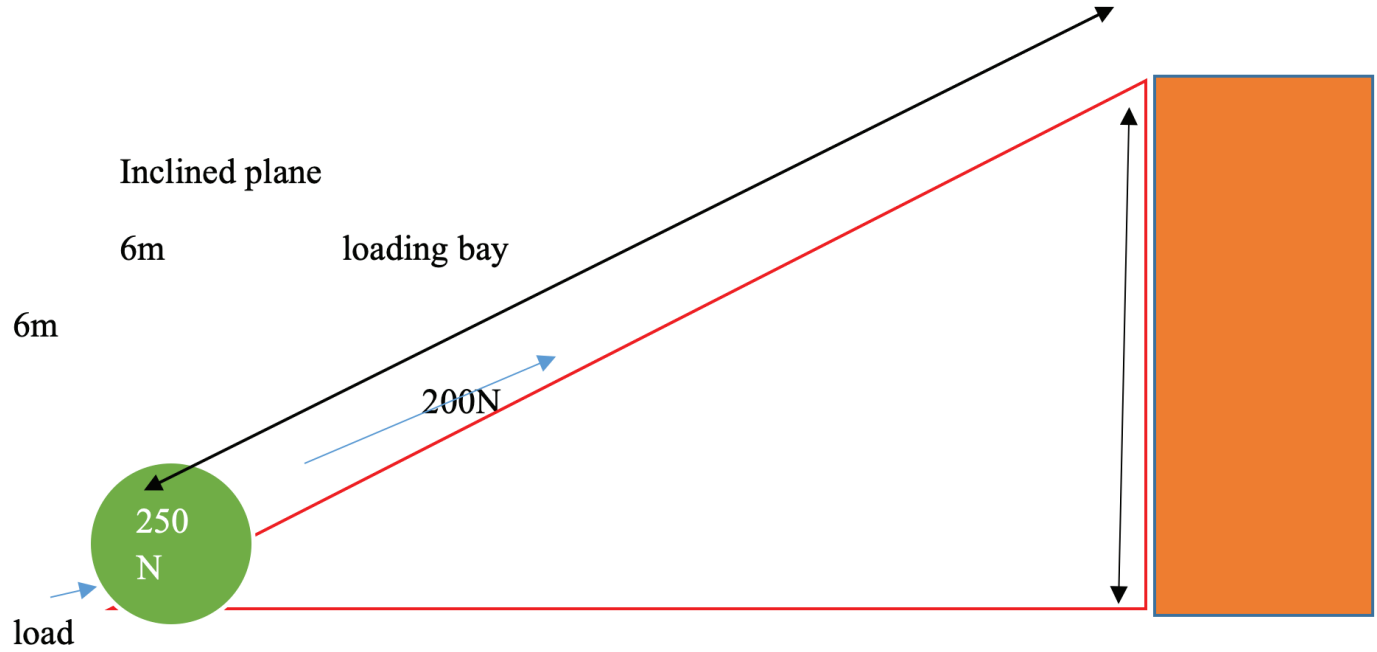


Fig 22.2 The inclined plane

Mechanical Advantage of the Inclined Plane

The formula for calculating mechanical advantage still remains the same.

$$\text{Mechanical advantage} = \frac{\text{load}}{\text{Effort}}$$

$$= \frac{250\text{N}}{200\text{N}}$$

$$= \underline{1.25}$$

Velocity Ratio of the Inclined Plane

All machines have the same way of determining MA but for VR it differs from one machine to another. The VR of an inclined plane is given by length of incline divided by height of incline.

$$\text{V R} = \frac{\text{length of incline}}{\text{Height of incline}}$$

For the inclined plane above its VR is determined as follows:

The correct distances are as follows:

Distance moved by effort 6m

Distance moved by load 4m

The formula for calculating velocity ratio remains the same.

$$\text{Velocity Ratio} = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$$

$$= \frac{6M}{4M}$$

$$= 1.2$$

Take note that both MA and VR do not have units because the units cancel off.

22.3 PULLEYS AS MACHINES

Pulleys are rotating wheels over which a rope carrying a load is pulled over. Pulleys can be either fixed or immovable. Pulleys as machines help in making work easier through change of direction of applying effort force and also acting as a force multiplier.

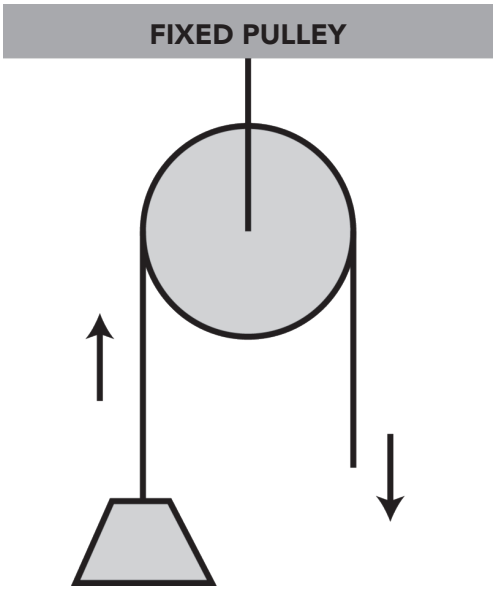


Fig 22.3 Single Fixed Pulley

The single fixed pulley has an advantage in terms of application of effort force. Consider when hoisting a flag, you pull it up when you are applying effort downwards. Mechanical advantage is 1 and velocity ratio is also 1. The distance moved by the effort is equal to the distance moved by the load. Single fixed pulleys are usually used in situations where the load is not too much.

MOVABLE PULLEY

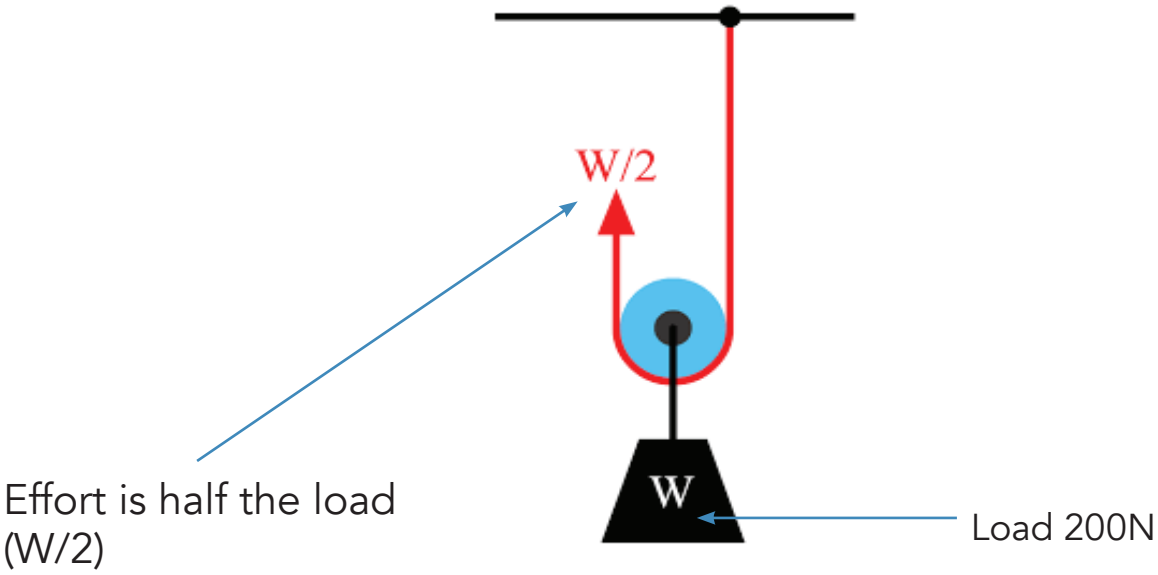


Fig 22.4 Single Moveable Pulley

Mechanical advantage

The formula for calculating mechanical advantage remains the same. In the pulley above the MA is as shown in the calculations below

$$\text{Mechanical Advantage} = \frac{load}{effort}$$

$$= \frac{200N}{150N}$$

$$= 1.33$$

Velocity ratio of a movable pulley

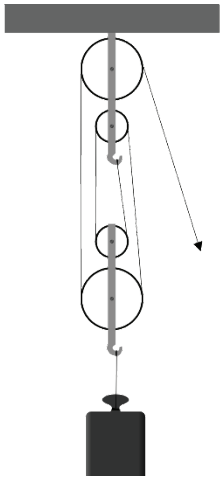
What do you think is the velocity ratio of this pulley? For a single moveable pulley, the VR is 2 meaning if the effort moves 2metre the load moves 1 metre. The advantage is in terms of MA which is greater than for a single fixed pulley. Here less effort is applied.

$$= \frac{1.33}{2} \times 100\%$$

$$= 66.5\%$$

BLOCK AND TACKLE

It combines fixed and movable pulleys. Fig 22.5 shows a block and tackle



Effort 150 N

Load 300 N

Fig 22.5 Block and Tackle

Mechanical advantage

The formula for calculating mechanical advantage remains the same.

$$\text{Mechanical Advantage} = \frac{\text{load}}{\text{Effort}}$$

$$= \frac{300N}{150N}$$

$$= \underline{2}$$

Velocity ratio

The velocity of this Block and Tackle can be found by:

- Counting the number of strings supporting the lower movable pulley.

Now what is the velocity ratio of this pulley system shown in Fig 22.5
.....

Hope you have visited garages where pulleys are used to lift engine blocks. Where else have you seen pulleys being used? If you visit large industries where boxed goods need to be loaded into vehicle, you probably have seen these pulleys.

Pulleys are used for many reasons but mainly for the following reasons:

They change the direction of movement of effort, by that it means you can use a pulley so that when you pull downwards the load moves up and vice-versa.

Objects can be raised or lowered to positions where it would have been difficult to get there by using hands.

EFFICIENCY OF PULLEYS

Block and Tackle need to be well oiled for them to reduce energy loss by friction.

The formulae for calculating efficiency remain unchanged.

$$\text{Efficiency} = \frac{\text{Mechanical Advantage}}{\text{Velocity ratio}} \times 100\%$$

$$\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} \times 100\%$$

$$\text{Efficiency} = \frac{\text{load} \times \text{load distance}}{\text{Effort} \times \text{Effort distance}} \times 100\%$$

Using fig 22.5 Efficiency = $\frac{\text{Mechanical Advantage}}{\text{Velocity ratio}}$ X 100%

= $\frac{2}{4}$ X 100%

= 50%

You will notice that pulleys like all other machines are not 100%. What do you think is the reason for this? Well moving parts in any machine produce friction and friction causes energy loses. Apart from friction the weight of the pulleys contributes is another cause for decrease in efficiency. How then can efficiency be improved?

Friction is reduced through lubrication. Lightweight materials for pulleys are used to also improve efficiency

GEARS AS MACHINES

There are 2 types of gears namely load gear and effort gear. Gears helps to change the velocity ratio of a mechanical system.

The formula for calculating mechanical advantage remains the same:

Mechanical Advantage = $\frac{\text{load}}{\text{Effort}}$

Velocity ratio in gears

The velocity of in gears = $\frac{\text{Number of teeth on load gear}}{\text{Number of teeth on effort gear}}$

Fig 22.6 Gears

Efficiency in gears

Gears need to be well oiled for them to reduce energy loss by friction.

The formulae for calculating efficiency remain unchanged.

$$\text{Efficiency} = \frac{\text{Mechanical Advantage}}{\text{Velocity ratio}} \times 100\%$$

22.3 ENERGY LOSS IN MACHINES

Have you ever tried to cycle a bicycle with little or no pressure in the tubes of the wheels? I am sure you found it extremely difficult to cycle even a very short distance. Have you ever wondered why, well the answer lies in energy loss in machines due to various factors?

Machines are not 100% efficient due to energy losses mainly due to:

Friction: moving machine parts rub against each other a lot thereby losing energy as heat and sound.

Weight of machine parts: machines with heavy machine parts require a lot of energy

How then can energy losses be reduced in machines? Refer to energy loses in pulleys for hints.

IMPROVING THE EFFICIENCY OF MACHINES

Energy losses by friction can be reduced by lubricating moving parts of the machines. By so doing friction is kept at minimal.

Efficiency can also be increased by reducing the weight of machine parts. Lighter machines are generally more efficient that heavy machine parts.

SUMMARY

By now you have learnt about the wonderful world of machines. You are now able to define and give examples of common machines. You should also be able to calculate mechanical advantage, velocity ratio and efficiency of machines. Importantly, you also dwelt on how machines lose energy and now these energy losses can be minimised. The world of machines should be clearly opening up to you. Should you have any challenges in understanding any of the concepts covered in this unit, please go through this whole unit again paying a lot of attention to all detail. When you have completely mastered concepts of this unit, now get ready to look into another interesting topic of special machines called petrol and diesel engines.

22.4 ASSESSMENT QUESTIONS

1. What is the correct formula for calculating Mechanical Advantage of a machine?

   a) M.A = $load$

   b) M.A = $\frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load}$

   c) M.A = $\frac{load}{effort}$

   d) M.A = $\frac{distance\ moved\ by\ load}{distance\ moved\ by\ effort}$

2. A boy uses a lever to lift a load of 500N, he applies an effort of 200N. what is the Mechanical advantage of the lever.
   a) 2,5N
   b) 10 000N
   c) 0.4
   d) 2,5

3. Fig 5 shows a machine used for rolling a drum up to the top of a loading bay , use Fig 5 to answer questions 3, 4, 5 and 6.

   Name the type of machine
   a) Crowbar
   b) Inclined plane
   c) See-saw
   d) Pivot

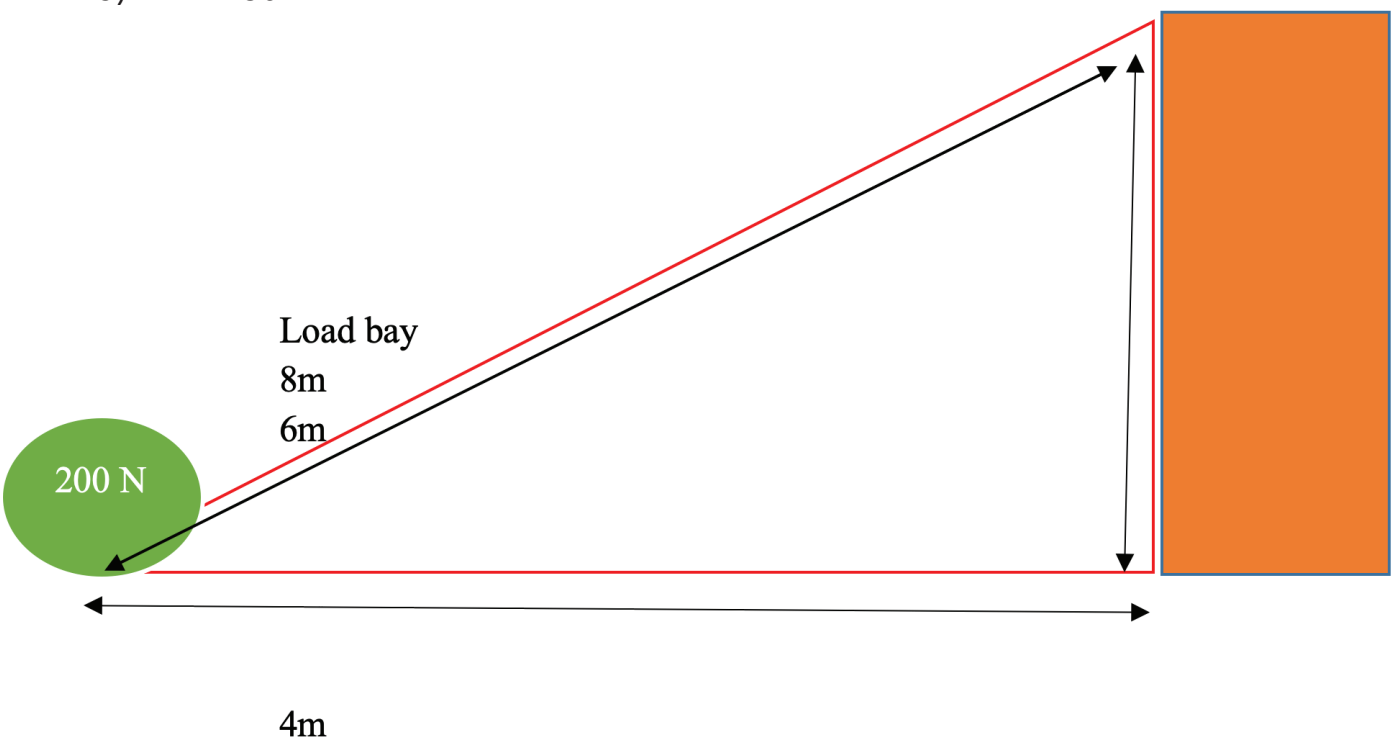


Fig 5

4. What is the mechanical advantage of the system?
   a) 1,25
   b) 0,5
   c) 20N
   d) 800N

5. What is the velocity ratio of the system?
   a) 48
   b) 13,3
   c) 2
   d) 1,3

6. Using work output and work input, what is the efficiency of the system as a percentage?
   a) 9,3
   b) 93
   c) 63
   d) 39

7. What is the velocity ratio of a single movable pulley?
   a) 1
   b) 3
   c) 2
   d) 4

8. When a machine is well lubricated the following change except
   a) Mechanical advantage
   b) Efficiency
   c) Work input
   d) Velocity ratio

9. The following factors increase the efficiency of a machine except?
   a) Lubricating
   b) Reducing weight of machine parts
   c) Increasing the weight of machine parts
   d) Introducing on rollers moving parts

10. What is the velocity ratio of gears with a load of 20 teeth and an effort gear of 10 teeth.
   a) 0,5
   b) 2
   c) 100
   d) 200

11. What is the effect of removing heavy machine parts with lighter ones?
   a) Efficiency decreases
   b) Velocity ratio increases
   c) Velocity ratio decreases
   d) Efficiency increases

12. A load of 120N is lifted by an effort of 60N. What is the mechanical advantage of the system?
   a) 0,5
   b) 2
   c) 120
   d) 80

13. If a load of 80N is lifted 2m high by an effort of 40n moving a distance of 5m. What is the efficiency of the system?
    a) 80%
    b) 20%
    c) 100%
    d) 90%

14. Question 14 and 15 refer to fig 6

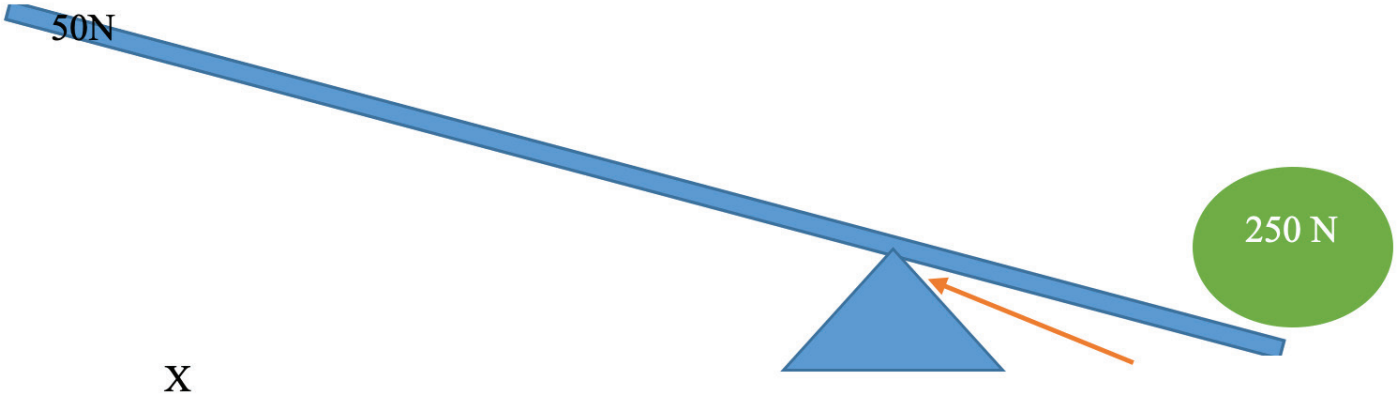


Fig 6

Name the instrument
    a) Pulley
    b) Block and tackle
    c) Lever
    d) Hammer

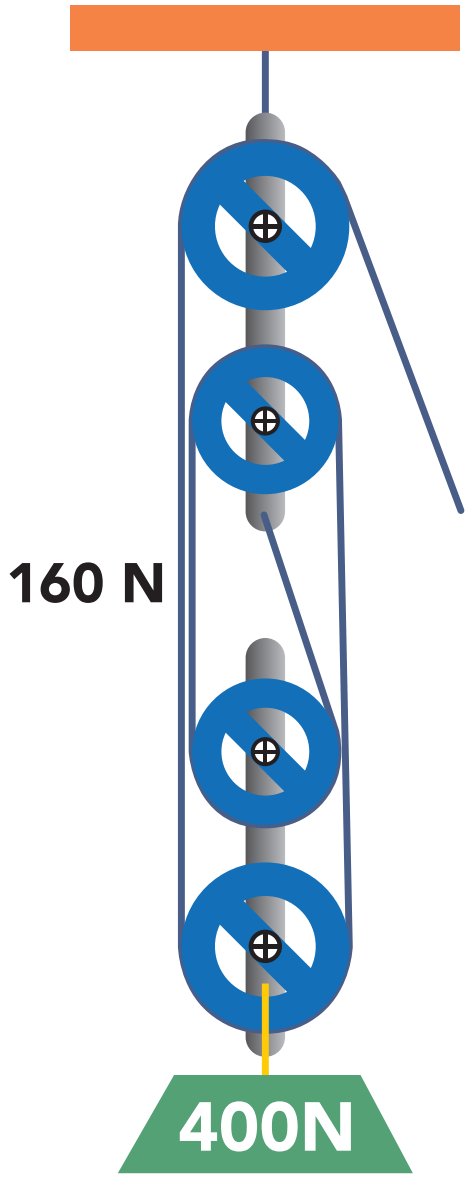
15. Identify part X
    a) Fixed pulley
    b) Fulcrum
    c) Wielding bar
    d) lever

STRUCTURED QUESTIONS

1. Define and give 2 examples of machines

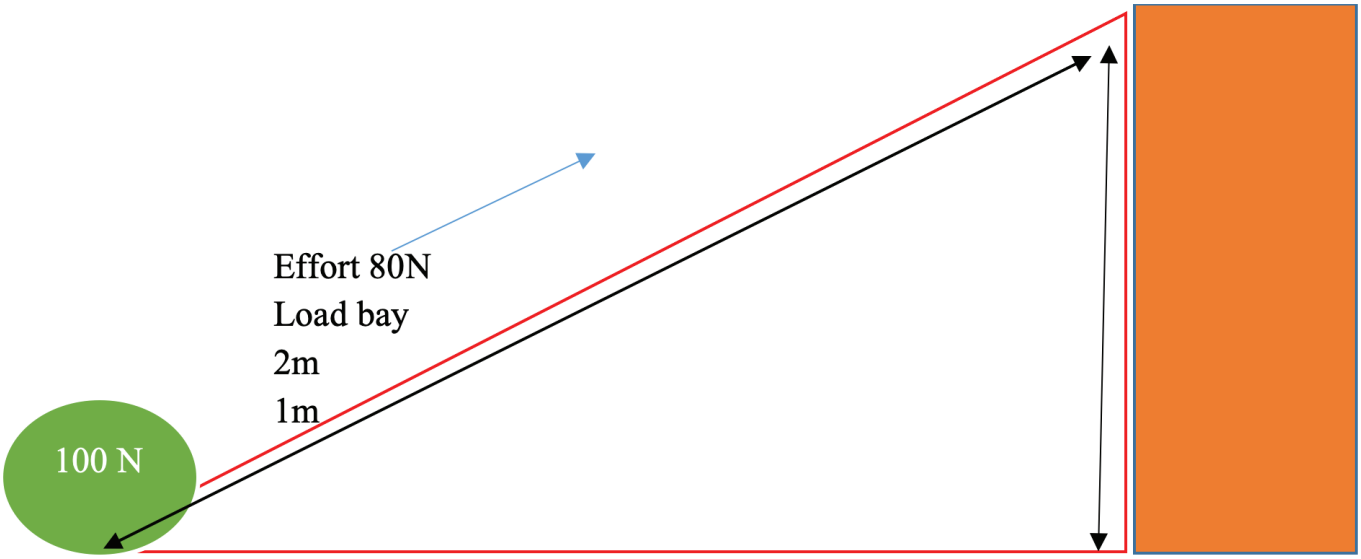
.....
.....
.....
.....
.....[2]

2.



a) Calculate the mechanical advantage of the system [2]
b) What is the velocity ratio of the system[2]
c) How can energy loss in this pulley system be minimised[3]

3.



a) Calculate velocity ratio of the machine [2]
b) Calculate Mechanical advantage of machine [2]
c) Calculate efficiency of the inclined plane [2]
d) What is the effect of increasing the length of inclined plane above 2m on the
   i) M.A [2]
   ii) V.R [2]
   iii) Efficiency [2]
   iv) Work output [2]

4. State two ways of increasing the efficiency of machines [2]

SUGGESTED ANSWERS

1 b
2 c
3 a
4 c
5 a
6 c
7 c
8 c
9 d
10 b

Structured questions

1 It receives sound waves and converts it into electromagnetic waves which are sent through wires to the receiving telephone .

2 It receives electromagnetic waves and boasts them so that they become more powerful so as to reach places far away.

3 E-mail and Wi-Fi

4 Data is converted into electromagnetic waves which are sent through space and are then received by any electrical gadget such as a computer which converts electromagnetic waves back into readable data.

5 Converts electromagnetic waves into sound waves.

6

Analogue signal	**Digital signal**
Continuous wave	Broken wave pieces re-joined
Slow	Fast
More data loss	Less data loss

7 Optical fibres, sheathed pair cables, coaxial cables.

UNIT 23: ENERGY

Contents:

Introduction

The sun is the source of energy on earth. However, it is very far away, have you ever wondered how that energy from the sun eventually reaches the earth. In the last unit, you learnt about forms of energy. In this unit you will learn about the methods of heat transfer and the practical applications of these methods.

OBJECTIVES

By the end of the unit you should be able to:

- Define conduction
- Practically identify good and bad conductors of heat.
- Practically compare rates of conduction by different conductors of heat.
- Practically show conduction in liquids.
- State good reflectors, absorbers and emitters of heat.
- Outline the operations of a solar cooker and a solar water heater.

KEY WORDS

- Conduction - the movement of heat energy through a solid without the movement of matter as a whole.
- Convection - the movement of heat in liquids and gases through the movement of matter as a whole.
- Radiation - it is the movement of heat energy through a vacuum.
- Vacuum - an empty space without air.
- Absorption - taking in of heat.
- Reflection - to send away heat.
- Emission - to release heat.

TIME: 8 HOURS

STUDY SKILLS

- Make sure you have understood the topic on energy before you move into this topic.
- Make sure you have understood the key words to help your understanding of ideas.

23.1 CONDUCTION OF HEAT ENERGY

You have often noticed how some objects when placed in a source of heat like a fire, these objects will feel equally hot even from those ends not placed into the source of heat. What you would have observed is conduction.

Activity 1

Aim: To identify conductors and insulators of heat

Apparatus/Materials: Source of heat-a fire would be best

A Small dry wooded log about half a meter long

A small metal bar.

A wire.

Method

1 Place the three pieces of materials into the source of heat at the small time.
2 Leave them in the heat for about 5 minutes.
3 Feel the other end of the rods placed into the source of heat.
4 Record your observations

CAUTION; AVOID BURNING YOUR FINGERS.

Observations

Material	Feeling at start of experiment	Feeling at the end of experiment
Metal bar		
Wire		
Wooden block		

If you observed that the metal bar and the wire felt hot from ends not put into the source, then you correctly observed that the wooden block had little or no temperature change from the other end then you are correct. Such substances which do not allow heat to pass through them are called insulators.

Metals are generally good conductors of heat than non-metals. This is because metals free electrons that move further away from the atom, carrying heat away as they move. The list below shows the order of conduction from a few selected metals:

Best conductor…… Copper

Aluminium

Brass

Least conductor……..Iron

USES OF CONDUCTORS AND INSULATORS

Now that you have seen that metals conduct heat differently, it is now time to look at the uses of these different conductors and insulators based upon their characteristics.

Insulators are used in places where heat movement is not wanted, the following are some of their uses;

1-Pot handles

2-Car brake pads

3-Tyres for motor vehicles

Now, state two more uses of insulators.

Good conductors of heat also have specific uses. Try to think of some of their uses. The list below shows some of the uses of specific conductors.

1. Copper is used in making hot water pipes and car radiator pipes.
2. Aluminium is used to make heat transfer material in electrical equipment.

23.2 MOVEMENT OF HEAT BY CONVECTION

You have probably experienced a sudden change in air temperature as you walked through an open area in your locality. What could probably have caused the temperature changes. Well those are called convectional currents. You should also have seen boiling water and wondered what makes it to move up and down as it boils.

Convection is the movement of heat through liquids and gases by movement of matter itself.

Activity 2

Aim: To demonstrate movement of heat by convection in water.

Apparatus/Materials: Source of heat- a fire would be best

A boiling tin or a beaker

Red soil or potassium permanganate crystals.

4 Put water in the boiling tin or beaker.
5 Heat the water until it boils
6 Add red soil or potassium permanganate crystals
7 Observe what happens to the colour of water.

Observations

What did you observe?

Take note:
If you observed that the water was coloured by the red soil or potassium permanganate in circles around the water container, then you correctly observed the proceedings of the practical. If you did not observe the lines of colour circulating in water, please re-do the practical paying a lot of attention to the colouring the water.

Conclusion
What conclusion can you make from the results of the experiment?

Note: If concluded that heat is transmitted in circles called convectional currencies then you are correct.

Activity 3

Aim: Showing conventional currents in air.

Apparatus/Materials:

Candle

Cardboard box

Transparent plastic

Method:

Set up the apparatus as is shown on Fig 21.1.

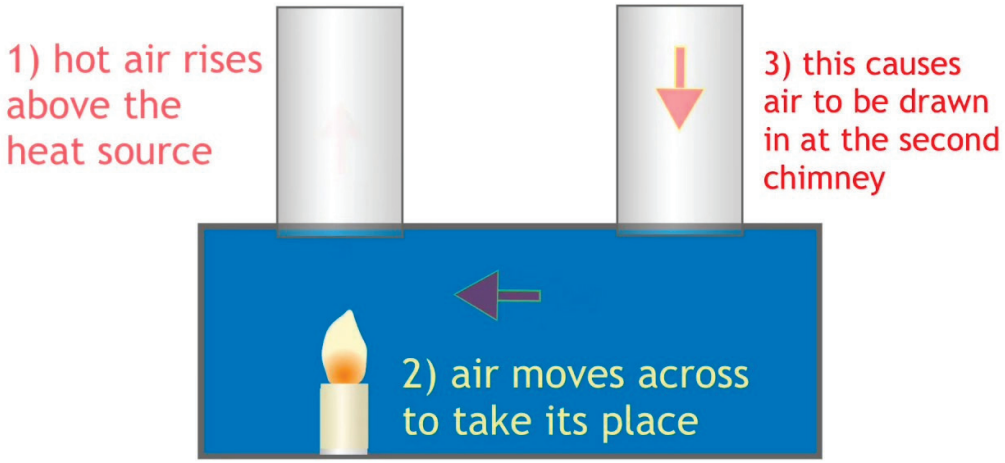


Fig 23.1: Diagram showing convectional currents in air.

- Observe the movement of the smoke in and out of the card box.
- On fig 22.1 put arrows to show the movement of smoke in and out of the cardboard box.

Conclusion

Now what conclusion can you make from the experiment?

If you concluded that movement of smoke particles showed that heat moves by convection, then you are correct. If you did not make the same conclusion, then revisit it.

Now use the questions below to find out how much you have understood on the concept of movement of heat by convection.

(1) a. Define convection. [2]
b. In a boiling can, why does heated water move to the top of the can?

23.3 HEAT TRANSFER BY RADIATION

Ever wondered how heat from the sun reaches us even if it has to pass through very long distances without air on its way to the earth. Well, the answer lies in this new method called radiation.

Definition: Radiation is the movement of heat through a vacuum.

Different surfaces emit, absorb and reflect heat differently.

Tip: On a very hot day which colour and type of clothes will make you feel hotter or cooler? The answer lies in the absorption, reflection and emission of radiant heat by different surfaces.

Activity 4:

Aim: to compare reflection of heat from dull and shiny surfaces.

Apparatus/Materials

- cold water
- two thermometers
- black and dull tin
- shiny white tin

Method

1 Set up the apparatus
2 Put same amount of water in the tins.
3 Measure the temperature of the water at the beginning.
1 Put the two containers in direct sunlight for 1 hour. Measure the final temperatures of water in the two tins.

OBSERVATIONS

Now put your results in the table below:

	Initial temperature	Final temperature
Black dull tin		
Shiny white tin		

What conclusion can you make from the results above?

- I hope that you correctly concluded that dull surfaces and dull colours are good absorbers of heat whilst shiny surfaces are good reflectors of heat.

The table below will help you to understand the concept of emission and absorption of heat.

23.4 Good absorbers, reflectors and emitters of heat.

Table 1: comparing dull and shiny surfaces in terms of reflection, emission and absorption of radiant heat.

Surface	Reflection of heat	Absorption of heat	Emission of heat
Dull black	Ad	good	Bad
Shiny white	Good	bad	Good

The solar heater is an important piece of equipment especially in areas without electricity or cheap forms of energy for heating water.

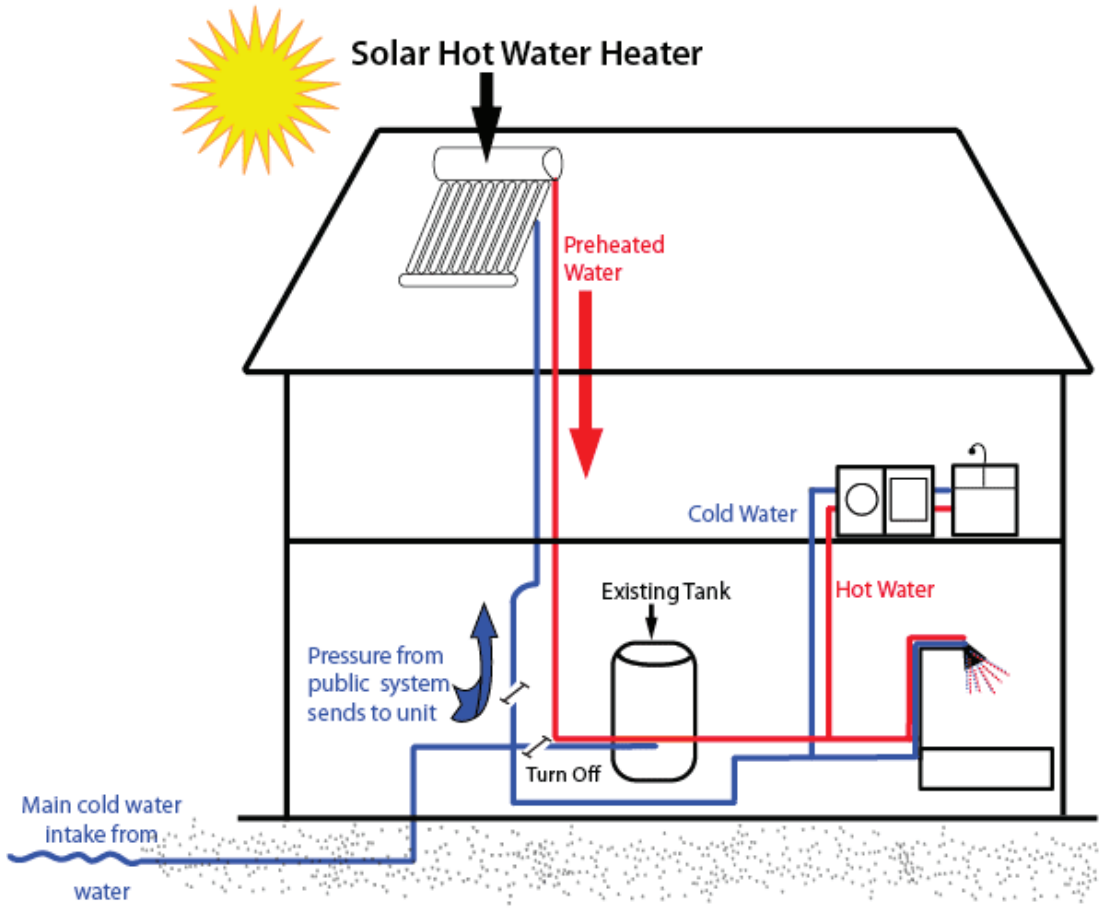


Fig 23.3: Diagram showing solar water heater.

Activity 5

State some of the features of the solar water heater which make it heat water quickly.

Now compare your answer with those given below.

It is painted in black to absorb as much heat as is possible.

It is made of copper pipes which are good conductors of heat.

It has insulators to prevent heat loss by conduction.

23.4 SOLAR COOKER

This uses solar energy for cooking. It has a shiny and curved surface to reflect heat to the focal point where the cooking pot is placed. The diagram below shows a solar cooker.

Fig.23.4 Solar Cooker

SUMMARY

In this unit, we have covered the concepts of movement of heat by conduction, defining it and also comparing conduction of heat by different conductors. We have also covered the concept of movement of heat by convection and radiation. At this point, you should also state good and bad conductors, emitters and reflectors of radiant heat. If you have challenges in any one of the concepts covered in this unit, please go again through this topic until you fully understand it. We now move on to the next related topic of work done.

23.5 Sample assessment questions

1. How does energy from the sun reach the earth? [2]
2. Draw a diagram to show the convectional currents in air. [5]
3. What are some of the good uses of heat insulators? [3]
4. State 5 examples of insulators [5]
5. State any 5 uses of insulators. [5]
6. Define conduction [2]
7. State the order of conduction of the following metals stating with the best conductors iron, copper,aluminium, and brass [2].
8. Define radiation [1].
9. What colour is best suitable to paint in hot areas and why?

UNIT 24: PETROL AND DIESEL ENGINES

CONTENTS

INTRODUCTION

Cars are probably men's most loved and valuable invention. Cars are seen as a reflection of a person's wealth and influence. In this unit you are going to learn about how engines that drive cars work. You are going to learn about how a four stroke petrol engines operates. The operational framework of a diesel engine will also be looked at in this unit. You will also cover work on modern petrol and diesel engines. This is an interesting unit, open your mind to it and welcome the wonderful world of fuel engines.

OBJECTIVES

By the end of this unit, you should be able to:

- Describe the operation of a four stroke petrol and diesel engine.
- Explain the role of the fuel injector and carburettor.
- Describe the operation of modern petrol and diesel engine.
- Outline the advantages of modern petrol and diesel engines over old petrol and diesel engines.

KEY WORDS

Piston	A tightly fitting movable part inside the cylinder of an engine
Carburettor	The part of a petrol engine that mixes petrol and air.
Cylinder	Hallow space inside an engine block which is fitted with pistons and valves.

TIME: 8 Hours

STUDY SKILLS

Make sure that you have understood all the key words mentioned above so that your understanding of the concepts being taught will be enhanced. You also need to have a deep understanding of the concept of action and reaction forces taught in the previous unit. This is the underlying principle of fuel engines hence it is important that you master these concepts before moving into this unit.

24.1 FOUR STROKE PETROL ENGINE

Surely you have seen cars being driven or you have probably driven one yourself. I think you have wondered or you are still wondering how engines move cars. Now stop wondering you are now about to find out about the mystery of petrol engines being demystified.

Fuel engines use the concept of using the force of explosion of a burning fuel to move the piston. In a petrol engine petrol is burnt in a confirmed area called a cylinder which is inside the block housing the engine.

A piston, which is fitted into the cylinder moves up or down depending upon the stage of operation of the engine. The piston is connected by rods to a crankshaft which is moved up and down by the pistons as is shown on the diagram below:

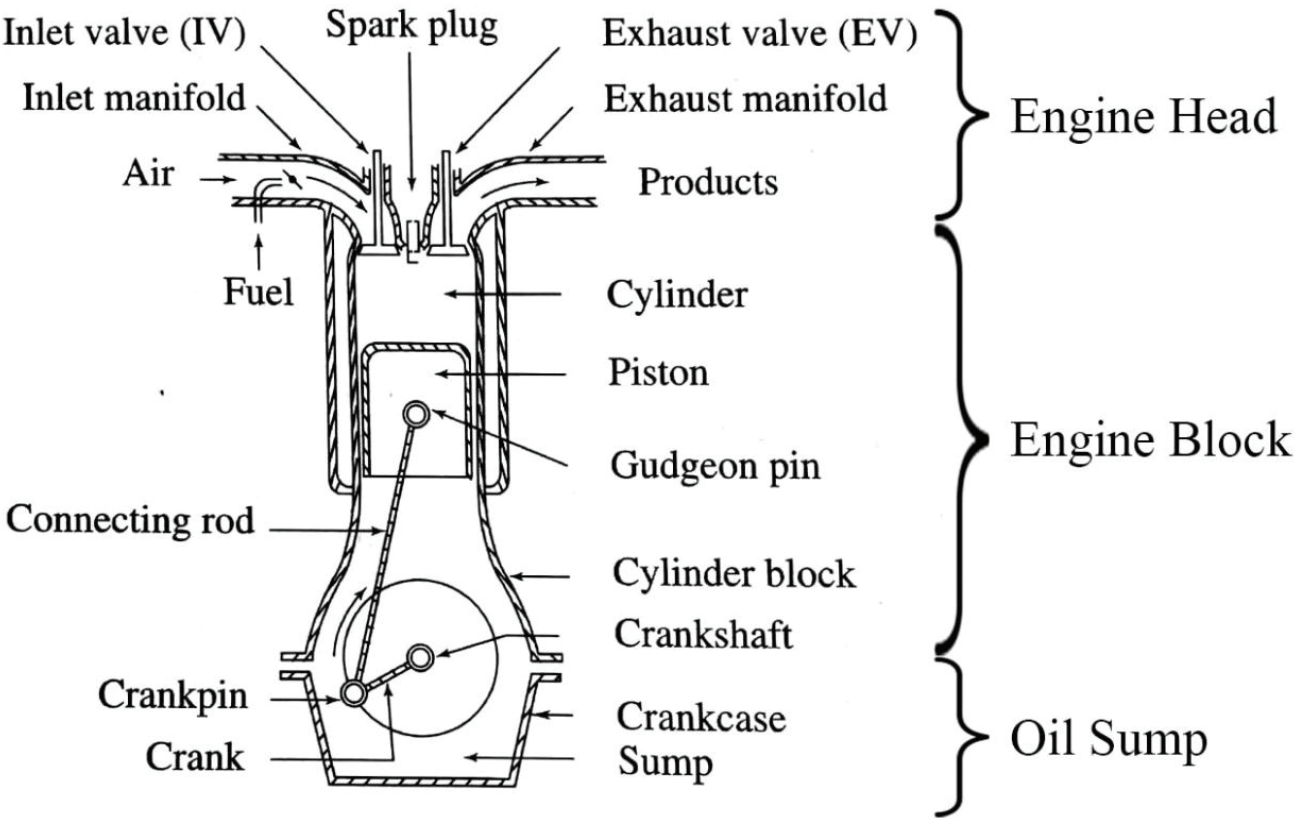


Fig 24.1 Petrol engine Cylinder

Valves

They open and close openings of the combustion chamber or cylinder. When a valve moves inwards it opens up and when it moves outwards it closes the opening

There are of two types, the inlet valve and the exhaust valve and they are labelled as such on the diagrams of engine in Fig 24.1

Inlet valve opens to allow petrol/air mixture to get into the cylinder.

Outlet valve/ exhaust valves opens up to allow burnt gases to escape from the cylinder into the exhaust pipe.

The spark plug

It is an electrical device which produces electrical sparks which burns the fuel gases that will have been fed into the cylinder.

The crankshaft

It has a shape shown below, on it are mounted the connecting rods which are joined to the pistons. The continual movement of pistons up and down created a smooth rotation of the crankshaft. The end of the crankshaft is connected to the gearbox which in turn move the shafts which move the wheels.

The four strokes of a petrol engine.

The strokes follow a pattern which is repeated over and over as the engine runs

Inlet/ intake stroke

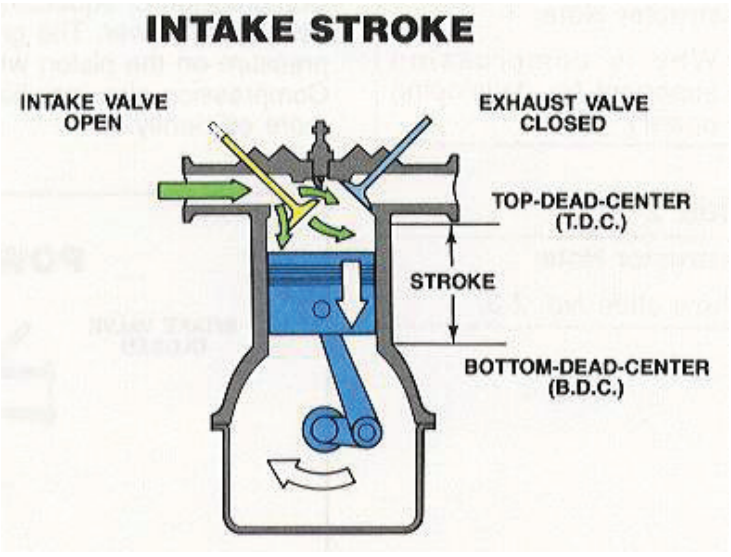


Fig 24.2 Intake Stroke

The piston moves down.

Pressure inside cylinder decreases

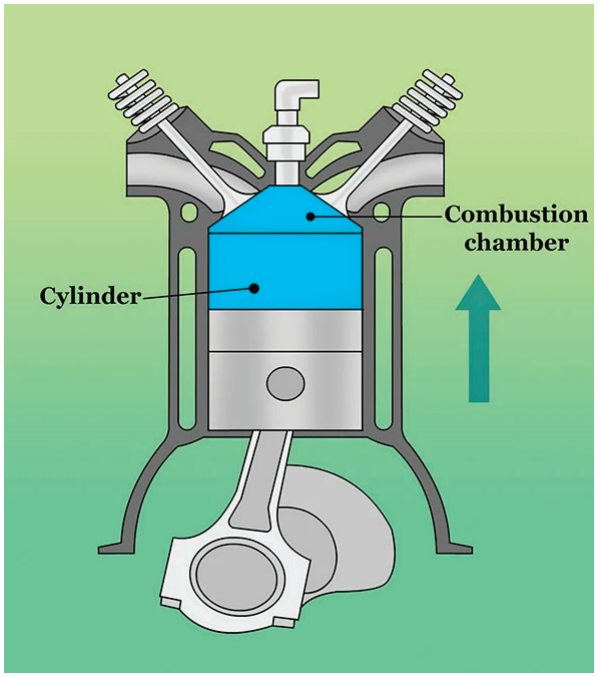
Inlet valve is open allowing petrol air mixture to enter the cylinder.

Exhaust valve is closed.

What do you think is the next stage? After this intake stroke comes the compression stroke

The compression stroke

The compression stage is summarised in a diagram below



24.3 Fig Compression Stroke

During this stroke both valves are closed and the piston moves upwards compressing the petrol air mixture. What do you think is the effect of having a piston with worn out rings which allow gases to escape downwards during compression? Worn out rings reduce the compressional power of an engine. The compressional stage causes the temperature of the petrol air/mixture to sharply rise. Then next comes the power stroke.

Power stroke

Both valves are closed. Spark plug releases an electrical spark. Petrol and air mixture burns with an explosion pushing the piston down with a large force which in turn turns the crankshaft. The force of the explosion and the exhaust gases to push the piston down and this is the power stroke of the engine. Fig 24.4 shows the power stroke.

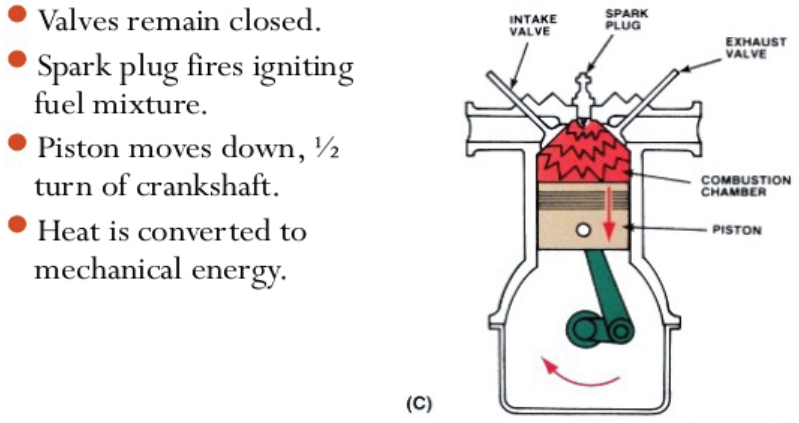
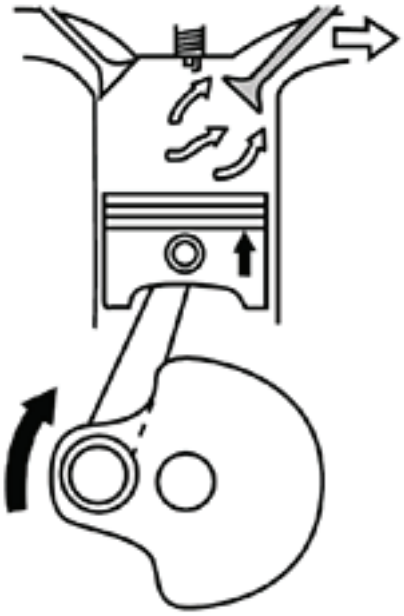


Fig 24.4 Power Stroke

The engine now undergoes the last stage called the exhaust stroke.

Exhaust stroke. During this stroke the following events take place. The exhaust valve opens, The piston moves upward, Exhaust gases are pushed out



24.5 Exhaust Stroke

At the end of the cycle the piston will have pushed all the exhaust gases out. The piston will be at the highest point in the cylinder. The cylinder now prepares for the inlet stage beginning another cycle of the of the four strokes which is repeated over and over as long as the engine is running.

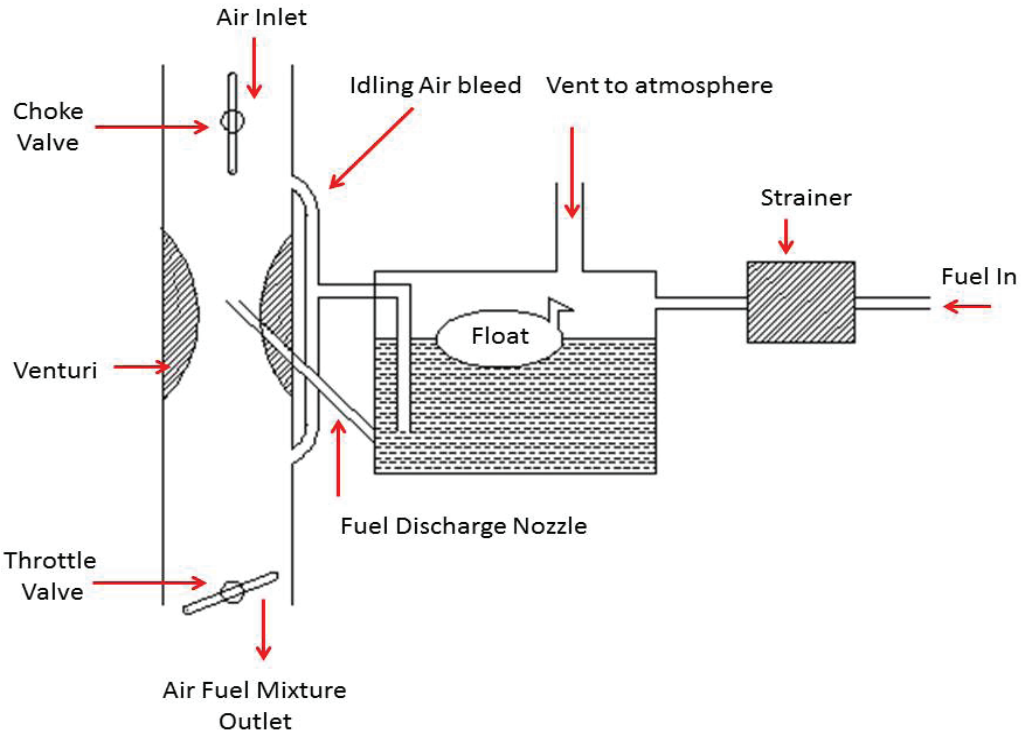
22.2 THE CARBURETTOR

It mixes petrol and air before entering the cylinders. What enters the cylinders?

Through the inlet valves is a petrol /air mixture as a vapour.

The carburettor ensures a correct proportion of petrol as to air mixture so that the efficiency of the engine is at its highest. Correct mixture of petrol and air ensures that complete combustion takes place

Shows a Carburettor



24.6 The Carburettor

FUNCTIONS OF PARTS OF THE CARBURETTOR

The air fitter cleans air from dust and other solid particles before mixing it with petrol vapour. As such the air fitter has to be regularly cleaned and replaced to ensure highest engine efficiency.

The petrol fitter cleans petrol from solid particles which might be present. The

cleaned petrol is then pushed through nozzles called jets into the carburettor.

The choke controls the amount of air that mixes with petrol

The throttle controls the amount of petrol air /mixture that goes to the cylinders

Common Carburettor Problems

Blocked air fitters

The engine has problems in starting and even when it started has low engine power output.

Less air mixes with the petrol

This can be corrected by cleaning or replacing the air fitters.

Blocked air fitter result in the production of carbon monoxide which is a poisonous gas. This is because the burning fuel does not have enough air /oxygen to completely burn the fuel. Shortage of air results in incomplete combustion

Blocked jets

The engine has poorly idling speed and randomly cuts, this can be corrected by blowing air through the nozzles to unblock them. At times when the jets are blocked the car engine may not run due lack of fuel.

Worn-out jets

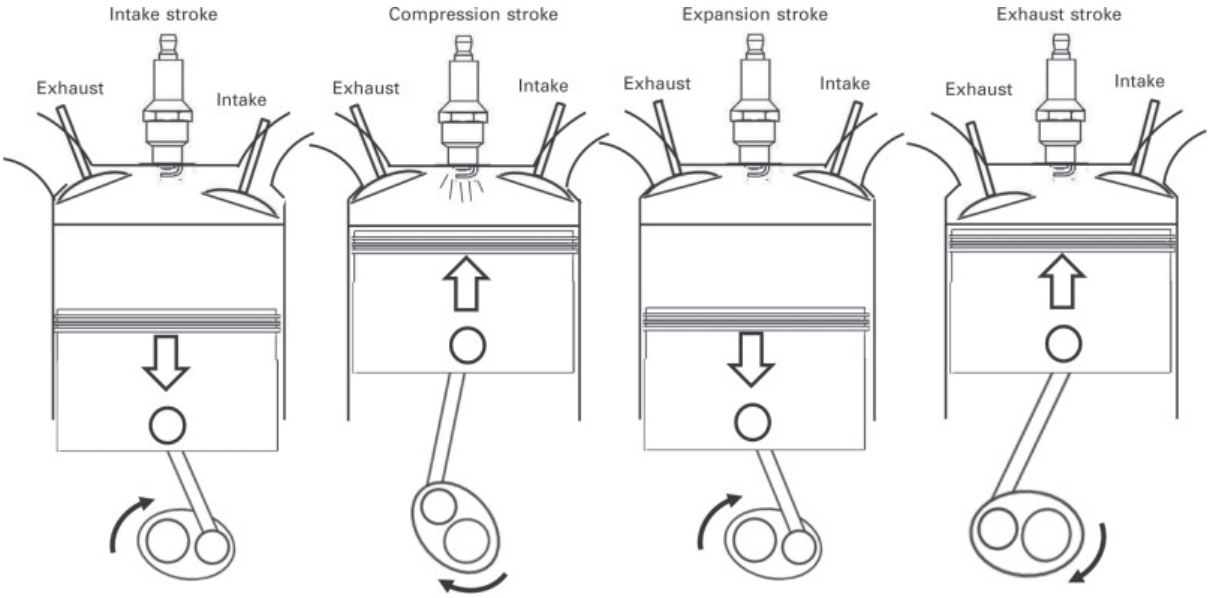
Worn-out jets have larger openings which allow more fuel to be mixed with less air. This unproportioned mixture of air and fuel causes incomplete combustion. Incomplete combustion produces carbon monoxide which pollutes the atmosphere

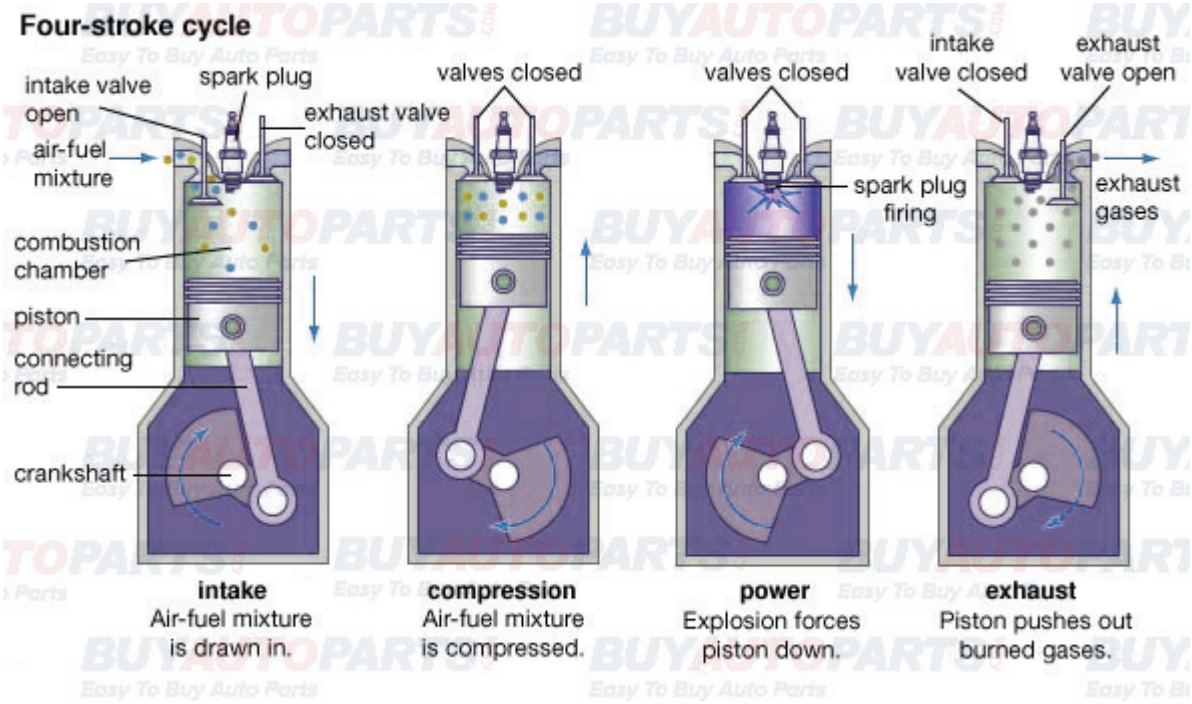
24.3 THE FOUR STROKE DIESEL ENGINE

The engine is named after its inventor Ralph Diesel. Diesel engines are also called compression engines. It uses diesel for fuel.

It has no carburettor but has a fuel injector which injects fuel directly into the cylinders.

It also has no spark plug but the fuel self- ignites due to the high temperatures from high compression in the cylinders.





INLET STROKE

- Inlet valve opens
- Air only rushes into the cylinder

COMPRESSION STROKE

- Both valves are closed
- Air is powerfully compressed and temperature of the air sharply rises

POWER STROKE

- Both valves are closed
- A jet of diesel is injected under very high pressure by the fuel injector into the hot air in the cylinder
- The injection ignites the diesel and an explosion occurs
- Piston is pushed down by the explosion and exhaust gases as in petrol engine.

EXHAUST STAGE

- The exhaust valve opens
- The piston moves upwards
- Exhaust gases are pushed out through the exhaust valve

TIP

A diesel engine is more efficient than a petrol engine of the same size.

Engines lose energy as heat and sound, a petrol engine is about 25% efficient while a diesel engine is about 40% efficient.

ACTIVITY 1

Aim: to observe old and new engines.

Method: visit a garage nearby should there be any.

Ask the garage attendant, mechanics or workmen there to show you engine blocks of new and old engines.

Observations

If you managed to visit a garage what did you notice about new and old engines.

24.4 A COMPARISON OF OLD AND NEW ENGINES.

OLD ENGINES	NEW ENGINES
Heavy	Light
Petrol engines moulds used carburettor to mix petrol and air.	Have computer programmed fuel injectors for both petrol and diesel engines.
Less efficient – consume more fuel for a same size modern engine	More efficient- consume less for the same size of an old engine.

TIP

Nowadays engines have a lot of cylinders to increase efficiency and power.

SUMMARY

I hope you found this unit interesting and stimulating to the mind. You have learnt about the structure and operations of both petrol and diesel engines. By now you should be well conversant with the function and of a carburettor, its general problems and how these can be corrected. This unit also took you through a comparison of old and modern engines. Should you have any challenges in any of the concepts covered in this unit, please re-visit it and also seek information from our sources especially the internet should you have access to it. When you have completely mastered this unit you can now move on to the next. Now let us see how much you have understood from the unit.

24.5 Sample assessment questions

1] Which part cleans air as it enters the carburettor?

A petrol fitter

B jets

C air fitter

D choke

2] Why is petrol cleaned as it enters the carburettor?

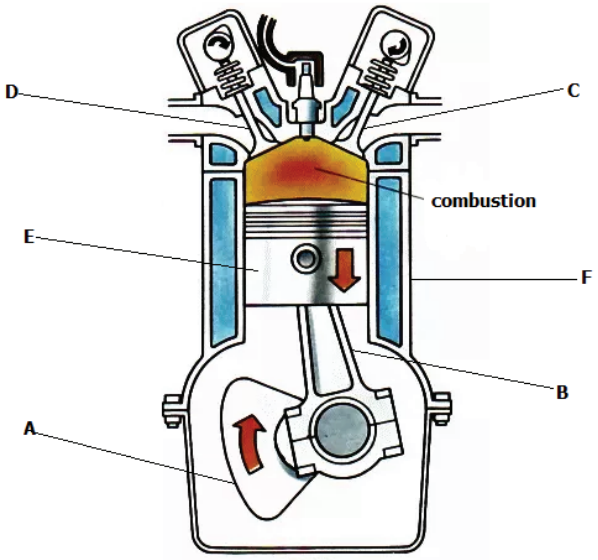
A so that it gains heat

B To remove liquid impurities

C so that it mixes easily with air

D To remove solid impurities

Questions 3-7 refer to Fig 22.8



3] Identify part A

A piston

B outlet valve

C crankshaft

D cylinder

4] Identify part B

A connecting rod

B inlet valve

C outlet valve

D piston

5] What stage of the engine is shown on fig 20.5

A inlet

B power

C compression

D outlet

6] How does pressure inside part the cylinder change during the intake stage?

A increases

B remains the same

C spark plug releases electrical sparks

D decreases

7] What is the effect of worn out piston rings on the efficiency of an engines?

A reduces

B remains the same

C increases

D none of the above

8] On comparison, engines with more cylinders are---------- than those with less cylinders but being of the same size.

A more powerful

B less efficient

C more efficient

D less powerful

9] During the compression stage in a diesel engine?

A petrol and air mixture is compressed

B fuel gas mixture is ignited by a spark plug and explodes.

C air only is compressed

D exhaust gases escape through the exhaust valve

10] After the power stage, what happens to exhaust gases?

A escape through the inlet valve

B enter the cylinder through the inlet valve

C escape through the exhaust valve

D remain in the cylinder

11] Engines lose energy due to

A heat energy only

B sound energy only

C kinetic energy

D heat and sound energy

12] What is the percentage efficiency of a diesel engine?

A 40%

B 25%

C 30%

D 50%

13] What is the percentage efficiency of a petrol engine?

A 20%

B 25%

C 40%

D 75%

14] Which part is found on a petrol engine but not on a diesel engine?

A piston

B outlet valve

C spark plug

D crankshaft

15] For a car which travels in dusty roads always which part should be cleaned or replaced regularly?

A petrol filter

B air filter

C spark plug

D tyres

STRUCTURED QUESTIONS

1. The Carburettor- mixes petrol and air before entering the cylinders
2. a) Inlet valve open, exhaust valve closed, piston moves downwards, petrol and air mixture
enters the cylinders.
b) Exhaust valve closed, petrol and air mixture is burnt, piston moves downwards

3.

Modern engines	Old engines
Have fuel injectors	Have carburettors
More efficient	Lees efficient

4. Worn out rings reduce the efficiency of an engine.

5. Chemical energy to kinetic energy then potential energy.

6. Blocked air and petrol filters reduce the efficiency of an engine.

7. Carbon monoxide results when the engine burns petrol in a limited supply of oxygen.

8. When an engine runs without enough oil, friction between moving parts becomes high causing the engine parts to expand beyond their usual size causing the engine to stop working.

STRUCTURED QUESTIONS

1] What is the role of the carburettor in a petrol engine [3]

2] Describe the events that take place during the following stages

a) Inlet [4]

b) power [4]

3] Compare old and modern engines [6]

4] Outline the effects of worn out rings of the piston on the efficiency of an engine [2]

5] State the energy changes that take place when a diesel engine moves a lorry 2km up a mountain. [3]

6] During servicing a vehicle, petrol and air fitters should be cleaned or replaced regularly why [2]

7] Which poisonous gas is produced from faulty engines, describe how it is formed [5]

8] Oil moves around the engine to lubricate moving parts, what is the effect of moving an engine without oil [2].

SUGGESTED ANSWERS

1. C
2. D
3. C
4. A
5. B
6. D
7. A
8. A
9. C
10. C
11. A
12. A
13. B
14. C
15. B

UNIT 25: TELECOMMUNICATION

Contents

INTRODUCTION

The world is now a global village –meaning that information can be sent and received quickly to and from any point of the globe, thanks to advancement in telecommunication technology. In this unit, you are going to learn about how information can be sent through the cellphone and e-mail. You are going to cover concepts on signal transmission, the operation of these signal transmitters and receivers. This is an interesting unit, go through it and understand it, bearing in mind that the world is also counting on you to bring new and better ways of sending and receiving information across the globe.

OBJECTIVES

By the end of this unit, you should be able to:

- describe communication over a distance cell phone
- describe communication over an e-mail
- list down types of media for signal transmission
- describe how signal is transmitted in different media transmitters
- describe the operation of cell phones and related signal transmitters and receivers.

KEY WORDS

Cell phone- an electrical device that allows communication to another such device via a network signal

Satellite – an electrical device in space that receives and sends waves to and from various places.

TIME: 8 Hours

25.1 THE OPERATIONS OF A CELL PHONE

In order for you to understand the operations of a cell phone you need to understand some technological advancements that led to the production and use of the cell phone.

DRUMS AND SMOKE

From ancient times, men have been using various methods of communicating over long and short distances. For communicating over short distances men have been using sound mainly. Information could be relayed through word of mouth or beating drums loudly to convey a message. Drums however, had a problem of producing sound which could not reach very far

-away distances where such information is required. To improve on that another method of communication was employed, the use of smoke. The smoke signal could be seen further away, where sound signals could be heard. Still smoke signals were too general and could still be affected by changes in distance. This is when the telephone was invented.

THE TELEPHONE

Activity 1

Aim: to send voice messages through a wire and tins.

Apparatus/Materials:

- Two metal tins
- Thick copper cable about 3m long or a rope of medium thickness.

Method

- Make an opening at the centre of each tin.
- Fasten the cans to each end of the rope or wire.
- Pull the ends of the rope or wire tight using the cans.
- Speak slowly and softly into the can while your partner listens from the other end.
- Reverse the process with you listening and your partner speaking.

Results

We hope you observed that when you listened carefully and your partner were able to hear words coming through the rope or wire audibly.

Conclusion

Sound waves can travel through a rope or wire.

It is upon this basis that the telephone was developed.

Basically in a telephone sound waves are converted into electrical impulses from one telephone and they move through telephone wires to the receiving telephone which then converts the electrical impulses into words again which are then heard by the receiving person. This was a great improvement as people in very faraway places could be verbally talked to. However, there were two main problems to this system.

a) Your phone needs to be physically connected to the line and persons not connected to the system were left out.
b) Some places are too remote or it is difficult to set up lines in such places as the mountainous places. A lot of places and people cannot be connected. This led to invention of the cell phone.

25.2 THE CELL PHONE

It is based on the concept of converting information into electromagnetic waves or radio waves. These waves do not need a medium for their transmission, they can travel through water or even a vacuum. As such each cell phone converts information which can be words, picture or written data into electromagnetic waves. These are then transmitted through an antenna into space. The power of these waves are increased by a cell phone mast whose picture is below

Fig 25.1 Cell phone mast

When the signal reaches its intended receiver, it is picked by the antenna of the receiver which then sends the electromagnetic waves to a decoder in the cell phone. The decoder converts electromagnetic waves into sound or pictures or written words as according to the information send.

Benefits of using a cell phone:

- Verbal communication- sending and receiving of words between persons.
- Sending and receiving pictures
- Sending and receiving of text messages via platforms such as whatsapp, facebook
- Sending and receiving of videos.
- Video calling – you see the person you are talking to.
- Teleconferencing – cellphones are interconnected such that conference can take place even when people are far away from each other
- Sending and receiving of electronic mail.

You can add more advantages should you have any.

Now what do you think are the disadvantages of a cellphone?

a) They are highly technological devices which are generally expensive to buy and repair.
b) It needs to be connected to a network provider who will then connect the cellphone to access the electromagnetic waves in space, no network no service.

25.3 THE E-MAIL

E-mail stands for electronic mail

This is mail which is sent electronically from one electronic device to another.

The electronic mail can be in the form of letters, documents, picture and books among many other print media items.

The mail is sent from such a device can convert print media into radio and light waves, such devices include the cellphone, laptop, tablet and computer among others.

The device has to be connected to the internet or Wi-Fi so as to send or receive the electronic mail. The receiving device converts the radio and light waves of the e-mail into readable data on the receiving device.

Advantages

What do you think are some of the advantages of the e-mail?

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.....

Here are some of the advantages:

1) Information or data is sent very quickly from one place to another.
2) Very effective- large volumes of documents can be effectively sent between devices.
3) Cheap- large traffic of data can be sent cost effectively between places.
4) As long as there internet connectivity data can be sent between places regardless of distance.

Disadvantages

What do you think are the disadvantages of e-mail?

.....

.....

.....

.....

We hope you mentioned that there is need for internet connectivity so as to send and receive e-mail and where there is no internet there is no access to e-mail.

25.4 SIGNAL TRANSMISSION

Signal is transmitted by two main methods namely Analogue and digital signals.

Analogue signal

The signal is carried in the form of a continuous wave. The wave signal varies over time, the frequency and amplitude of this signal may take many different values as the wave is being transmitted.

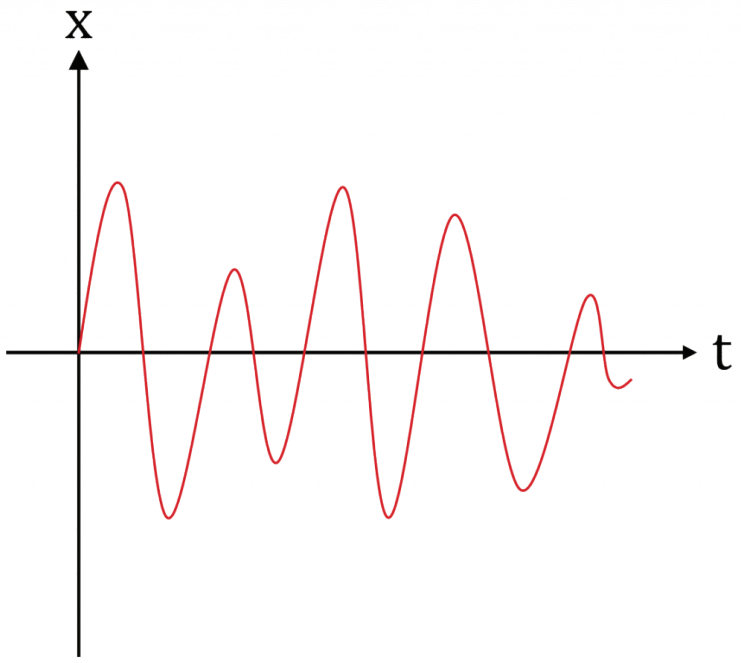


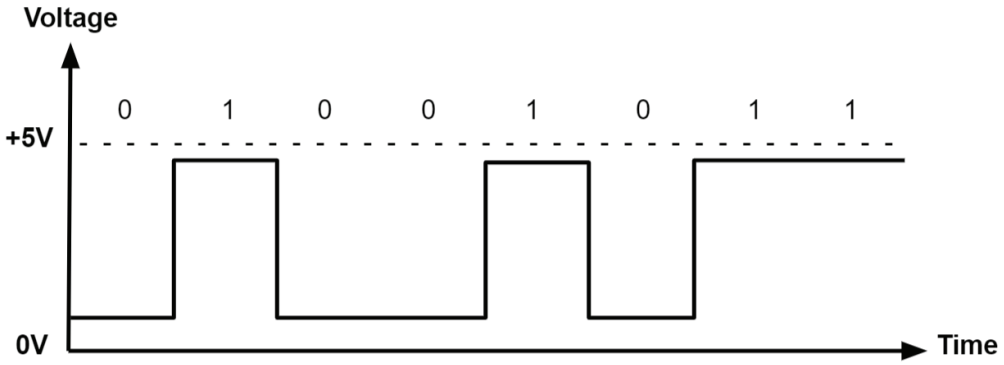
Fig 25.3 Analogue Transmission

Analogue signals tend to loose energy along the way, they therefore travel less distances as compared to digital signals.

DIGITAL SIGNAL

In this type of signal, electrical signal is cut into small bits. The bits take the form of electrical pulses which takes any of the two values: either positive which can also be called 1 or negative which can also be called 0. The signal is transmitted in bits of 1 and 0. In digital transmission there is little loss of energy therefore sound and signal quality is usually very high.

Fig 25.4 shows an illustration of a digital signal



25.5 OPERATIONS OF SIGNAL TRANSMITTERS AND DECODERS

Media for transmission

Communication can be done through the following signal transmitters and receivers these include the radio, television, cellphone, fixed line and computers. The signal is transmitted as wireless media or guided media.

Guided media

In this form of transmission, the signal is carried by a cable which keeps the signals within it. Copper cables are mainly used, because signal is kept within a cable, this has resulted in this method being called guided transmission. There exist a variety of cables for the purpose of transmitting signals. These include:

- Coaxial cables
- optical fibre
- sheathed pair cables
- twisted wire
- braid shielded cable

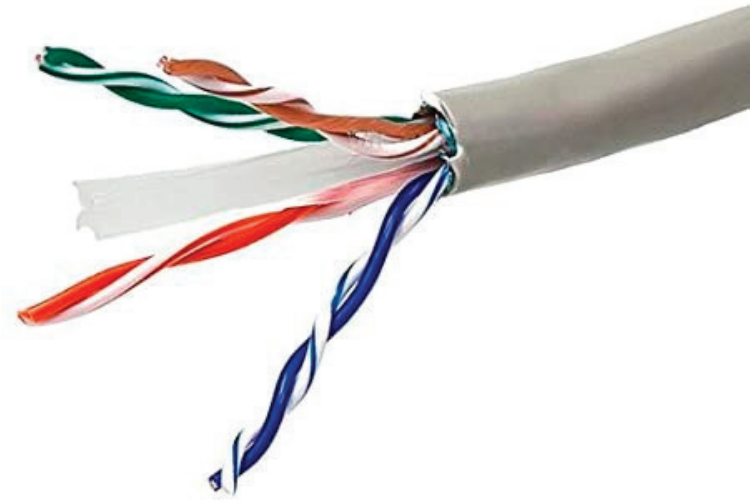
Cables that carry signal through copper cables have a weakness of energy or signal loss along the way. As such signal boosters that amplify the signal along the way are made use of.

Optical fibre/ cables

Signal is transmitted in the form of light through the cable. The walls of the fibre continuously refract light signals along it as it passes through the cable.

Optical cable is faster and carries much more data than other forms of guided media.

Copper Media



Unshielded twisted-pair cable

RJ-45 connections

Fig 25.5 different types of transmission media

Wireless media

In this method of transmission electromagnetic waves are sent from an electrical device that produces and sends such waves. The electromagnetic wave can be in the form of radio waves, light waves, infrared and microwaves. These waves travel through space at a very high speed. A receiver takes in the waves which are then decoded or transformed into sound or any other form that is understandable to the user.

The electromagnetic waves are sent into space in all directions, because there is no need for cables to transmit signal, this is then called wireless communication.

Wi-Fi

These is when wireless communication is used in a controlled environment such as a bank, school, internet shop, hospital or any other institution. The authorized users of the Wi-Fi should have a special pass word to access the Wi-Fi

SUMMARY

By now you have explored the wonderful world of telecommunication. You have learnt about how sound and other signals are converted into other forms of energy. You also have explored how cell phone and the e-mail operates. By now you should be able to define and differentiate between analogue and digital signal. You also explored the world of signal transmitters and receivers. At this point you should be able to show how guided signal transmitters operate, listing their examples and also stating their advantages and disadvantages. You should be by now well acquainted with the use of internet for communication. Should you have any challenges with any concepts covered in this unit please re-visit the concept and also seek for information from other sources especially the internet should you have any access.

25.6 SAMPLE ASSESSMENT QUESTIONS

1] Which form of information cannot be sent or received by a fixed telephone?

A Sound
B Video
C Written message
D None of the above

2] What is the purpose of an antenna on a cell phone?

A Decode signal
B Encode signal
C Produce sound
D Receive and send signal

3] Which of the following is a characteristic of an analogue wave?

A Continuous wave
B Bits of waves joined together
C Bits of waves not joined
D None of the above

4] Which of the following is not part of guided signal transmission?

A Sheathed pair cable
B Optical cable
C Wireless transmission
D Twisted wire cable

5] The correct order of events for data transmission from sender to receiver is:

A Sender- decoder-transmitter-receiver
B Receiver-transmitter-decoder-sender
C Transmitter-sender-receiver-decoder
D Sender-transmitter-decoder-receiver

6] What is the advantage of digital transmission over analogue transmission?

A It sends signal as bits
B It sends signal as a continuous wave
C There is less signal loss along the way
D There is more signal loss along the way.

7] The following are advantages of using the e-mail over letter send by postal vehicles except:

A Cheap
B Reliable
C Requires no network connection
D Fast

8] The following use wireless communication except:

A Radio
B Television
C Fixed telephone line
D Cell phone

9] Signal cannot be transmitted as:

A Radio waves
B Light waves
C Sound waves
D Heat waves

10] What is Wi-Fi?

A Uncontrolled wireless signal
B Controlled wireless signal
C Use of coaxial fibre
D None of the above

STRUCTURED QUESTIONS

1] Describe how a telephone operates [3]

.....

.....

2] What is the purpose of a cell phone mast? [2]

3] State any 2 methods of transmission of wireless media. {2]

4] How is information send and received through the e-mail? [3]

5] What is the function of a decoder in a cell phone? [2]

6] Compare digital and analogue signal? [4]

7] Signal is lost along the way in some guided signal transmitters such as the coaxial cable, how can this be prevented? [4]

8] Outline the order of events when talking through a cell phone from one person to another person receiving words [4]

9] List down any 3 types of media for signal transmission [3]

10] Draw and label a diagram showing analogue signal transmission [5]

Structured questions

1 It receives sound waves and converts it into electromagnetic waves which are sent through wires to the receiving telephone.
2 It receives electromagnetic waves and boasts them so that they become more powerful so as to reach places far away.
3 E-mail and Wi-Fi
4 Data is converted into electromagnetic waves which are sent through space and are then received by any electrical gadget such as a computer which converts electromagnetic waves back into readable data.
5 Converts electromagnetic waves into sound waves.

6

Analogue signal	Digital signal
Continuous wave	Broken wave pieces rejoined
Slow	Fast
More data loss	Less data loss

9. Optical fibres, sheathed pair cables, coaxial cables.

SUGGESTED ANSWERS MULTIPLE CHOICE

1 C
2 D
3 A
4 B
5 C
6 A
7 C
8 A
9 C
10 C
11 C
12 D
13 B

Unit 26 ELECTROMAGNETISM

CONTENTS

INTRODUCTION

Remember the time you picked up a magnet and picked up some small pieces of metal. Did you ever wonder what was really happening? Why metals only were being attracted but non -metals not? What are magnets? A difficult question indeed but we can describe properties of magnets. In this unit we are going to look at the effect of electricity in a conductor. We are going to look at the behaviour of a conductor that is carrying a current. After this we are going to study how this conductor carrying a current behaves when placed in a magnetic field.

OBJECTIVES

After going through this unit you should able to:

- Describe an experiment to demonstrate that a current carrying conductor has a magnetic field around it.
- Explain the operation of a simple DC motor.
- Describe the operation of a simple DC and AC generator
- Describe hydro and thermal power generation.

KEY WORDS

Conductor: an electrical conductor is a material that allows current to pass through

Magnetic field: an area around a magnet where there is magnetic force

Magnet: this is a material or object that attracts other metals made of iron,cobalt,nickel and their alloys

Electromagnet: this is a type of magnet which is produced when an electric current passes through a conductor

TIME: 8hours

STUDY SKILLS

You need to revisit your Level 1 work on magnet where you meet difficulties refer do not despair read through the unit noting down difficult areas which you then discuss with either your tutor or friends doing the same level.

26.1 MAGNETIC FIELDS

What is a magnetic field? To answer this question, think about this situation. Imagine you are a prefect at one school then you visit your friend in another school and discover that the learners are misbehaving there. Are you going to exercise your powers as a prefect to maintain order there? The answer is a big NO. Your influence ends around your school. Now think yourself as the magnet and your school as the magnetic field. Now to answer our question on what is a magnetic field we say it is an area around a magnet where there is magnetic force. See the diagram below to fully understand this.

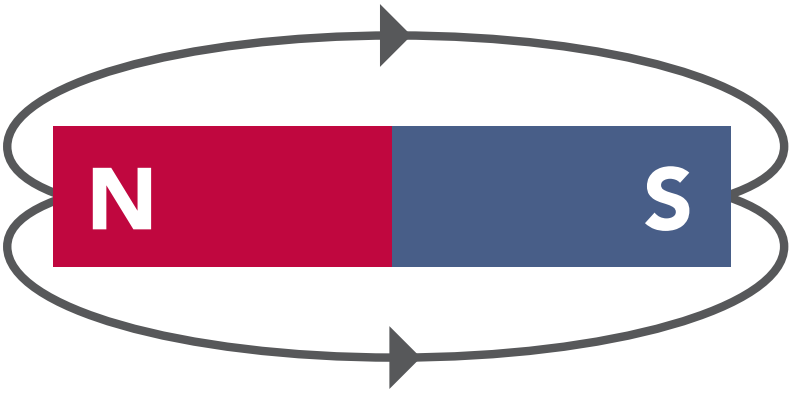


Figure 26.1 Magnetic Field around a bar magnet.

26.2 ELECTROMAGNETISM

How does a conductor carrying a current behave ? To answer this question let us do this simple

activity.

EXPERIMENT 1

AIM: To investigate the behaviour of a conductor carrying a current.

APPARATUS/MATERIALS: A piece of copper wire(conductor), iron filings, sheet of paper, two torch cells, connecting wires

DIAGRAM

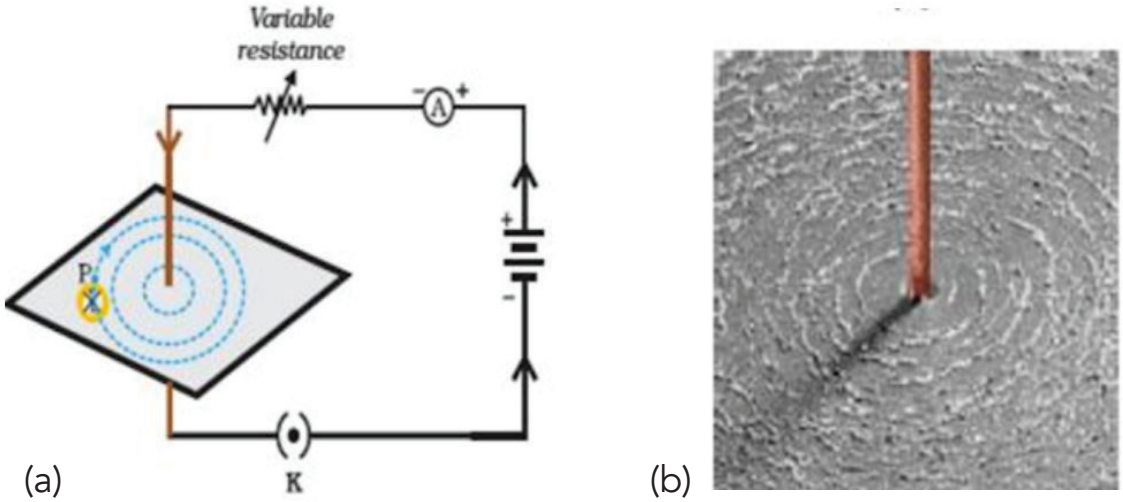


Figure 26.2 Behaviour of a Current Carrying Conductor

METHOD

Connect your apparatus as shown in the diagram.

Sprinkle iron filings over the paper and observe how they are arranged.

Then switch on your circuit and observe how they iron filings behave.

What did you observe when you switched on the circuit ?

OBSERVATIONS

You should have observed that the iron filings aligned themselves in circles around the conductor when current was flowing but when there was no current flowing in the conductor the iron filings did not show any pattern.

CONCLUSION

This experiment confirms that when a conductor is carrying a current it becomes a magnet therefore the conductor has a magnetic field around it. This type of magnet is called an electromagnet since the magnetism is due to an electric current flowing in the conductor.

26.2 DETERMINING THE DIRECTION OF THE MAGNETIC FIELD AROUND A CONDUCTOR CARRYING A CURRENT

As we have seen above that when a conductor is carrying a current it behaves as a magnet so we need to determine the direction of the magnetic field. To do this we use the Right Hand Corkscrew Rule or the right hand grip.

If you have a conductor as shown below use your right hand shown below to determine the direction of the magnetic field around it ONLY if it is carrying a current.

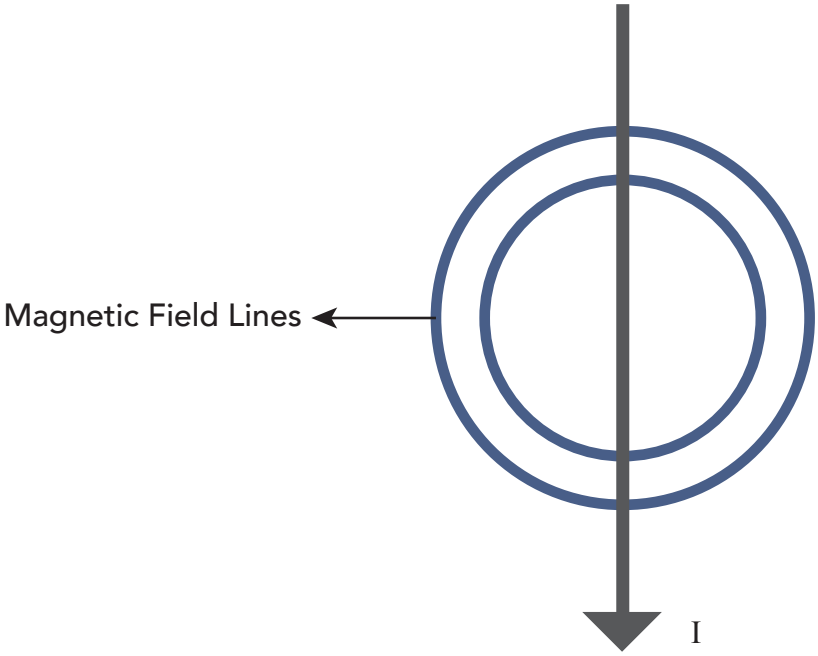


Figure 26.3 Magnetic Field around a conductor

Can you put arrows on the above diagram to show the direction of the magnetic field ?

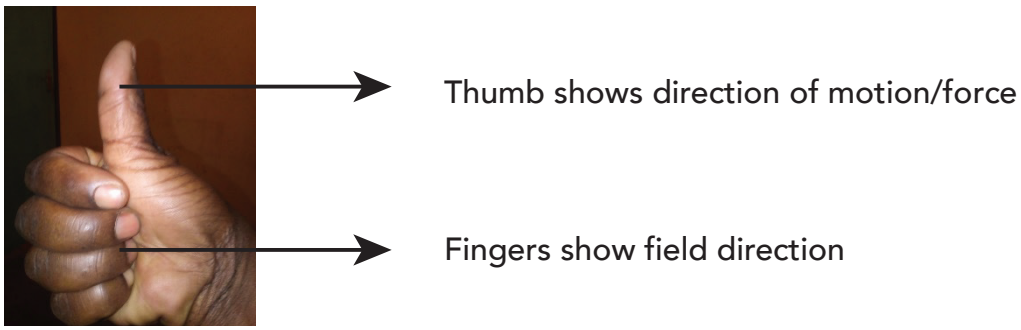


Figure 26.4 Right Hand Corkscrew Rule

You have learnt how to show the direction of the magnetic field around a conductor carrying a carrying. Now let us see what happens to that conductor when we place it in a magnetic field provided by permanent magnets.

Have you ever tried to bring two magnets close together ? Yes I guess you have done so sometime if not try, it look for two magnets and bring them together. If you have done this before recall what happened. Yes ! The magnets either came together or failed to do so. When they came together we say they attracted but when they failed to do so and you could feel the force pushing the magnets away from each other we say they repelled. Now lets move on to our next question.

WHAT HAPPENS WHEN A CURRENT CARRYING CONDUCTOR IS PUT IN A MAGNETIC FIELD

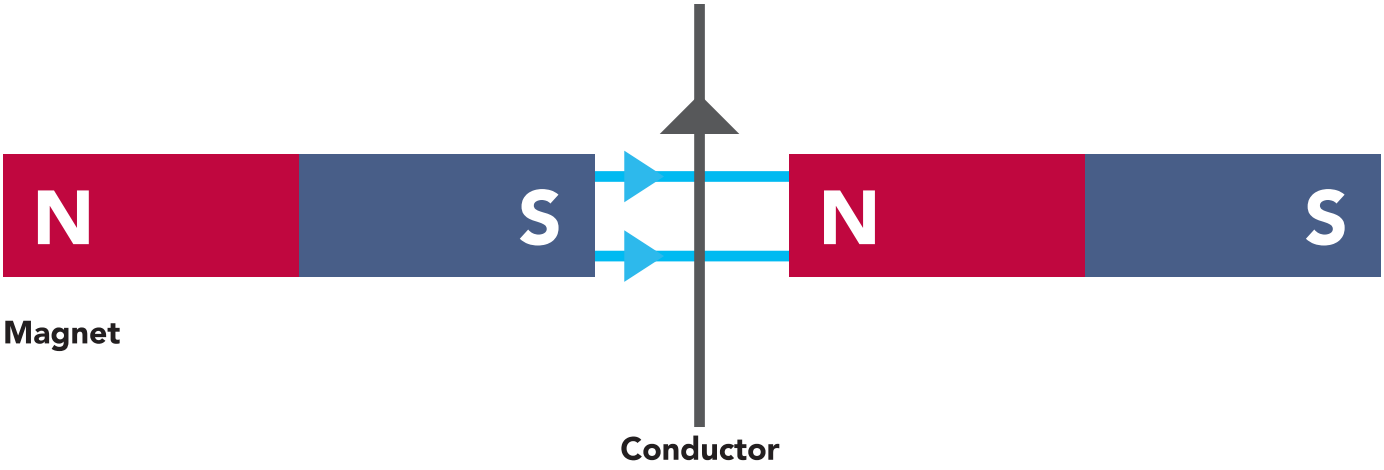


Figure 26.5 Conductor carrying a current between two magnets

When a conductor carrying a current is placed in a magnetic field it experiences a force that is it moves. This is referred to as the MOTOR EFFECT. Why does it move? Remember we said two magnets brought close together either attract or repel each other. This attraction or repulsion results in movement. Let us reflect back we said a conductor carrying a current behaves like a magnet so when it is brought within a magnetic field of other magnets, its magnetic field and that of the other magnets interact either through ATTRACTION or REPULSION.

When something moves we need to know the direction it is moving to. So where does this conductor move? To get the direction we use Fleming's Left Hand Rule.

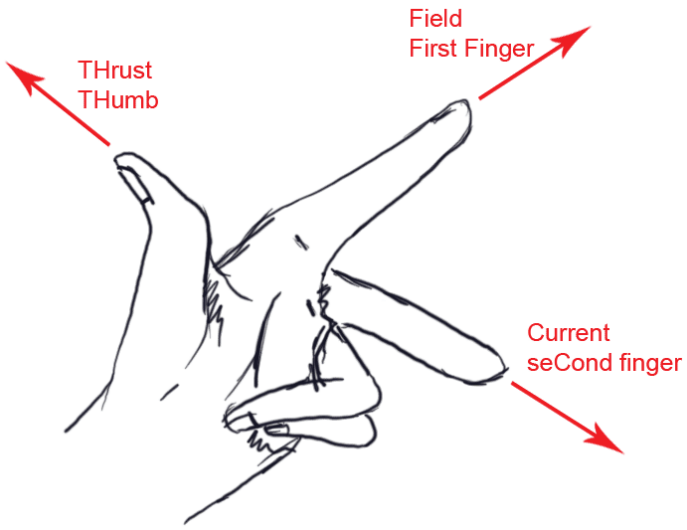


Fig.26.6 Fleming's Left Hand Rule

Take your left hand and arrange you thumb, first finger and second finger as above, the thumb points to the direction of the force(Thrust), second finger shows the direction of the current and the first finger the direction of the magnetic field. You need to find where the thumb is pointing and this is the direction of movement of the conductor.

Can you determine the direction in which the conductor moves in Fig.26.5? If you find it difficult revisit the Fleming's Left Hand Rule again.

Before we go to our next section on the simple DC Motor let us see what we have learnt so far by answering this short exercise.

ACTIVITY 1

1. Using the letters T for thrust, C for current and F for magnetic field to show what each of the fingers below represent by labelling each arrow by each of the letters above.

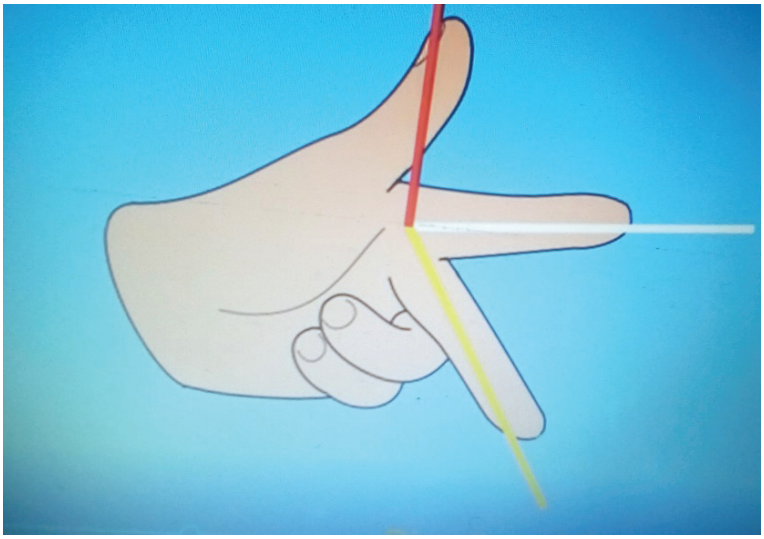


Figure 26.6 Fleming's Left Hand Rule

2. How does a conductor carrying a current behave like?
3. Which rule is used to determine direction of magnetic field around a conductor carrying a current?

26.3 THE SIMPLE DC MOTOR

The working or operation of a simple DC motor is based on the principle that when a current carrying wire (conductor) is placed in a magnetic field, it experiences a mechanical force. The direction of this mechanical force is given by the Fleming's Left hand rule discussed above.

REMEMBER! If you put a conductor in a magnetic field and pass a DC current through it the conductor will MOVE and this the MOTOR EFFECT.

NB. DC CURRENT IS FROM A BATTERY

Simple Structure of a DC motor

A simple DC motor consists of permanent magnets which provide the magnetic field and coil which becomes an electromagnet when current flows through it. This coil is attached to the commutator which reverses current when the coil flips over that is after every half a revolution. The reversal of the current ensures that the coil always rotates in the same direction. The current in the coil is fed by the carbon brushes which make a sliding contact with the commutator. See diagram below.

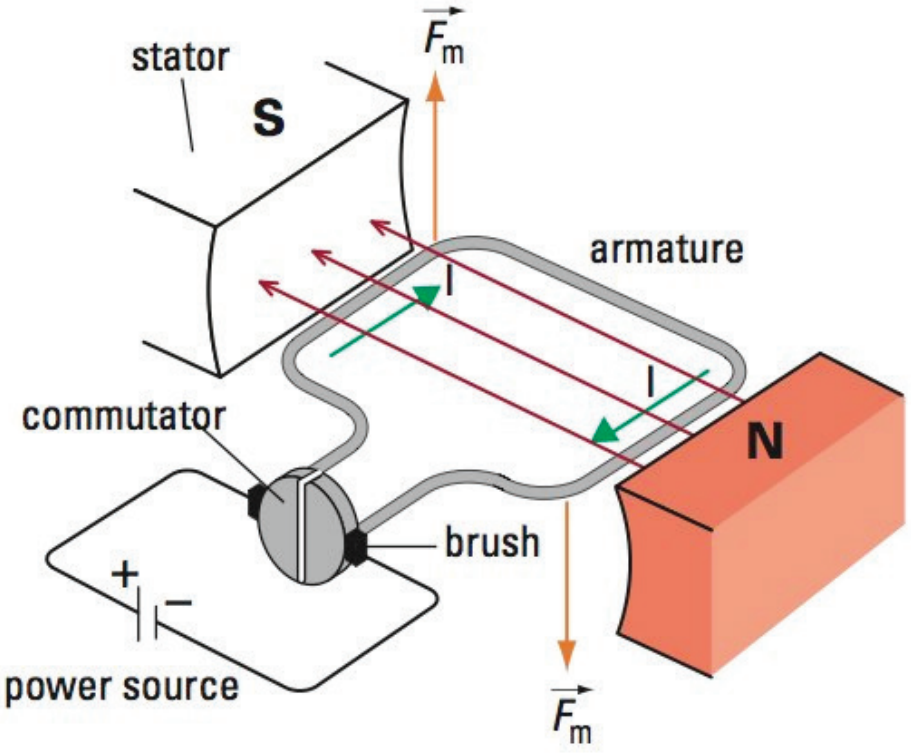


Figure 26.7 Simple DC motor (from the internet)

FACTORS

Can you think of how we can make the electric motor rotate very fast? Yes, I am sure what came to your mind is increasing the size of the current by using more cells. That is right. However there are other two factors, these are increasing the size of the magnetic field by use of strong magnets. The last factor is to increase the number of coil turns. In summary we can say the speed of an electric motor is dependent on the size of current fed into the coil, strength of the magnetic field and the number of the coil turns. When you change anyone of the factors above

there is a change in speed of the motor. However, what you are familiar with usually is the effect of current change as it can easily be investigated for example if you get a small electric motor and connect it to say one cell then increase the number of cells to two the speed changes.

USES

Can you list down at least 10 appliances or electrical gadgets which when connected to electricity either mains of DC move? I give my example of an electric fan as one use of electric motors.

Having looked at the DC motor we now move on to the DC generator.

26.4 THE GENERATOR EFFECT

So far we looked at the motor effect where you learnt that when a conductor carrying a current is placed in a magnetic field it experiences a force. Now let us look at what happens when a conductor is made to move in a magnetic field.

Let us try this short practical activity. You need a bar magnet, a piece of copper wire which you will make into a coil and also need a centre zero galvanometer. Make a coil out of this copper and connect the free ends to the galvanometer. Slide the bar magnet in and out of the coil and observe how the galvanometer respond. You should have observed that when you moved the magnet in and out there was a current reading shown by the galvanometer. You also noticed that the direction of that current changed when you were pulling out the magnet. See Figure 25.4

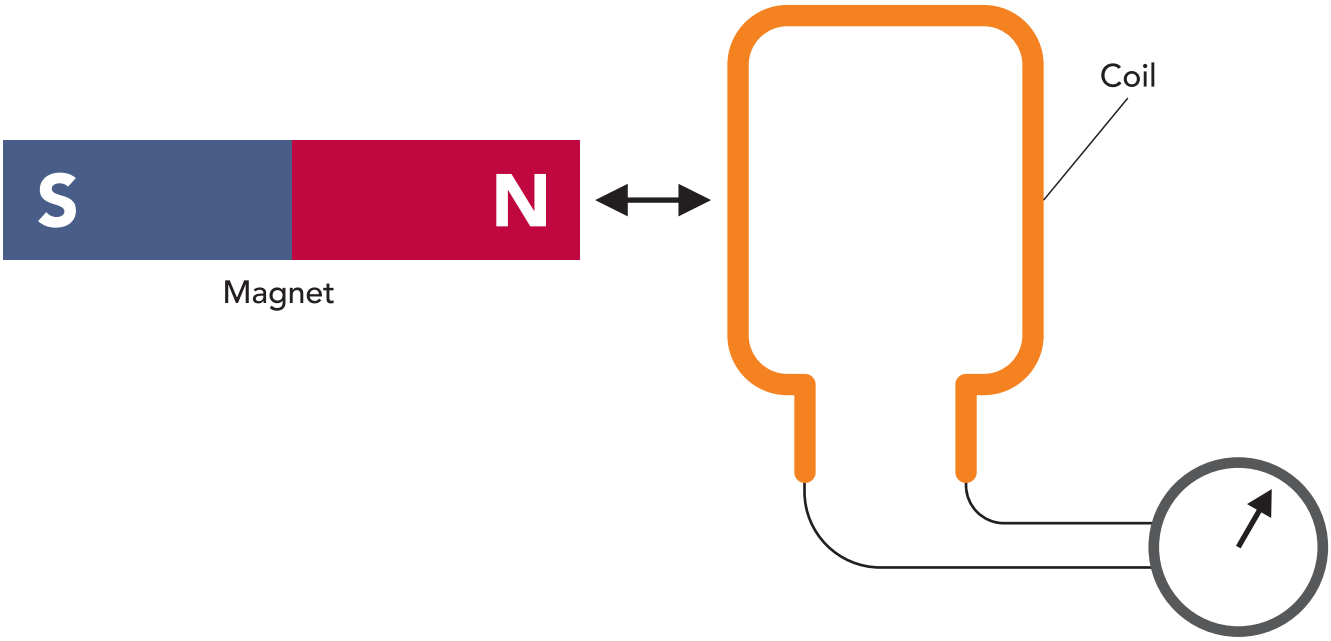


Figure 26.8 Demonstrating the magnetic effect

From the above activity we have seen that we can generate a current into the conductor by making it move into a magnetic field. This is the generator effect. The generator effect says that when a conductor moves in a magnetic field, an e.m.f is induced in it.

26.5 THE DC GENERATOR

A generator and an electric motor is the same thing in terms of structure but only differ in terms of uses. Just like a simple DC electric motor a simple DC generator has a coil which is rotated in a magnetic field by an external force like falling water in Hydroelectric Power Stations or the bicycle wheel in the case of a bicycle dynamo. The generator converts mechanical energy into electrical energy whereas an electric motor converts electrical energy into mechanical energy. When you connect electricity to a generator it becomes an electric motor and when you turn the coil in an electric motor it becomes a generator. In other words, the difference between a motor and a generator is based on use otherwise they are similar structurally.

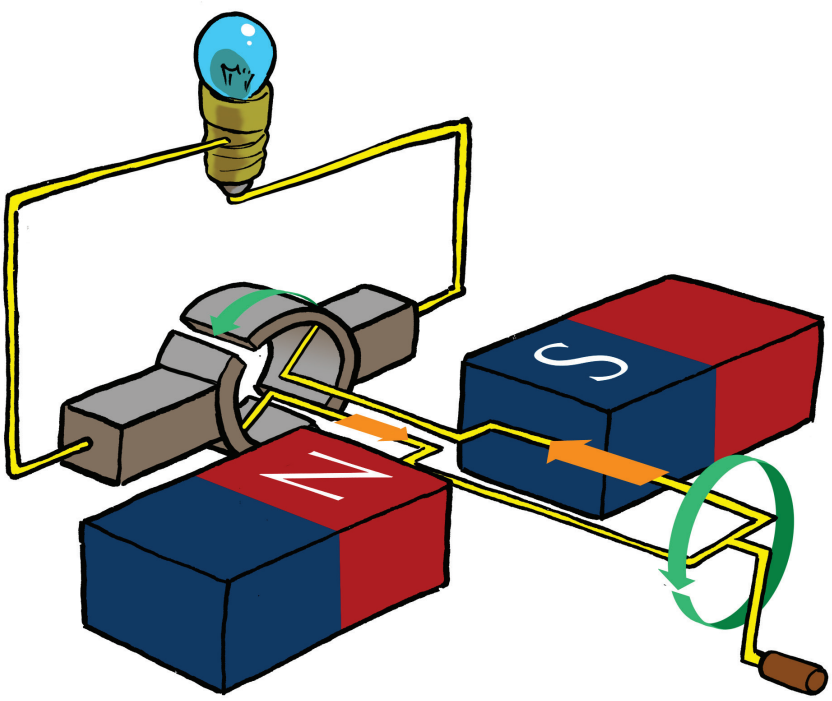


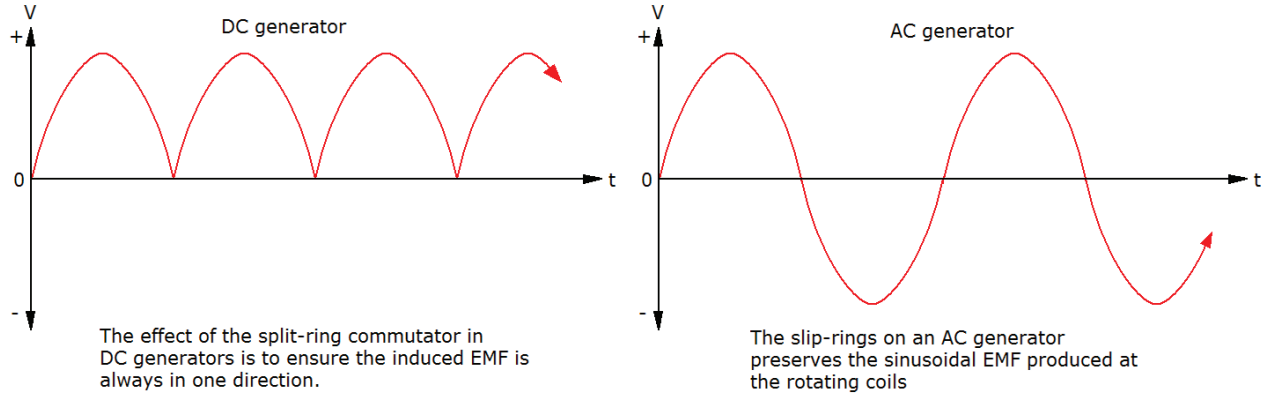
Figure 26.9 Simple DC Generator

The operation of a generator is based on the Generator Effect.

The magnitude of the emf induced is determined by the speed in which the coil is rotating. If you have ever cycled a bicycle with a dynamo you might have noticed

that to produce more current to light up your lamp you need to cycle faster. The number of coil turns and the area of these coils also determine the size of the output voltage. Just like in electric motors the strength of the magnets is also another factor. The output nature of the voltage is dependent upon the type of generator. A DC generator produces an emf as shown in Figure 26.10.

VOLTAGE OUTPUT OF A DC GENERATOR



The effect of the split-ring commutator in DC generators is to ensure the induced EMF is always in one direction.

The slip-rings on an AC generator preserves the sinusoidal EMF produced at the rotating coils

Figure 26.10 Graph of Voltage Output

This output shows that current produced always flows in the same direction. This is due to the commutator which in this case reverses the connections with the external circuit after every half revolution. Contrast with use of commutator in a DC motor which reverses current so that coil rotates in one direction.

However, in the AC generator the emf produced is always changing direction. To change a DC generator into an AC generator the commutator is replaced by slip rings. See the diagram below of an AC Generator.

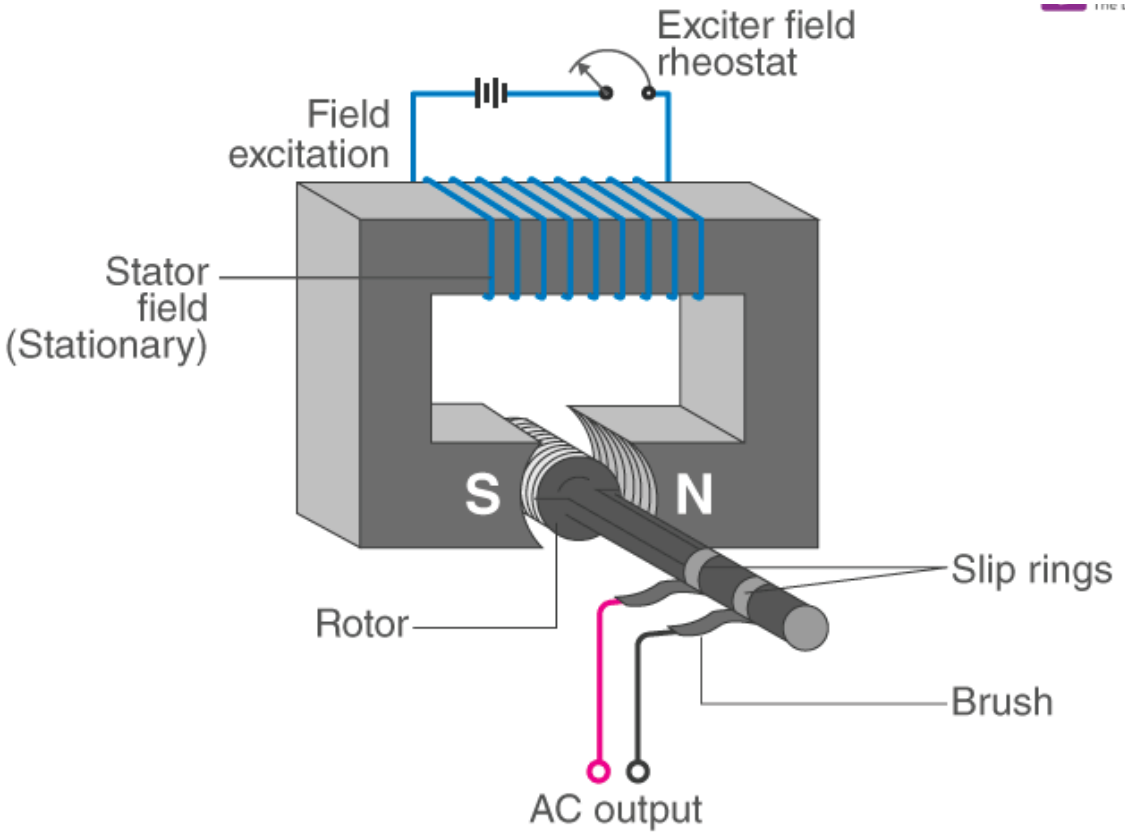


Figure 26.11 Simple AC Generator/Alternator

VOLTAGE OUPUT OF A SIMPLE AC GENERATOR

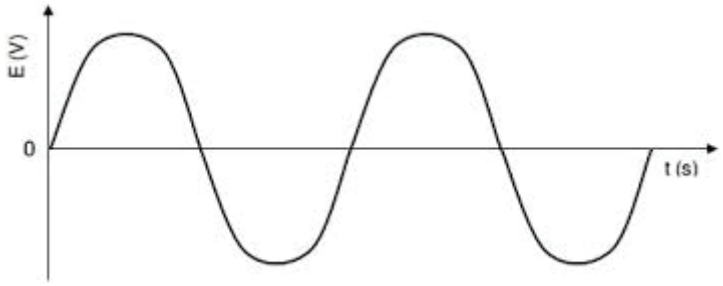


Figure 26.12 AC Voltage Output

26.6 APPLICATIONS OF ELECTROMAGNETISM

How do we get our electricity from Hwange or Kariba? Can you think about this? Our electricity is generated as AC in giant alternators that are rotated by falling water at Kariba or by pressurized steam in all thermal power stations like Hwange, Harare, Munyati and Bulawayo power stations. The main energy changes in these power stations are mechanical, which is kinetic energy of the rotating coils to electrical energy. For domestic use or small scale we use smaller generators. The flow diagrams below summarize the energy changes in a hydroelectric power station and thermal power station

26.2.7 HydroPower Generation

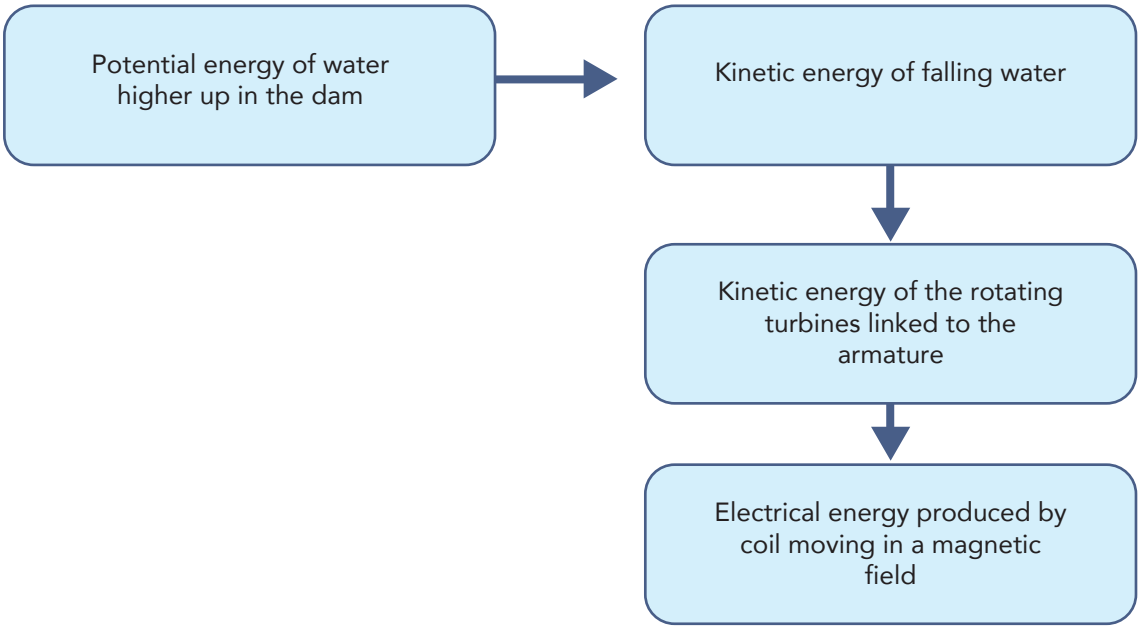


Figure 26.13 Flow diagram of energy changes in a Hydroelectric Power station

In Zimbabwe our major Hydroelectric power station is at Kariba though we now have some smaller plants especially in Manicaland. What do you think is the major disadvantage of such a power station that relies on water? What happens during times of drought? Think about this before you move on to the next section

26.7 Thermal Power Generation

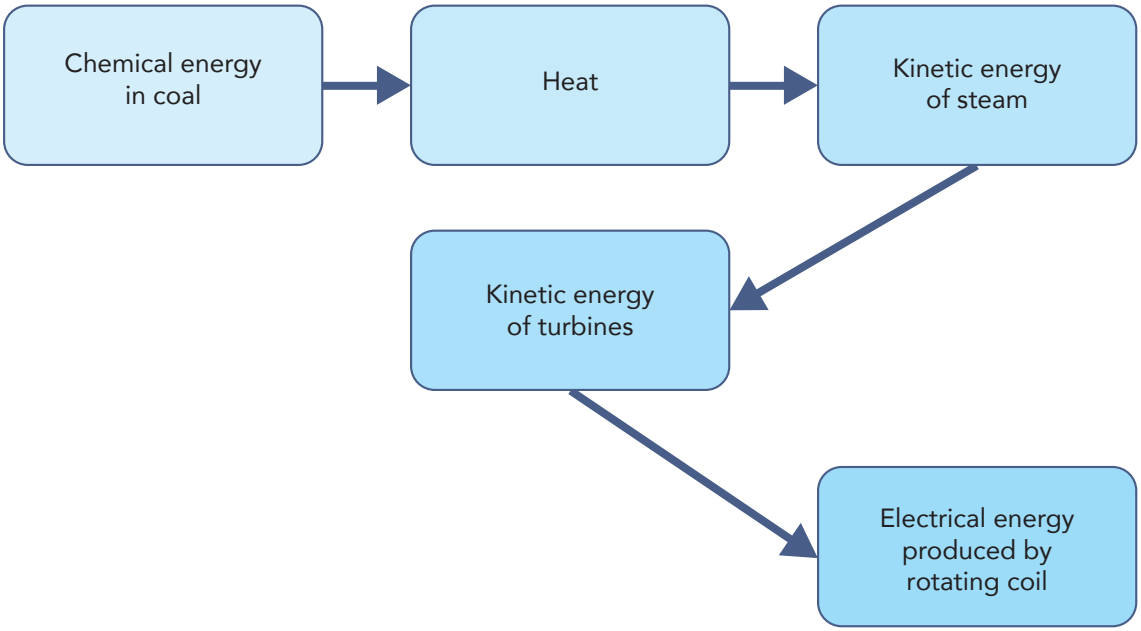


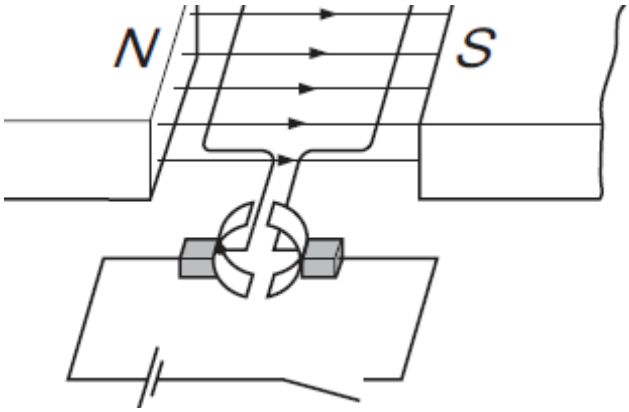
Figure 26.14 Flow diagram of energy changes in a Thermal Electric Power station

The energy changes above are almost similar to what happens in a hydroelectric power station. Instead of falling water rotating the turbines, it is the steam that is used. See the energy changes below. Hwange power station is our major thermal power station in Zimbabwe. Can you suggest a reason why? Hwange is the main source of coal which is used as a fuel in this type of station. What are the environmental implications of using coal as a fuel? I hope by now you have seen how electromagnetism is important in our daily lives. Before we move on to our next unit on Static Electricity let's see how much you have learnt by attempting the work below. If you do not get it right in the first place do not lose hope go through the unit again.

26.8 ASSESSMENT QUESTIONS

SECTION A Answer all questions

1. The diagram shows a simple d.c. motor.



The switch is closed and the coil rotates.

Which change makes the coil rotate in the opposite direction and at a faster rate?

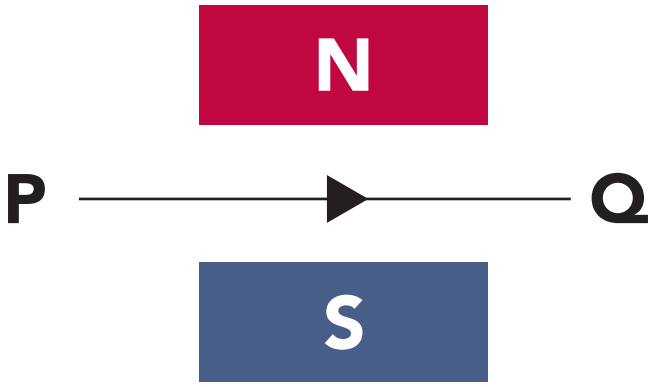
A increase the current in the coil and increase the number of turns in the coil

B reverse both the magnetic field and the current in the coil

C reverse the magnetic field and decrease the current in the coil

D reverse the magnetic field and increase the current in the coil

2. The diagram shows a wire PQ between the N-pole and the S-pole of a magnet. There is a current in the wire in the direction of the arrow.



What is the direction of the force on the wire PQ?

A into the page

B out of the page

C towards the N-pole

D towards the S-pole

3. What proves that a metal bar is a magnet?

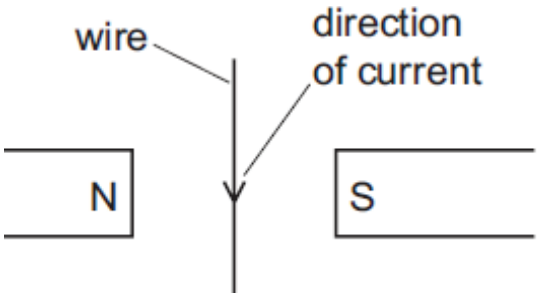
A It attracts both ends of a compass needle.

B It attracts one end of another magnet.

C It conducts electricity.

D It repels one end of another magnet

4. A current-carrying wire lies between the poles of two magnets, as shown.



What is the direction of the force on the wire?

A into the plane of the paper

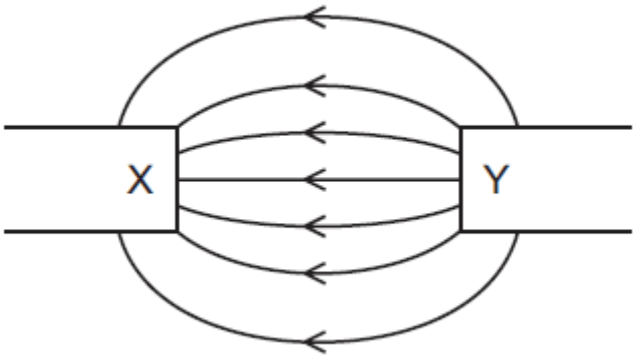
B out of the plane of the paper

C towards the left

D towards the right

5. The diagram shows the pattern and the direction of the magnetic field between two magnetic poles X and Y.

Which types of pole are X and Y?



	X	Y
A	N-pole	N-pole
B	N-pole	S-pole
C	S-pole	N-pole
D	S-pole	S-pole

SECTION B Answer in the spaces provided.

6.(a) In a DC motor, what is the function of the commutator?

(b) State three factors that affect the speed of an electric motor.

(i)_____

(ii)_____

(iii)_____(3)

(c) Give any two practical uses of electric motors.

(i)_____

(ii)_____(2)

7. Describe a simple experiment to demonstrate that a conductor carrying a current acts as a magnet.

(6)

8. Explain giving reasons the advantages and disadvantages of hydro electricity over thermal electricity (4

ANSWERS TO ASSESSMENT QUESTIONS

Section A

1). D 2). A 3). D

4). B 5). C

Section B

6 (a) A commutator makes current flow only in one direction

(b) (i) Strength of the magnet

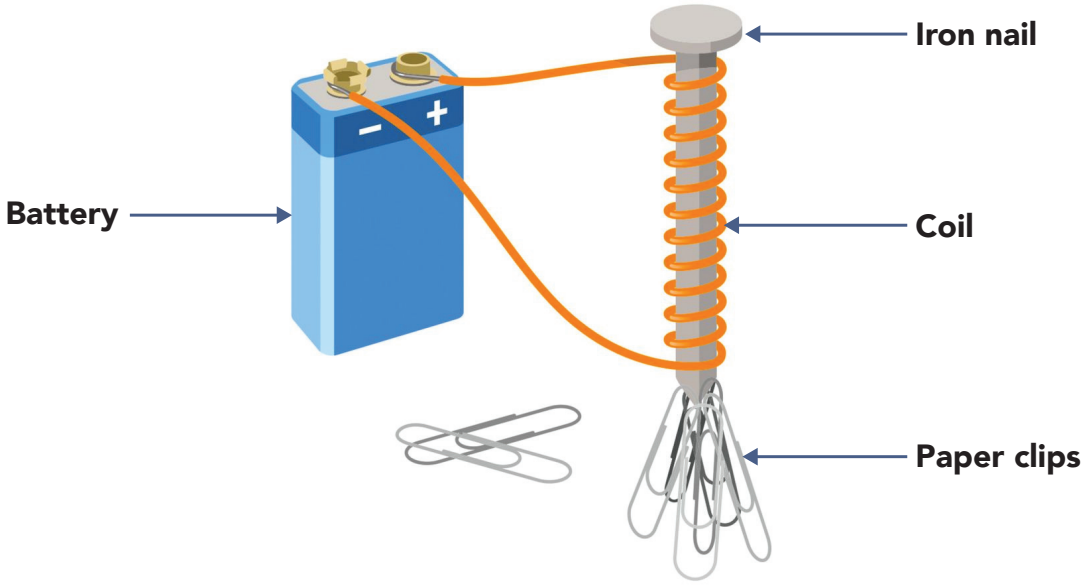
(ii) amount of current supplied to the motor

(iii) number of turns in the coil

(c) (i) lawn mower
(ii) electric drills; electric fan (2 marks for any two correct)

7. An iron bar or nail is wound by a conductor as shown by the diagram below.

When electricity is switched on, electricity induces a magnetic field on the iron bar or nail. The nail picks up paper clips as shown on the digram.



8.

Advantages	Disadvantages
Renewable	Affected by drought
Cheap	Disturbs natural habitats
Clean	

UNIT 27: STATIC ELECTRICITY

CONTENTS

INTRODUCTION

Before we begin this unit let us go back to what you covered in Atomic Structure in your Chemistry Section. What did we say make up atoms? Yes, atoms are made of protons, neutrons and electrons. What you also learned was that protons are positively charged, electrons are negatively charged but neutrons as the name says are neutral meaning neither positive nor negative. In this unit we want to see what happens when an object loses or gains electrons. We are also going to look at lightning and see how dangers associated with it can be minimized. At the end of the unit you are going to have a short test to check how far you have understood. Enjoy your studies.

OBJECTIVES

After going through this Unit you should be able to:

- describe simple experiments to show electrostatic charging
- describe forces between charges
- describe the production of lightning
- explain the principle of a lightning conductor
- state dangers of lightning
- state safety precautions against lightning

KEY WORDS

The following are some of the key words you will meet in the unit. Make sure you understand them as they appear in the unit.

Protons: positively charged particles in an atom

Electrons: negatively charged particles in an atom

Conductor: a material that allows electricity to pass through

Insulator: a material that does not allow electricity to pass through

TIME: 8 Hours

STUDY TIP

Before you proceed with this unit go back to your Chemistry Section on Atomic Structure.

27.1 ELECTROSTATICS

From your experience what do you observe when you take off either your jersey of any clothing item made up of nylon or wool in the dark?

Write down your observation in the box below

OBSERVATION

ACTIVITY 1 : ELECTROSTATIC CHARGING

Take your pen or plastic ruler rub that on hair or use your jersey to rub the pen or ruler. Tear off small pieces of paper and place them on any surface for example table. Bring the pen that you have just rubbed to the papers and see what happens. Write down your observation in the box below

OBSERVATION

It is clear that at one time you saw some sparks of light when you were taking off your clothes. It is also true that you have observed that when you brought your

rubbed pen close to the small pieces of paper, the papers jumped onto the pen.

All the above is to do with our topic that is ELECTROSTATICS.

Electrostatics is the study of electricity at rest. What do you understand by the term electricity? Can you write down your answer before you proceed? You will recall that electrons are mobile and because of this an atom can either gain or lose electrons. When this happens the atom is left with either an excess or deficiency of electrons. This state of either having more or less electrons constitutes what we call a charge. Electrostatics deals with charges that are stationary.

CONCEPT OF A CHARGE

An atom is neutral. What does this mean? The number of electrons is equal to the number of protons in a neutral atom.

Hope you get it right that when an atom loses electrons it remains with fewer electrons than protons. An atom becomes positive. WHY? Let us imagine an atom X that has 11 electrons and 11 protons. If it loses one electron it remains with 10 electrons and 11 protons. Remember protons are fixed in the nucleus. The ten electrons cancel out the ten protons leaving out one proton. From this it is clear that we remain with a positive charge. The opposite is true when an atom gains electrons we get more electrons than protons and the atom becomes negative.

So we can say a charge is either an excess or deficit of electrons.

The S I unit for a charge is the coulomb (C).

We have seen what a charge is and we now move on to investigate how similar or different charges behave.

EXPERIMENT ON ATTRACTION AND REPULSION OF CHARGES

AIM: To demonstrate the attraction and repulsion of charges

APPARATUS/MATERIALS: 2 polythene rod / 2 plastic rulers, 2 perspex rods,Sewing thread, Woollen cloth

METHOD

Set your activity as follows.

- Part A. Take your polythene rods rub them with woollen cloth.
- Suspend on polythene rod as shown in the diagram above
- Bring the second rod close to the suspended rod and observe what happens

See Figure 27.1 below

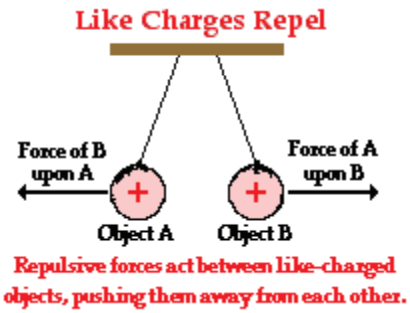


Fig. 27.1 Interaction of Like Charges

Part B. Rub one polythene rod and suspend it (when a polythene rod is rubbed by woollen cloth, it gains electrons from the cloth and the rod becomes negatively charged)

Take your Perspex rod and rub it with woollen cloth(when a Perspex rod is rubbed by a woollen cloth it loses electrons the cloth and it becomes positively charged)

Bring the Perspex close to the suspended polythene rod and observe. See Fig. 27.2

PART B

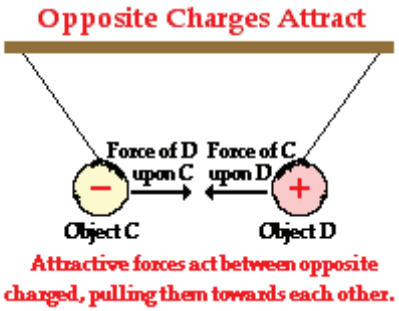


Fig. 27.2 Interaction of unlike charges

Write your observations in the Table Below

PAIR	OBSERVATION
Polythene –polythene	
Polythene –Perspex	

DISCUSSION

From your practical activity you have observed that when two charged polythene rods were brought together the suspended rod moved away from the rod that you were holding with your hand. This moving away is called REPULSION.

When you brought the charged Perspex rod close to the suspended charged polythene the suspended polythene rod moved towards the charged Perspex rod. This is ATTRACTION.

Repulsive forces operate between objects with like charges for example two negatively charged polythene balls.

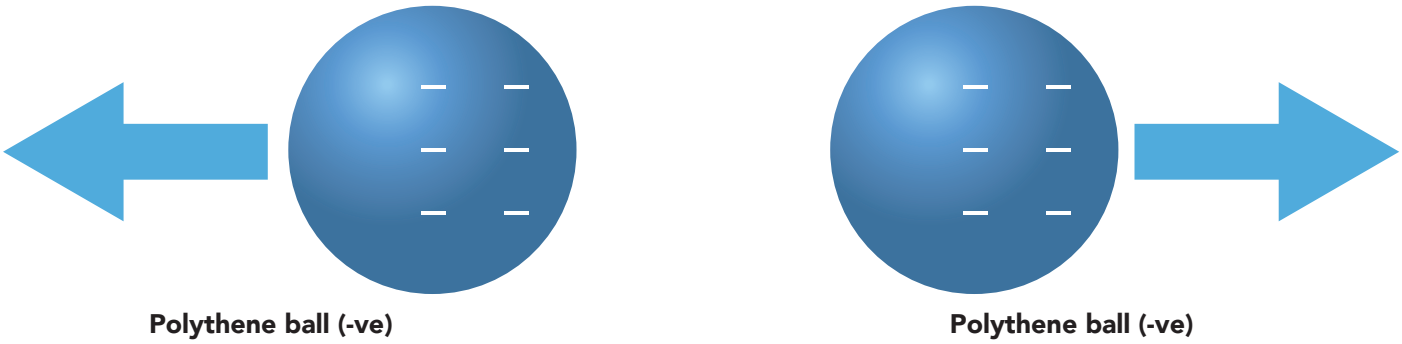


Fig 27.3 Forces between like charges

Attractive forces are between objects with unlike charges as also shown below.

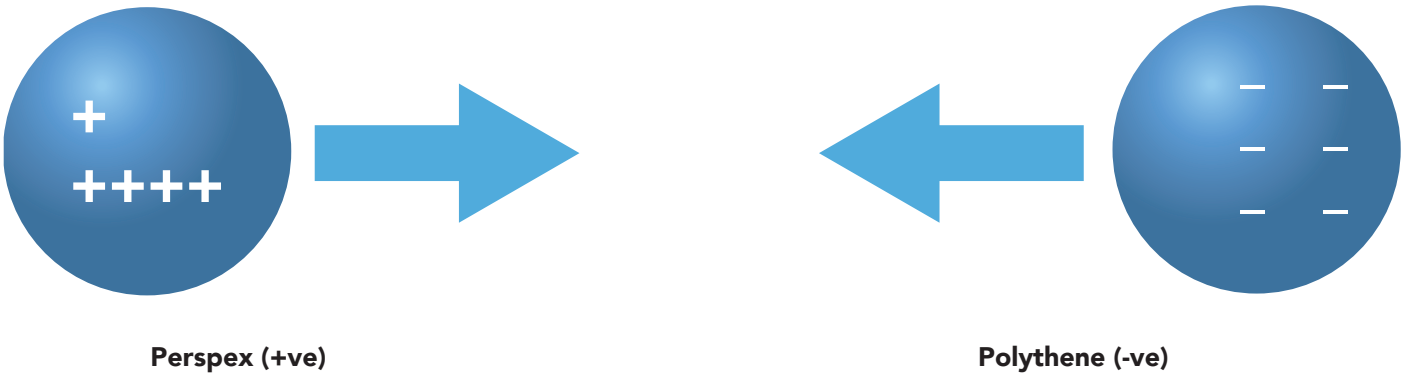


Fig 27.4 Forces between unlike charges

SUMMARY

Let us see what you have learnt so far before we proceed to the next topic.

- Charges can either be positive or negative
- Matter is positively charged when electrons are removed and is negatively charged when electrons are added
- Like charge repel, unlike charges attract.

27.2. LIGHTNING

Lightning strikes 7 family members, killing 2

By Newsday

- February 7, 2018

A LIGHTNING bolt struck seven family members, who were resting under a tree at their homestead in Mudzi, killing two while five of them, including two babies, sustained injuries last Saturday.

(Newsday, 2018)

Lightning happens when the negative charges (electrons) in the bottom of the cloud are attracted to the positive charges in the ground. How does this happen? When two clouds move past each other there is electrostatic charging resulting in the bottom cloud becoming negatively charged. Lightning is a natural electrostatic discharge.

THE LIGHTNING CONDUCTOR

A lightning conductor is a metal rod mounted on a structure for example a house its use is to protect structure from a lightning strike. The lightning conductor is made of a conducting material for example copper. When a charged cloud is over the structure the electrons in the cloud repel the electrons in the spikes that are at the top of the conductor. These electrons move down the conductor leaving the top part of the conductor positively charged. The positive top part ionizes the air around the spikes giving positive air particles that stream up into the cloud to cancel the negative charge. The other way in which the conductor protects the building is that the conductor offers a good path for the charge to flow down to the ground when lightning strikes instead of flowing through the building which is a poor conductor. In other words, the lightning conductor acts as an EARTH.

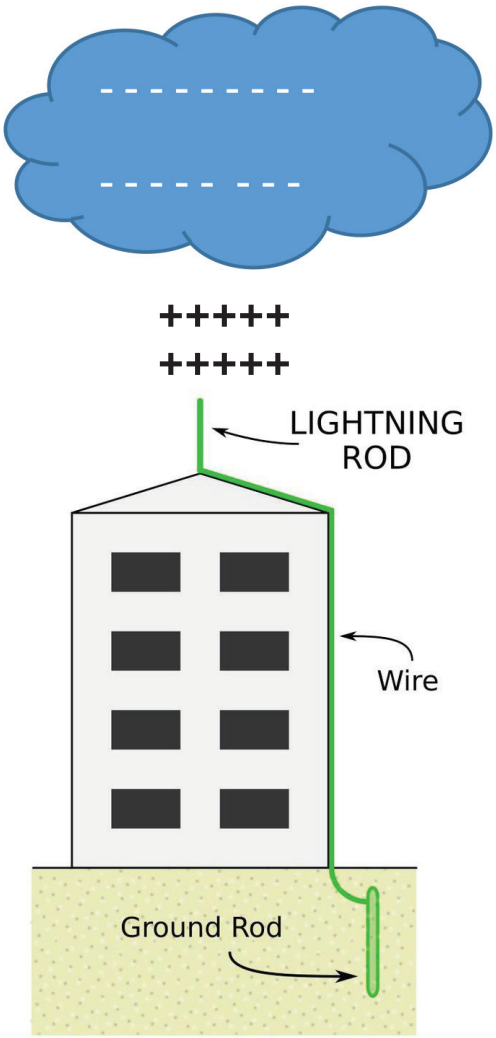


Fig. 27.5 Lightning Conductor on a building

DANGERS OF LIGHTNING AND SAFETY PRECAUTIONS

Lightning causes electrocution and burns structures especially those made of combustible materials like thatch grass for our rural homes. The two dangers of lightning are electrocution through high voltage and heating effect. How can you protect yourself from lightning?

Can you write down any safety precautions against lightning in the space below.

_____

_____

_____

_____

Let us see if what you wrote above is correct. The following are some of the ways you can protect yourself from lightning.

1. Avoid taking shelter under a tree
2. Avoid touching metallic objects like water tapes during a storm
3. If cycling get down from the bicycle and sit down where you maintain your height as minimal as possible.
4. Avoid using an umbrella when there is thunderstorm
5. Use a lightning conductor to protect your dwellings
6. Do not play in water when raining.

SUMMARY

- Lightning conductor protects structures from being struck by lightning
- Only electrical conducting materials are suitable for lightning conductors
- Always take precautions to avoid lightning dangers

27.3 ASSESSMENT QUESTIONS

Attempt all the questions below without referring to your answer book.

1. (a) Draw an atom and label the protons, neutrons and electrons (3)

(b) Which of these particles is easily removed? (1)

2. (a) Show the charges in the following rod A if B is negative

(b) Give a reason for your answer in 2(a)

(2)

3. Suggest and explain and three precautions against lightning.

Precaution (i)_____

_____

Reason_____(2)

_____

Precaution (ii)_____

_____

Reason_____

_____(2)

Precaution (iii)_____

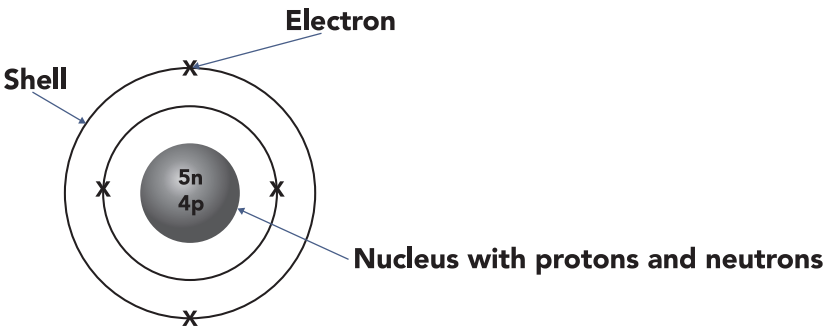
_____

Reason_____

_____(2)

ANSWERS TO ASSESSMENT QUESTIONS

1(a)



(b) electrons

2(a) A is negatively charged

(b) rod A repelling rod B which is negative

UNIT 28: CURRENT ELECTRICITY

CONTENTS

INTRODUCTION

In this unit you will learn about the physics of electricity. Remember in Level 1 you learnt about conductors and insulators. You also looked at what we mean by electricity as a flow of charge. In this unit we are going to build on from what you learnt and hope you will enjoy studying this wonderful aspect of physics that make our lives bright. We are going to look at Shgthe Ohm's Law and resistors in this unit and the rest will be covered in Unit 29.

OBJECTIVES

After going through this unit you should be able:

- Describe Ohm's law
- Determine total resistance of resistors in series and in parallel

KEY WORDS

Resistance: the force opposing flow of current

Voltage: also referred to as potential difference

Current: flow of electrons or current

TIME

This a rather shorter unit compared to Unit 26 and you are expected to spend no more than 8 hours on this unit.

STUDY SKILLS

Science requires you to be too inquisitive. This will help you enjoy science and its nature. Try the practical activities in the unit to fully understand the concepts covered in the unit.

28.1 OHM'S LAW

The current through a conductor depends on the voltage which we usually refer to as potential difference that is applied across the conductor. Let us take this analogy to help you understand this. In a water supply we need the pump to push the water that is pumping it. In electricity this pump is the power supply for example the battery. The force which is the push is the voltage. Water is the current that is only moving when there is the force. So what we are saying is that for current to flow there has to be a force that pushes the current and this force is the potential difference. Now what happens when the force is less? Yes you got it right the current also becomes less. There is a direct relationship between voltage and current and this relationship is called the OHM'S Law. This is in respect of the scientist called Georg Ohm who investigated this around 1826.The Ohm's Law is stated thus:

The current flowing through a metal conductor is directly proportional to the p.d. across its end provided the temperature and other physical conditions remain constant.

Can you state which these other conditions that are kept constant are?

Mathematically this law can be written as : $V \propto I$ where V is voltage and I is the current.

EXPERIMENT 1; VERIFYING OHM'S LAW

What you will need.

- 4 torch cells
- Voltmeter FSD 5V
- Ammeter FSD 2.5 A
- Switch
- Conductors
- Circuit board
- Torch bulb

What you will do.

Connect your apparatus as shown in the circuit below

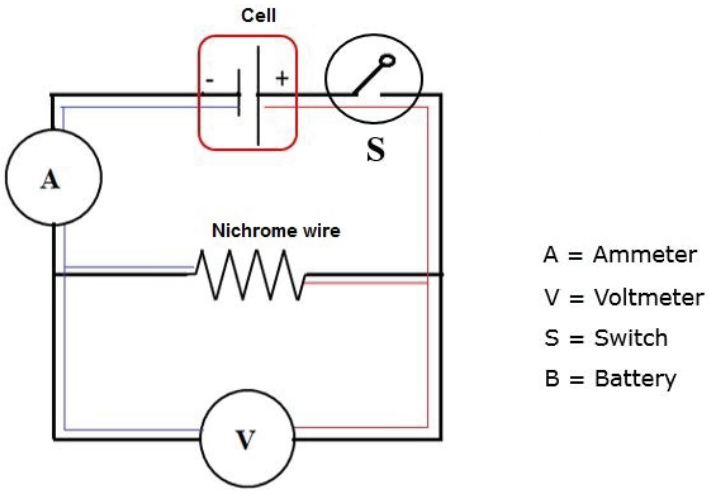


Figure 28.1 Circuit to verify Ohm's Law

Start by connecting one cell measure voltage and current and record in the Table below. Add another cell and record the voltage and current again. Repeat the same procedure till you have added all the 4 cells

Table 28. 1 Voltage and Current Readings

Number of Cells	Voltage(V)	Current (A)
1		
2		
3		
4		

After this plot a graph of voltage versus current and find the gradient of the graph. We believe you still remember how to determine gradient from your mathematics modules.

Findings

You have observed that the gradient is constant and this gradient is the resistance. What then is resistance? We said voltage is that force that drives current. Well whenever something is moving we also have a force that opposes that motion for example friction in moving objects. In electricity that friction is called resistance. Resistance results from collisions of electrons as they move along a conductor. Remember flow of electrons is current. What do you think is the effect of cross sectional area on resistance?

V,I and R Calculations

(a) If there is p.d. of 12V across a wire of resistance 4Ω ,what is the current that flows along the wire?
(b) What is the p.d. across the same wire above if a current of 6A flows through?

Use the relationship $\frac{V}{I} = R$

28.2 RESISTANCE

We have seen above how V and I are related and we have also seen that if we increase voltage, current also increases. These two are linked by resistance which is the opposition to flow of current. Resistance can also be determined by doing the same experiment above and you measure voltage and current then divide voltage by current. This is the voltmeter-ammeter method of measuring resistance. Now let us look at factors that affect resistance. Remember we mentioned above that one reason why we have resistance is the collision of electrons as they flow. So what do you think of the resistance of a thin wire and a thick wire of the same type? Yes, a thick wire has more cross sectional area than a thin wire so offers less resistance. Can you state this factor? Yes, cross sectional area or thickness. The other factor is the length of the wire. When we stated the Ohm's Law we said at constant temperature. Yes, temperature is one other factor that affects resistance of a conductor. In other words, when verifying the Ohm's Law temperature must be held constant otherwise if the temperature is varied using the same conductor the law will not be obeyed.

Before we move on to the next sub unit let us rewind what we have learnt so far by answering the following questions.

(a) State the Ohm's law
(b) What are the limitations of the Ohm's law?
(c) Give three factors that affect resistance
(d) Describe a simple experiment to determine the resistance of a conductor

Hopefully you attempted the above questions. If you did not do well go back to relevant sections of the unit and read through.

RESISTORS

Resistors are devices that are specifically made to provide resistance. Think of a radio, does every component of the radio require the same current?No. Some components require more current others very small current and to make this possible we have resistors that offer different resistances.

Symbol of a resistor

The above is the symbol of a resistor that you will meet in your studies. As we have said above that resistors are devices that are specifically made to provide different resistances, it implies that in an appliance like a radio different parts of the radio require different sizes of current and to achieve this it means different resistors are used. One way to achieve this is to combine resistors to come out with different resistances. Resistors can be combined either in series or in parallel. Now let us look at how resistors behave in series or in parallel. We are going to consider two resistors in each case.

Resistors in Series

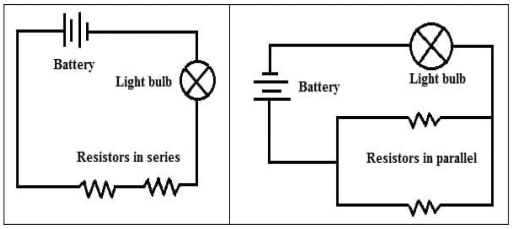


Figure 28.2 Resistors in series Circuit

There are mainly two basic rules when dealing with two resistors in series. (a) The current is the same at all points around the circuit. That is the current passing through each resistor is the same. (b) The sum of the p.d.s across the resistors is the same as the p.d across the battery.

Experiment to determine the combined resistances of the two resistors above show that the total resistance is the sum of those individual resistances. So in Figure 27.2 the combined resistance is 3Ω + 2Ω= 5Ω

REMEMBER. The combined resistance of resistors in series is the sum of all the resistances. If we have R1, R2 and R3 the total resistance R is given by the following equation.

R = R1 +R2+R3

So from the above it is clear that when you want to increase your resistance in a circuit you just combine your resistors in series that one after the other and you get a higher resistance and less current. Let us now look at what happens when resistors are arranged in parallel. Can you think of why at times we need to combine resistors in parallel? What will be the effect on the size of current flowing through the circuit?

Resistors in Parallel

The circuit below shows the same resistors as above but this time arranged in parallel. In parallel circuit the p.d across each resistor is the same as the p.d across the battery but current passing each resistor depends on the size of the of the resistance. For example more current passes through the 2ohm resistor than the 3ohm. The currents through the resistors add up to equal the current in the main circuit.

Experiments confirm that the total resistance is less than any of the given resistances. If we have two resistors of 2 ohms and 3 ohms it means our total resistance is less than 2 ohms.

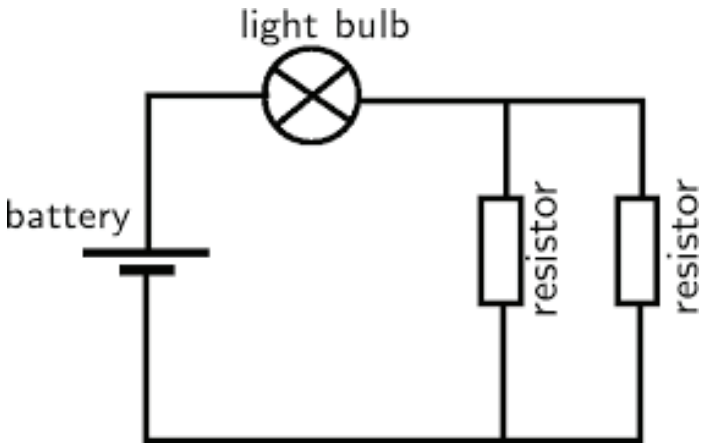


Figure 28.3 Resistors in parallel

To determine the total resistance R in the above circuit the following formula is used.

Total resistance (R) = $Productofresistances \div Sumofresistances$

R= $\mathrm{R}=\frac{R1R2}{R1+R2}$

So in the circuit above the total resistance R is (2 x3)/(2+3) =1.2Ω.

You can see that the combined resistance is less than the lowest resistance. We are saying in the event that you want a total of 1.2ohms' resistance in your circuit but you do not have that resistors but you have the 2ohm and the 3ohm. You combine the two resistors in parallel and obtain the required resistance.

NB The above formula only applies to two resistors in parallel for more than two another formula is used and you will cover this in Level 3 as for now we only consider two resistors in parallel.

SUMMARY

Resistance opposes the flow of current and this can be determined by the voltmeter –ammeter method.

Resistors are devices that are made to provide given resistances

Resistors can be arranged either in parallel or in series

Total resistances in series is given by adding all the resistances in the circuit.

Total resistance in parallel is always less than the lowest resistance in the circuit.

28.3 ASSESSMENT QUESTIONS

1. The data below show results from an experiment to verify Ohm's Law.

p.d (V)	Current (A)
1.0	0.18
2.0	0.36
3.0	0.54
4.0	0.72
5.0	0.86
6.0	0.94

(a) Plot a graph of current against p.d. Mark on the graph the point Y beyond which Ohm's Law no longer applies. (4)

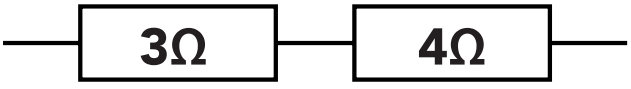
(b) Calculate the resistance of the material up to point Y. (2)

(c) Use your graph to determine the current when a there is a p.d. of 2.5 V across. (2)

2. What would be the effect on the resistance of a wire if (a) its length is increased (b) its diameter is increased (c) its temperature is increased. (3)

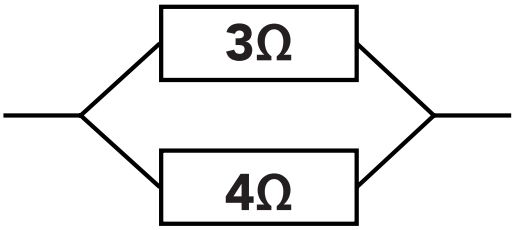
3. Determine total resistances in the following:

(a) Two resistors in series of resistances 3ohms and 4 ohms



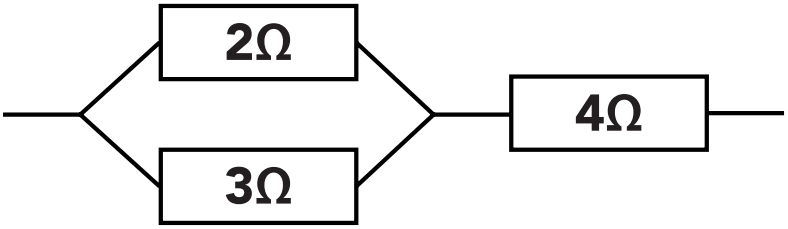
(1)

(b) Two resistors in parallel of resistances 3ohms and 4 ohms



(2)

(c) Two resistors in parallel and one resistor in series with the parallel resistors



(2)

4. With the aid of a well labelled diagram describe how you would determine the resistance of a tungsten filament lamp. You are given 4 by 1.5 V cells a voltmeter, an ammeter, switch, conductors and the lamp. (10)

ANSWERS TO ASSESSMENT QUESTIONS

1.Has to plot the graph

2(a) resistance increases

(b) resistance decreases

(c) resistance increases

3(a) total resistance in series you add so it 7Ω

(b) Total resistance for two resistors in parallel is given by dividing product by sum

$(4 \times 3)/4+3 = 12/7$

$=1.7\Omega$

(c) $(2x3)/(2+3) + 4$

$= 5.2\Omega$

4. See Experiment 1

For diagram

UNIT 29: ELECTRICAL POWER, ENERGY AND ELECTRICITY IN THE HOME

CONTENTS

INTRODUCTION

Electricity is one important thing that almost everyone cannot do without. Electricity in the home, electricity in the industry and electricity everywhere. In this unit you are going to look at how we calculate power and energy. Knowing how to calculate these help you understand how our electricity usage is charged for. You are also going to look at safety issues when using electricity so that you become aware of electrical hazards and how they can be minimized. Due to ever increasing demand of electricity as a result in increase in population the unit will end by looking at alternatives ways of getting electricity in a cheaper and cleaner way that is photovoltaic systems. Hope you will enjoy the unit.

OBJECTIVES

After going through this unit you should be able to:

- Calculate electrical power and energy
- Describe electrical hazards and safety precautions
- Wire a 3 pin plug
- Describe uses of electricity in the home
- Calculate cost of electricity
- Explain the use of solar voltaic systems

KEY WORDS

Power: rate at which energy is being changed from one form to another

Watt: unit of power

Joule: unit of energy

STUDY SKILLS

You must always refer to previous units on electricity as you go through this unit.

TIME: 8 hours

29.1 ELECTRICAL POWER AND ENERGY

In the previous unit you looked at resistors. Resistors like the tungsten filament lamp convert electrical energy into heat and light. You need to know the rate at which such energy changes are taking place. From your experience you have used different electric lamps that produce light differently. We have those known as energy savers. Are they bright? Try to look for packaging of electric lamps and check if all are rated with the same power.

What is it that we mean by power? Can you think about it before reading further? We said energy is changed from one form into another by a resistor but can we tell how much is changed per unit time? Power is the rate at which such energy changes are taking place. The term rate means per unit time. So power is how much energy is converted into other forms per unit time.

$$Power = \frac{energy\ changes}{time\ taken}$$

You remember from the unit on measurements that the SI unit for energy is the joule (J) and the SI unit for time is the second (s). Therefore, the unit of power is the joules per second (J/s). which is also known as the watt (W).

Different electrical appliances we use in our homes have different power ratings. What this means is that they consume energy differently. Let us consider an electric iron and your smartphone. Which of the two consumes more electrical energy? Of course it is the electric iron. We now need to learn how to determine power and energy. We need to do a bit calculations but do not be afraid it is straight forward mathematics.

CALCULATING ELECTRICAL POWER AND ENERGY

At one time in your life you have used electric cells maybe for your torch or remote controls. The power given by these cells is dependent upon its voltage that is the p.d. across its terminals and the current it supplies. For example, the common torch cell has a p.d. of 1.5V and if we know the current it is supplying we can calculate its power output by multiplying the voltage by the current:

power = p.d. x current.

P =VI where V is the voltage and I is the current.

Do not be confused with the two formulae, this last one is the one that we will mostly use in our calculations. The power you get is still measured in watts (W). However, some appliances have power running into thousands so we use the term kilowatt.

IkW being equal to 1000watts.

Let us now look at how we calculate electrical energy. If we know the power output of say a battery, then we can easily calculate the energy that battery is supplying by using our first equation of power.

$$\boldsymbol{Power} = \frac{\boldsymbol{energy\ chnges}}{\boldsymbol{time\ taken}}$$

When we make energy the subject of the formula we get this equation:

energy= power x time

This can be written in symbols as E=Pt where E is the energy, P is power and t is time. The same equation E = Pt can be further expressed as E =VIt where VI is power.

There is another term which we will study when we look at paying for electricity. This is the kilowatt hour (kWh). This is the unit for energy supplied to an appliance with a power rating of 1kW in 1 hour. We leave it here and we are going to consider towards the end of this unit.

Now let us practice calculating power and energy in the following activity.

ACTIVITY 1 Power and Energy Calculations

1. A water heater changes 200joules of electrical energy into heat every second when connected to a 20V supply.

   (a) What is the power of the heater?

   (b) What is the current through the heater?

   (c) If the supply voltage were to fall to 10V, what current would then flow through the heater and what would be the power output?(Pople, Explaining Physics, 1990)

2. A small water heater is rated at 12V 60w. Calculate the current through it.(Pople, Explaining Physics, 1990)

3. An energy saving light bulb is rated 5V 3W. Calculate the current that passes through it.

29.2 ELECTRICAL SAFETY

In as much as electricity is very important in our lives, it can also be a danger to our lives if we do not take precautions. We have read stories of people being electrocuted either in their homes or at workplaces and all these disasters could be prevented if we take precautions.

ACTIVITY 2 QUIZ ON ELECTRICAL HAZARDS AND SAFETY

Study the situations in the table and tick if a hazard or a safety precaution.

	SITUATION	HAZARD	SAFETY PRECAUTION
1	Damaged insulation		
2	Drying hands before touching electrical appliances		
3	Connecting many appliances on one socket		
4	Damp conditions		
5	Replacing a fuse with a wire		
6	Going to bed with a heater on		
7	Disconnecting all appliances when away from home for some time		
8	Using correct fuses		
9	Pushing a metal object into the mains plug hole		

Hopefully, the quiz has made you become aware of electrical hazards. Now think of ways of how to prevent the hazards you identified above. Select any three hazards above and suggest how the hazards can be prevented.

Hazard 1_____

Explanation_____

_____

Hazard 2_____

_____

_____

Hazard 3_____

_____

_____

THREE PIN PLUG

One way of avoiding electrical hazards is to use a plug when connecting appliances to mains electricity instead of inserting wires which can cause short circuits. The most common way to connect your appliances to the main electricity is to use either 3 pin or 2 pin plugs. Let us start by studying the 3 pin plug.

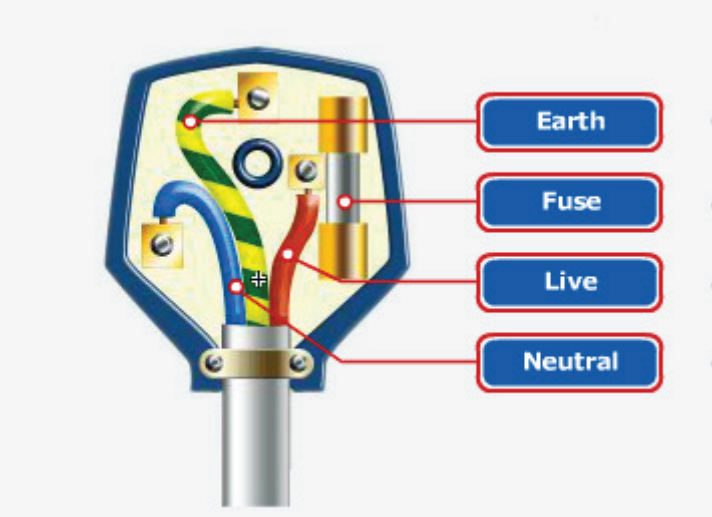


Figure 29.1 The 3 pin plug. Source(Jain, 2019)

The 3 pin plug consists of three pins as shown in Figure 28.1 above. The live wire is connected to the live pin, the earth wire is connected to the earth pin and finally the neutral wire is connected to the neutral pin. In order to identify these wires, we use a special colour coding which is as shown below.

Colour Codes

Live brown

Neutral blue

Earth green and yellow.

Let us look at this plug in more detail so that we see how it is important in electrical safety. Study Fig. 29.1 above again. Where is the live wire connected? You might have seen that the live wire is connected to the fuse. Why is that so? You are going to get the reason when we look at the use of the earth. The live wire supplies current to your appliance. From your Level 1 you learnt that current flows in a circuit. What this means is that the current supplied by the live wire to the appliance must also exit the appliance. This is the role of the neutral wire to carry current away from the appliance. What then is the use of the earth wire? The earth wire is connected to the earth pin in the plug and to the metal casing of the appliance. In a case where the live wire accidentally comes into contact with metal casing of the appliance, it means the whole body of the appliance for example your stove becomes live and if you touch it you get an electrical shock which can be fatal. If the stove is earthed, then the current is directed away to the ground by the earth and you are safe. The earth wire prevents electrical shocks when there is a short circuit mostly in appliances that have metallic casing. If the current leakage is too large the earth will cause the fuse to blow off and this again protects the user. The fuse acts as a circuit breaker.

You have seen that 3 pin plugs come in different forms and one type that you are familiar with is the 3 round pin. This is usually used for appliances that draw more current like stoves and electric irons. These plugs can tolerate more current that the 3 pin plugs that do not have round pins. Most 3 pin plugs can handle current of up to 13A.

It is very important to use the correct plug with the correct fuse rating. For example, if your appliance requires 10A you use a fuse that has a rating slightly higher than the normal current required by the appliance. In this case you use a 13A fuse. Why not use a 10A fuse?

As a rule, the fuse rating limit must be slightly higher than the current needed by your appliance. This is to prevent the blowing off of the fuse on slight current up surge.

THE 2 PIN PLUG

Not all your appliances have metal casings. Some have plastic casings and our old radios have wood casings. What happens when the live wire accidentally comes into contact with the body of such an appliance and you touch the casing? Nothing of course happens because the casing is an insulator.

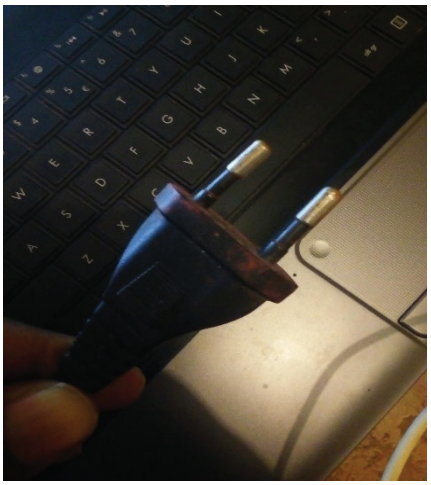


Fig 29.2 The 2 Pin Plug

The 2 pin plug is mostly used for appliances that work on low current and on appliances that do not need earth. These appliances do not have metal casings. Can you give examples of such appliances?

ACTIVITY 3 WIRING A 3 PIN PLUG

What you need

You need to know how to wire a 3 pin plug. In this activity you need a three core cable, small screw driver, a sharp knife, a 3 pin plug. You can buy the plug from any local electrical hardware shop if you do not have one at home.

What you must do

Identify the three wires the live, neutral and earth

Using your knife remove insulation from one end of each wire at most 4mm

Unscrew your plug and identify the pins

Loosen the screws on the pins

Now put the uninsulated end of the live wire in the live pin hole which is connected to the fuse

Put the neutral and earth wires in the respective pin holes and tighten the screws.

You can refer to Fig. 29.1 for guidance

Before you go to the next section on electricity in the home can you reflect on the questions below?

(a) Why is the earth pin usually bigger and thicker than the other two pins?
(b) What is the use of a switch in our circuits?
(c) Explain why a DVD player uses a 2 pin plug but a stove uses a 3 pin plug
(d) Why must you not push metal objects into the mains plug holes?

29.3 USING AND PAYING FOR ELECTRICITY

In this last section of your unit, you are going to look at uses of electricity, paying for electricity and the use of solar photovoltaic systems as another source of electricity.

29.3.1 USES

The uses of electricity in the home are basically for heating, lighting and powering your electrical devices. You use electricity for cooking. This is the heating aspect where electrical energy is converted to heat energy by your electric stove. You use electricity to provide you with light using light bulbs. Our radios, televisions, hair driers, phone chargers, irons, electric jugs and so on work on electricity.

PAYING FOR ELECTRICITY

Just like any commodity that you need to pay for electricity you use. In Zimbabwe we are slowly moving to prepayment instead of post payment. In prepayment just like your airtime you pay for the electricity before use. At one time domestic tariffs were set at 10c per unit meaning if you bought for $1.00 you would get 10 units. The unit used is the kilowatt hour (KW h). The number of units used depend on the type of the appliance. An appliance that draws more current uses more power within a short period of time than the one that draws less current.

Some households are still on post payment where the meter is read to determine consumption which is then charged according to the prevailing tariffs.

READING ELECTRICITY METERS

We have different types of meters some are digital and others are mechanical. For digital just take the reading displayed reading from left to right. This gives you the

kilowatt hours used and if you multiply that by the charges per unit you get the cost. See the meter below.

Fig. 29.3 Electricity Meter (Source npower.com)

What is the meter reading shown? If the cost per unit is 27 cents how much is the consumption shown in the meter?

Worldwide the cost of energy is becoming high hence the need to reduce energy consumption. On the week this unit was being written our domestic cost per unit rose from 10cents per KWh to 27cents. This meant that where a dollar would give you 10 units the same amount now gives you 3.7 units. This calls for saving electricity and some of the ways of doing this is to use energy saving bulbs, switching off our geysers and using solar water systems for heating water and also providing electricity.

29.4 PHOTOVOLTAIC SYSTEMS

Currently the country is in an energy crisis where our electricity generating plants are failing to provide enough electricity for the nation.

Solar photo voltaic systems provide clean and cheap electricity. Solar voltaic systems convert light energy from the sun into electrical energy. Zimbabwe is blessed to have more light hours and plenty of sunshine per day so this is the best

alternative. However, installation costs are initially high but after that operation costs are not that bad. What happens during the night when dark?

Think about back up storage batteries.

SUMMARY

It is our hope that you have enjoyed this unit and you are ready to solve our energy crisis in Zimbabwe. Science is there to offer solutions. You have learnt how safety is important when using electricity and you have also learnt how you are charged for power that you use and lastly you looked at alternative sources of electricity.

29.5 ASSESSMENT QUESTIONS

Section A

Answer all questions

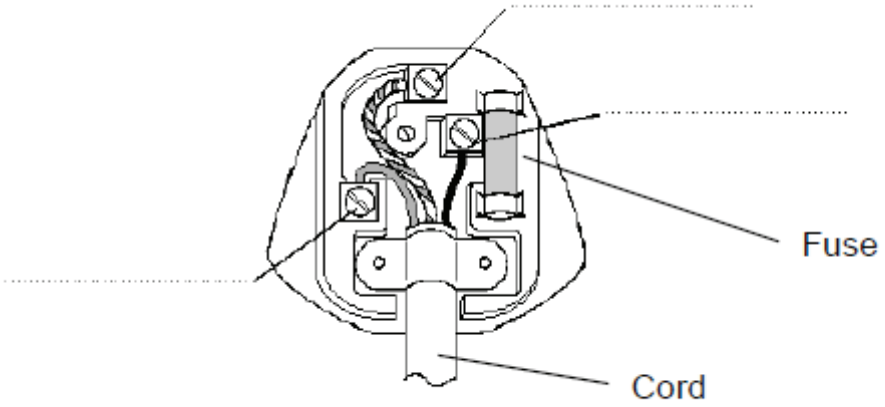
1. The S.I. Unit of power is
   - A. Henry
   - B. coulomb
   - C. watt
   - D. watt.hour
2. What is the colour code for the earth wire?
   - A. brown
   - B. red
   - C. green and yellow
   - D. blue
3. What is the use of the fuse?
   - A. to carry current to the ground
   - B. to break the circuit
   - C. to control current
   - D. to return current to the substation
4. Which of the following is not an electrical hazard?
   - A. inserting wires into plug holes
   - B. handling electrical wires with bare hands
   - C. connecting many appliances on one socket
   - D. avoiding use of wires in the place of fuses

5. The unit of electrical energy consumed is

A. joule
B. Kilowatt-hour
C. watt
D. ampere

SECTION B

6. The diagram shows a three pin plug that



(a) Label the parts on the diagram.
(3)

(b) Name a suitable material that can be used to produce:

The cord

.....

Reason

.....

.....

The pins

.....

Reason

.....

.....

(4)

(c) (i) State the colour of wire that is connected to the fuse

.....

.....(1)

(c) (ii) The fuse is a device in the plug that is added for safety and reduce the chances of electric shock.

Describe how the fuse works in order to ensure safety when using the plug.

.....

.....

.....

.....

.....

(3)

(c) (Iii) A hair dryer is made with a double plastic casing. Which wire is not present in the plug of this hair dryer? Give a reason for your answer.

.....

.....

.....

(2)

7. If electrical energy costs 47 cents per unit, calculate the cost of

(a) Leaving a 3KW stove switched on for 8 hours cooking beans

.....

.....

.....

.....

(3)

(b) Leaving a 120W colour TV on for 10 hours.

.....

.....

.....

.....

(3)

REFERENCES

Jain, A. (2019, July 6).

Pople, S. (1990). Explaining Physics. Oxford: Oxford University Press.

POSSIBLE-ANSWERS

Section A MCQ

1.C

2.C

3. B

4. D

5. B

Section B

6 (a) Refer to in text diagram of a fuse

(b) Cord----------plastic

Reason----------insulator

Pins----------metal

Reason----------good conductor of electricity

(c)(i) brown

(ii) fuse blows when there is too much current flowing due to short circuit

(c) (iii) earth

Reason: body made of insulator so offers double insulation

7. (a) A unit is kWh so 3kW for 8 hours gives 24kWh

24kWh @ 47c per unit gives 24 x $0.47= $11.28

(b) 120W for 10hours gives 1.2 kWh

Cost is 1.2 x $0.47=$0.56

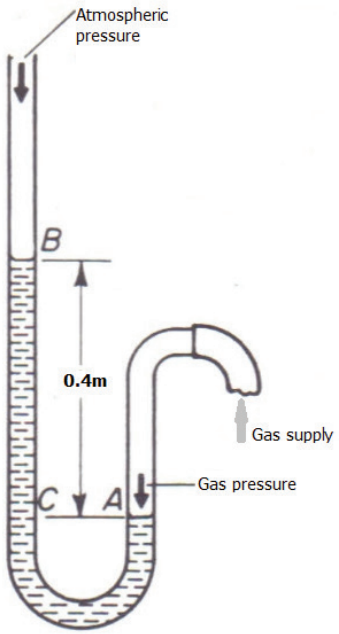
a b

- can increase or reduce pressure of a liquid from activity B.

- another important factor is density of the liquid, the larger the density of the liquid the higher the pressure will be.

Formulae for calculating pressure in liquids:

Pressure = density x Gravity X height



Given that atmospheric pressure is 2Pa and density of liquid is 0,2kg/m^3

Solution

Pressure of gas = atmosphere Pressure + pressure due to change in height

= 2Pa + density X height

= 2Pa + 0/2kgm^3 X 0,4m

= 2Pa + 0'8

= <u>2,8Pa</u>

MINISTRY OF PRIMARY AND SECONDARY EDUCATION

MODULE EXAMINATION

General Certificate of Education Ordinary Level

COMBINED SCIENCE 4003/1

PAPER 1 MULTIPLE CHOICE
Time 1 hour

INSTRUCTIONS TO CANDIDATES

Additional materials:

Multiple Choice answer sheet

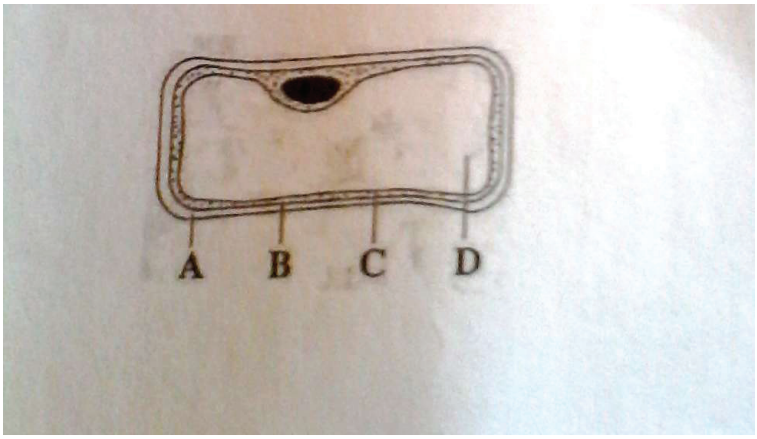
Soft clean eraser

Soft pencil (type B or HB is recommended.)

Calculator (Optional)

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the one you consider correct and record your choice in soft pencil on the separate answer sheet provided.

1. The diagram below shows a plant cell. Which part is the vacuole?



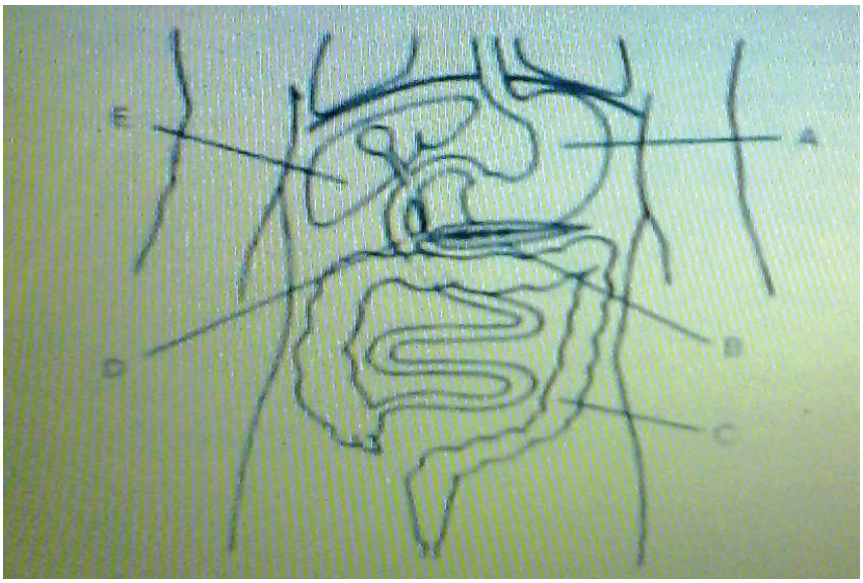
2. Palisade cells contain_____ to enable photosynthesis.

A Cell sap
B Cellulose
C Chlorophyll
D Vacuole

3. The last portion of the small intestine is called the_____.

A Duodenum
B Rectum
C Jejunum
D Ileum

The diagram below shows some of the organs in the human abdomen. Use the diagram to answer questions 4 and 5.



4. Which of the labelled part emulsifies fats?
5. Which part absorbs water?
6. How is an alveolus adapted for gaseous exchange?

A It has a dry surface.

B It has a thick alveolus wall.

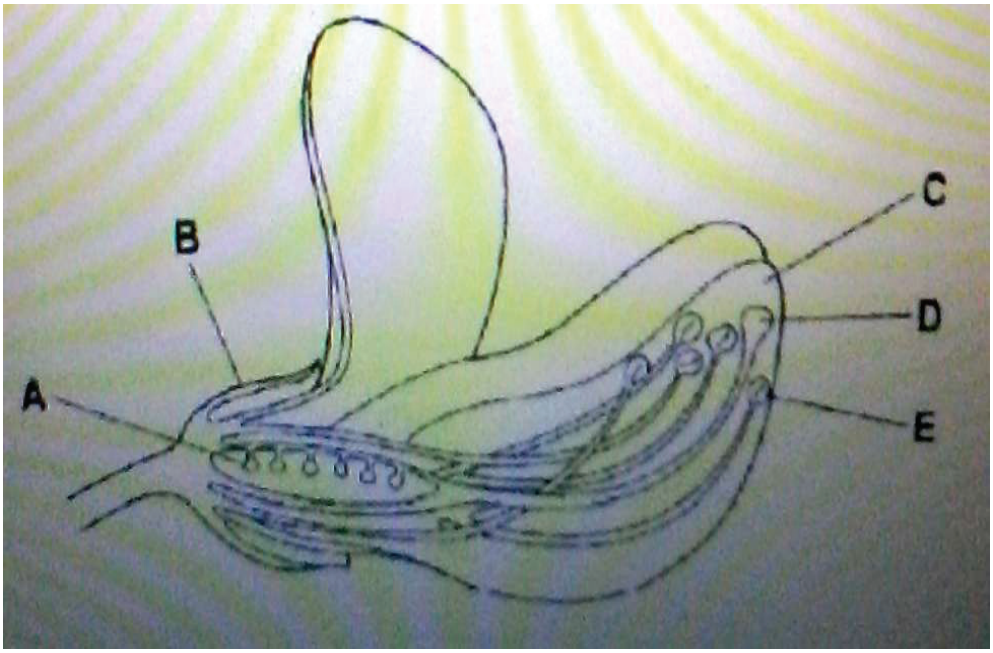
C It has a large surface area.

D It has a few blood capillaries.

7. Which one of the following is not a correct word equation of respiration?

A	Glucose	carbon dioxide + alcohol + energy
B	Glucose	carbon dioxide + lactic acid + energy
C	Glucose + oxygen	carbon dioxide + water + energy
D	Glucose + oxygen	carbon dioxide + lactic acid + energy

8. The diagram below shows a section through a bean flower



Which part receives pollen grains?

9. Which of the following are needed for germination?

A Carbon dioxide and water

B Chlorophyll and light

C Soil particles and mineral salts

D Water and suitable temperature

10. Which method of contraception is also effective in the prevention of sexually transmitted infections?

A Condom
B Spermicide
C Rhythm method
D The contraceptive pill

11. When a foetus is in the uterus, what carries oxygen away from the placenta?

A Amniotic fluid.
B Uterus lining
C Umbilical vein
D Umbilical artery

12. Which health condition has the following symptoms, skin sores, swollen glands, low white blood cell count?

a) Chancroid
b) AIDS.
c) Syphilis
d) Gonorrhoea.

13. Excessive consumption of alcohol leads to_____.

A Emphysema.
B Hallucinations
C Lung cancer
D Liver cirrhosis

14. Ebola is caused by a_____.

A Bacterium
B Fungus
C Protozoa
D Virus

15. The physical property used in fractional distillation is the difference in

A Densities of the liquids
B Boiling points of the liquids
C Melting points of the liquids
D Heat capacities of the liquids

16 . Which of the following piece of apparatus is not used in titration?

A Filter paper
B Volumetric flask
C Burette
D Pipette

17. An organic compound contains 84 % carbon(C) and 16 % hydrogen (H) by mass. [atomic mass of C is 12 and that of H is 1]

What is the empirical formula of the organic compound?

A CH
B CH_2
C C_2H
D C_2H_4

18. Which substance, in exhaust fumes, causes global warming?

A carbon soot
B carbon dioxide
C water vapour
D carbon monoxide

19. What is the use of limestone in the blast furnace?

A to produce slag
B to act as a fuel
C to produce carbon monoxide
D to reduce iron (III) oxide to iron

20. Given the three metals magnesium, copper and zinc which is the correct order of their reactivity starting with the least reactive?

A magnesium-copper-zinc
B copper-magnesium-zinc
C zinc-copper-magnesium
D. copper-zinc-magnesium

21 Which set is correct for the conditions of the Haber Process?

A iron and vanadium (v) oxide
B temperature of 450 ^{0}C and iron catalyst
C pressure of 200atm and vanadium (v) oxide catalyst
D nickel catalyst and pressure of 200atm

22. Which of the following is not a use of ethanol?

A beverage production
B solvent
C iron extraction
D fuel

23. Oxidation is defined as:

A loss of electrons, gain of hydrogen
B loss of electrons, gain of oxygen
C loss of oxygen, gain of electrons
D loss of hydrogen, gain of electrons

24. Iron is obtained from the Blast Furnace through reduction process. Which part of the charge is responsible for this process?

A Coke
B Slag
C Limestone
D Molten iron

25. What gas is produced when an acid reacts with a metal?

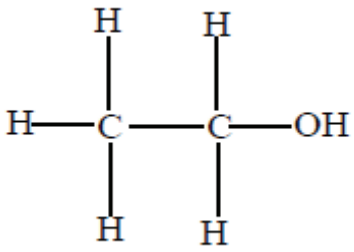
A Carbon dioxide
B Nitrogen
C Hydrogen
D Sulphur dioxide

26. Which substance, in exhaust fumes, causes global warming?

A carbon soot
B carbon dioxide
C water vapour
D carbon monoxide

27. The diagram shows the structure of an organic molecule.

To which homologous series does the molecule belong?



A alcohols
B aldehydes
C alkanes
D alkenes

28. The amount of electricity flowing through a point per given time is measured using a..

A Vernier callipers
B Voltmeter
C Ammeter
D Micrometer screw gauge.

29 The thickness of 20 pages of a book of equal thickness is 2.45cm. What is the thickness of 1 page?

A 2.45m
B 24.5m
C 0.0245m
D 0.00245m

30. The following methods increase the efficiency of a machine except..

A Applying oil to moving parts
B Applying grease to moving parts
C Increasing the distance moved by effort
D Reducing the weight of machine parts

31. The function of a carburettor in a petrol engine is to

A Clean petrol before entering the cylinder
B Clean air before entering the cylinders
C Mix petrol and air before entering the cylinders
D Burn petrol and air mixture as it enters the cylinders.

32. The main difference between D.C and A.C generators is that:

A A.C generators are larger than D.C generators
B D.C generators are larger than A.C generators
C D.C generators have slip rings whilst A.C generators have split rings
D D.C generators have split rings whilst A.C generators have slip rings

33. In a generator the following are ways of increasing voltage output except:

A Use stronger magnet
B Use a soft iron core
C Increase speed of rotation of coil
D Use thick wire in the generator

34. The following are examples of signal transmitters except:

A Optical fibre
B Coaxial fibre
C e-mail
D sheathed pair cables

35. The advantages of optical fibres over other signal transmitters is that:

A It is cheap to make
B There is little energy loss along the fibre
C There is a lot of energy loss along the way
D The balls attract each other.

36. Electricity is transmitted as A.C not D.C. mainly because:

A D.C. is cheaper to transmit
B A.C can travel short distances
C There is little energy loss along the way for A.C than for D.C.
D Both have the same characteristics

37. How is a voltmeter connected in a circuit to measure the voltage of cells?

A In series
B After the cells in a direct line
C Across the cells
D After a fuse in a direct line

38. The following measures reduce the unnecessary usage of electricity except:

A Switching off geysers at night
B Avoiding the use of ovens for baking
C Replacing bulbs with power saver bulbs
D Cooking using electricity

39. Electricity costs $1,50 per kilo watt hour. What is the cost of electricity when stove drawing 10 amps connected to a 250 volt supply is used for 30 mins?

A $2500
B $1,875
C $10- 00
D $25-00

40. On which wire is the fuse connected?

A Earth
B Neutral
C Live
D Appliance

MINISTRY OF PRIMARY AND SECONDARY EDUCATION

MODULE EXAMINATION

General Certificate of Education Ordinary Level

COMBINED SCIENCE **4003/2**

PAPER 2 THEORY

Candidates answer on the question paper

Additional materials: Calculator (Optional)

INSTRUCTIONS TO CANDIDATES

Section A

Answer **all** questions

Section B

Answer any **two** questions

Section C

Answer any t**wo** questions

Section D

Answer any **two** questions

SECTION A

Answer all the questions in the spaces provided

1.a) Fig 1.1 shows a cross section of a leaf.

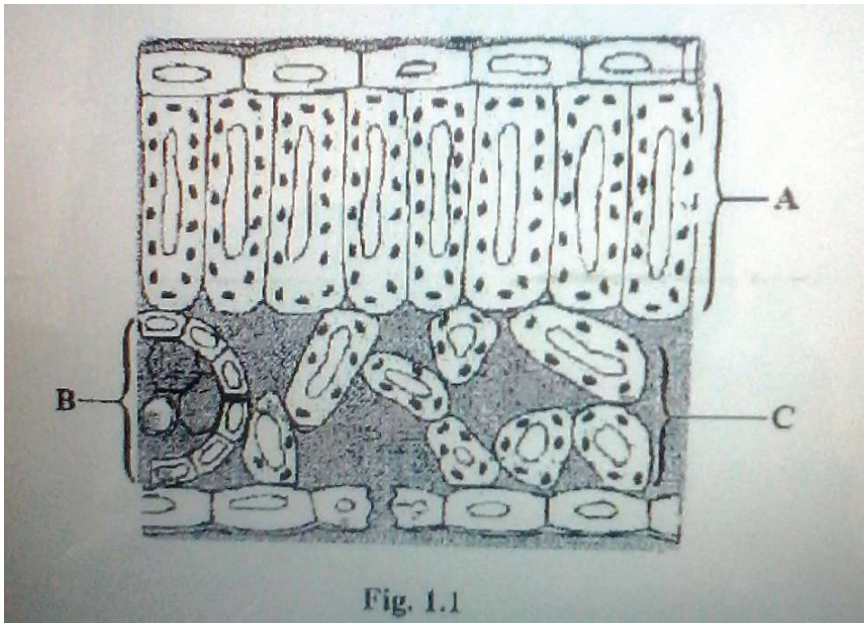


Fig. 1.1

i) Name tissues A, B and C.

A _____

B _____

C _____ [3]

ii) State any two visible differences between cells in tissues labelled A and C.

1 _____

_____

2 _____

_____ _____ [2]

iii) Which process mainly takes place in tissue A?

_____ [1]

(b) State any one advantage of transpiration in plants.

_____[1]

2. Fig 2.1 shows a red blood cell and a root hair cell.

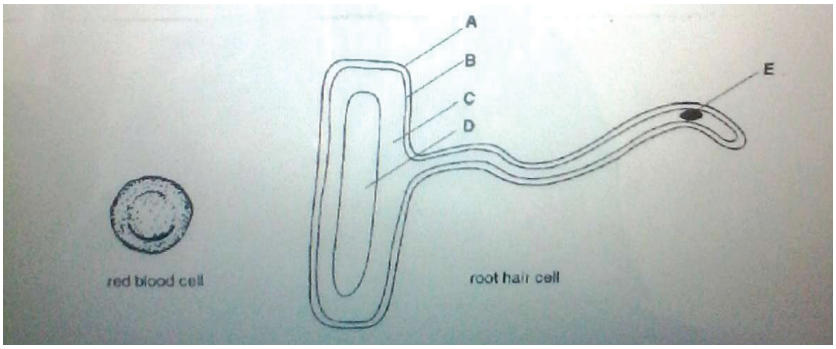


Fig 1

a) i) Select structures in the root hair cell which are also present in the red blood cell. In each case state the letter, A to E and name the structure.

1. Letter _____
Name of structure_____

2. Letter _____
Name of structure_____ [2]

ii) Name one structure which is typical of many plant cells but which is not present in the root hair cells.

_____
_____
_____[1]

(b) (i) State one major function of red blood cells and describe one way in which the cell is adapted to carry out its function.

Function

_____
_____[1]

Adaptation _____
_____
_____[1]

(ii) Apart from red blood cells which are other cells are found in the blood?

_____
_____[2]

3 (a) The nuclide notations of elements X and Y are given below.

$$^{35}_{17}\mathbf{Y} \qquad ^{23}_{11}\mathbf{X}$$

(i) State the number of protons and neutrons in element X.

protons_____

neutrons_____[2]

(ii) Give the nuclide notation for a possible isotope of Y.

[2]

(iii) Write the electronic configuration of element X.

_____[1]

(b) Calculate the relative molecular mass of sulphuric acid, H2SO4

[2]

4(a) Complete Table 4.1 on Industrial Processes

Process	**Catalyst**	**Product**
		Sulphuric acid
	iron	

[4]

(b) State any two reasons for electroplating materials.

Reason 1_____

Reason 2_____
[2]

(c) Oxygen is one of the industrial gases ,give any one industrial use of oxygen.

_____[1]

5.(a) Pair up the following instruments with the correct physical quantities they measure. An example has been given.

Quantity	Instrument
Length	measuring cylinder
Voltage	metre rule
Internal diameter	voltmeter
Volume of liquids	vernier calipers

[3]

(b) (i) What is the common error when taking readings from an instrument like a meter rule or measuring cylinder.

_____[1]

(ii) Calculate the density of an irregular stone of mass 50g, placed in a beaker with initial volume of 25cm^3 of water, when the stone is immersed the water rose to 50cm^3

_____

_____

_____
[3]

6. Fig 6.1 shows a stage in the operation of a four stroke petrol engine

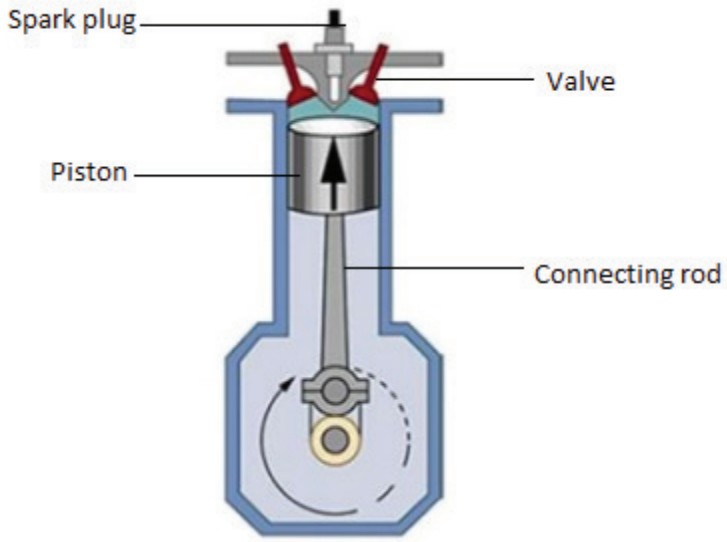


Fig 6.1

(a) Describe what happens before the stroke shown above

_____

_____

_____[3]

(b) What is the effect of blocked jets of a carburettor

_____

_____[2]

(c) Outline the advantages of modern petrol engines over old petrol engines

_____

_____[2]

Section B

Answer any two questions in the spaces provided

7. (a) Suggest and explain the effects on a person of a diet with:

(i) Too little fibre.

_____
_____
_____
_____[2]

(ii) Too much animal fat.

_____
_____
_____
_____ [2]

(b) Calcium and mineral salts are needed in the diet. Explain the role of calcium in the body.

_____
_____
_____
_____[2]

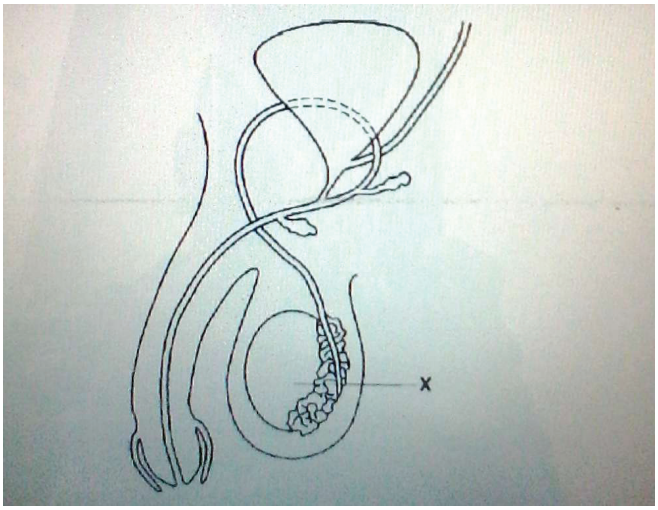
(c) State any three nutrient diseases in humans.

_____
_____
_____
_____
_____[3]

(d) What do you understand by the term chemical digestion?

_____
_____
_____
_____[1]

8. Fig 8.1.shows the male reproductive system.



(a) (i) Name the part labelled X and state two of its functions.

Name _____

Function1

_____

_____[2]

Function 2

_____

_____ [2]

(iii) Birth control can be brought about by surgery. Mark clearly on Fig.8.1 where such an operation would be carried out in a male. [1]

(b) The male sex hormone causes a number of changes in the body during puberty.

State two of these changes other than changes to the reproductive system.

1. _____

_____

2. _____

_____[2]

(c) Describe the route of the sperm from the testis to the ovum after ovulation.

_____

_____

_____

[3]

9. a) State how the following diseases are transmitted.

(i) Cholera

_____

_____

_____

(ii) Malaria

_____

_____

(iii) AIDS

_____

_____

(iv) Ebola

_____

_____

(v) Typhoid

_____

_____

[5]

(b) What is meant by the term substance abuse?

_____

_____

_____

[2]

(c) State the effects of sniffing glue.

_____

_____

_____

[3]

Section C

Answer any two questions in the spaces provided.

10 (a) (i) Define the term atom

_____

[1]

(ii) State the charges of a proton and an electron.

Proton_____

Electron_____

[2]

(b) An organic substance was found to contain 82.8% C and 17.2% H by mass.

Determine the empirical formula of the substance

_____

_____

_____

_____

[4]

(c) (i) Sodium chloride ,NaCl is an ionic substance and Chlorine ,Cl_2 is a covalent substance.

Describe ionic and covalent bonding.

_____

_____

_____

[2]

(ii) Give any one physical property of an ionic substance.

_____

[1]

11. Fig. 11.1 shows the blast furnace used for the extraction of iron.

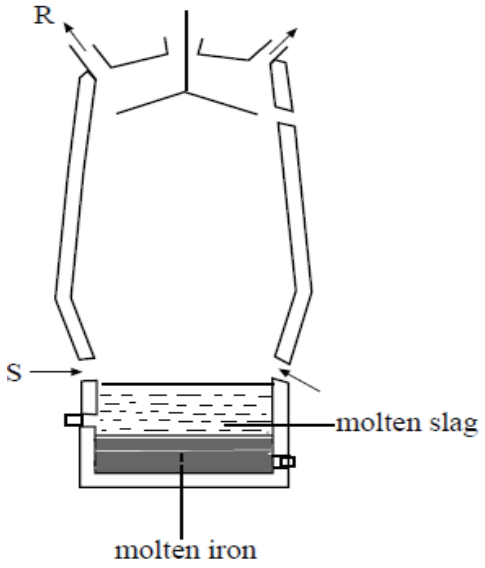


Fig.11.1

(a) State the three substances that constitute the charge from the top into the Blast Furnace.

Substance 1_____

Substance 2_____

Substance 3_____
[3]

(b) (i) Name the substance that enters the furnace through S.

_____[1]

(ii) State what is released through R.

_____[1]

(c) (i) One of the major impurities in iron ore is sand (silicon dioxide)

Describe with help of word equations how this impurity is removed from the ore.

_____

_____

_____

_____

_____

[2]

(ii) Describe the main reactions in the Blast Furnace.

_____

_____

_____

_____

_____[3]

12. Fig.12.1 shows a flow chart in the Production of Sulphuric Acid

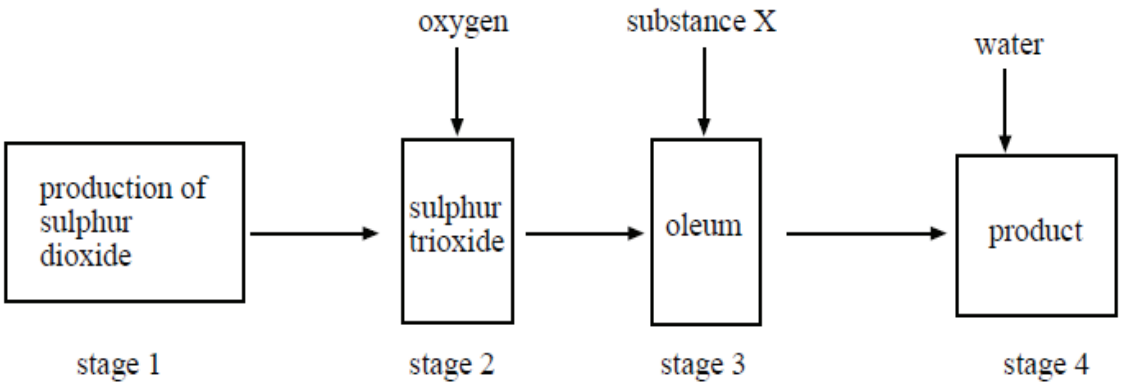


Fig 12.1

(a) Name the Process that produces Sulphuric acid.

_____[1}

(b) Why is sulphuric acid production usually used as a measure of a country's economic development?

_____

_____

_____[2]

(c) Describe what happens in Stages 1 to 4

Stage 1 _____

_____

_____

Stage 2 _____

_____

_____

Stage 3 _____

_____

_____

Stage 4 _____

_____

_____

[4]

(c) Give any 3 uses of sulphuric acid.

(i)_____

(ii)_____

(iii)_____

[3]

Section D

Answer any two questions in the spaces provided

13 Fig.13 .1 shows water heater

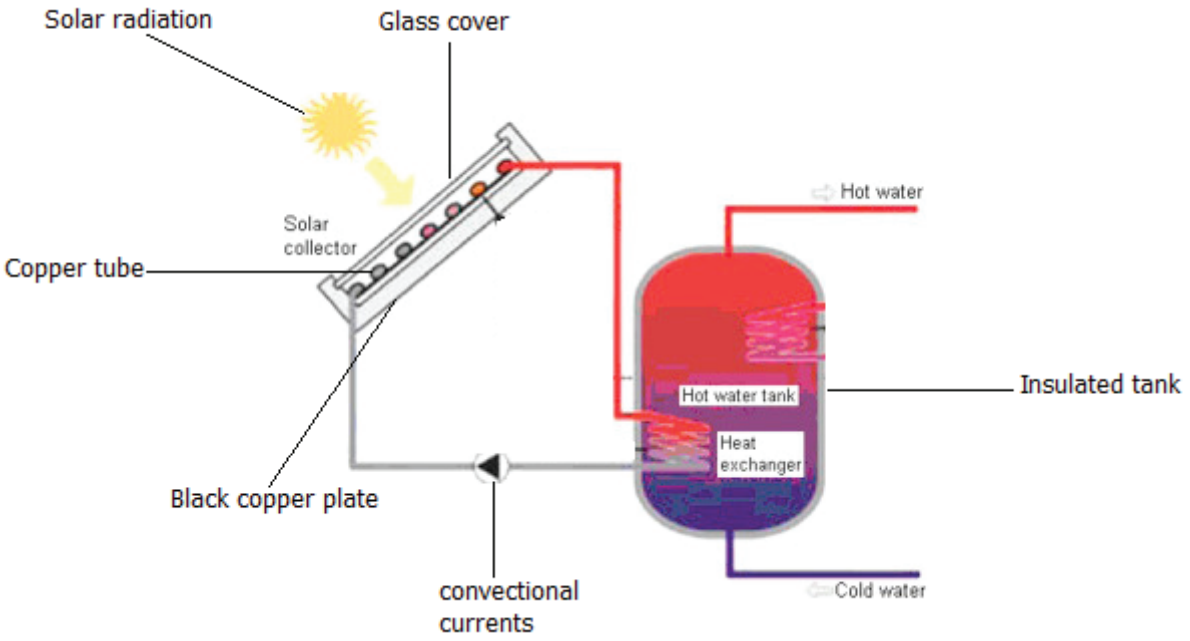


Fig 13.1

(a) Why are the copper tubing mounted against a surface coloured in black?

_____

_____

_____[2]

(b) Why is copper used in making the pipes of the solar water heater not another metal such as Zinc

_____

_____

_____ [3]

(c) Explain why the hot water outlet is above the cold water outlet.

_____

_____

_____ [2]

(d). Outline the energy conversion that take place on a solar water heater.

_____

_____

_____[2]

(e). Why is it advisable to use solar energy over forms of energy.

_____

_____[1]

14. The wi-fi is a very important method of telecommunication

(a) Describe how the wi-fi operates

_____

_____

_____

_____[3]

(b) What are the disadvantages of wi-fi

_____

_____

_____[2]

(c) Fig. 14.1 shows the components of a communication system.

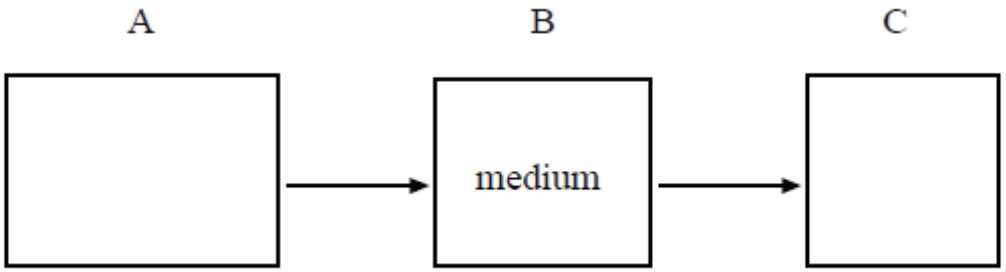


Fig.14.1

(i) Name components A and C.

A _____

C_____ _____
[2]

(ii) Describe the functions of component A.

_____

_____
[2]

(d) Describe one advantage of a cell phone over a landline.

_____

_____
[1]

15. Fig 15.1 shows a water tank with three outlets at different heights.

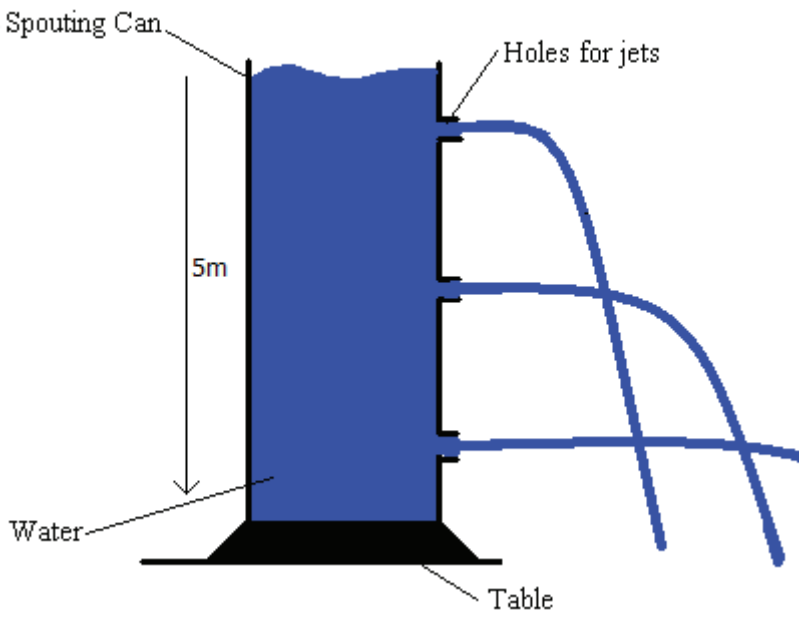


Fig.15.1

Given that the density of water is 1000kg/m^3 and gravitational force (g) is 10N

(a). Calculate the pressure of water at the bottom of the tank.

_____

_____

_____

[3]

(b). Explain why the bottom of earth dam wall is wider than the top.

_____

_____

[2]

(c). Calculate the pressure exerted by an air mass moving with a force of 250N against a wall 2m long and 5 m wide.

_____

_____

_____

[3]

(d). Pumps use atmospheric pressure to work. Give an example each of the following types of pumps.

Type of pump	Example
Lift pump	_____
Force pump	_____

[2]

MINISTRY OF PRIMARY AND SECONDARY EDUCATION

MODULE EXAMINATION

General Certificate of Education Ordinary Level

COMBINED SCIENCE **4003/3**

PAPER 3 PRACTICAL TEST

Candidates answer on the question paper

Additional materials: Calculator (Optional)

Candidates answer on the question paper

Additional materials:

As listed in instructions to Supervisors

Calculator (optional)

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer both questions.

Write your answers in the spaces provided on the question paper.

Use a sharp pencil for your drawings. Coloured pencils or crayons should not be used.

You should show the essential steps in any calculation and record all experimental results in the spaces provided in the question paper.

1. You are required to identify nutrients present in juice X.

You are provided with three boiling tubes, a test tube rack, a pair of tongs, a graduated syringe. Benedict's solution, hot water bath, juice X, solution P, solution R and access to a clock.

a) i) Carry out the tests described in Table 1.1 below and record the observations and deductions in the table.

Table 1.1

Test	Observations	Conclusions
Add about 2 cm^3 of juice **X** into a boiling tube and add two drops of solution **R** to the juice.		
Place about 2 cm^3 of juice **X** into a clean boiling tube and add about 2 cm^3 of Benedict's solution to the juice. Heat the mixture in a water bath.		
Place about 3 cm^3 of juice **X** into a clean boiling cube and add about 4 cm^3 of solution **P** the juice. Place the test tube in the hot water bath and leave it for about 3 minutes. After the 3 minutes, pour about half of the contents into another clean boiling tube. Add two drops of solution **R** to one of the portions.		
Add about 2 cm of Benedict's solution to the other portion and heat in the water bath.		

.....

..... [10]

ii) Identify solution R

.....
.....[1]

iii) State the colour of Benedict's solution

.....
.....[1]

iv) State the nutrients contained in juice X.

.....
.....

.....
.....[2]

v) Suggest one advantage of drinking juice X.

.....
.....

.....
.....[1]

vi) Suggest a possible identity of solution P.

.....
.....[1]

vii) State the process responsible for the change that occurred when solution P was added to the juice and the mixture heated.

.....
.....[1]

viii) Name the part of the alimentary canal where the process mentioned in (vii) occurs.

.....
.....[1]

b) State any two precautions that should be taken when carrying out the experiment.

.....

.....

.....

.....
[2]

2. a) You are required to determine the resistance of a wire, R..

Fig.2.1 shows the circuit diagram for the circuit which the supervisor set for you.

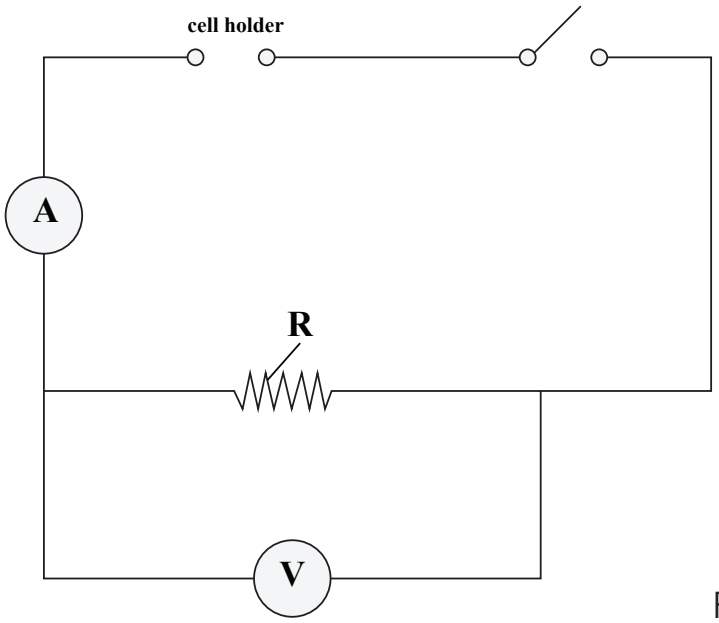


Fig. 2.1

i) Place one cell in the cell holder, close the switch and record the voltmeter and ammeter readings in Table 2.1.

Repeat the procedure adding one cell at a time until you use four cells.

Table 2.1

Number Of Cells	Voltage/V	Current/A

[10]

iv) Calculate, using the graph, the resistance of wire R.

[2]

v) Determine, clearly showing on the graph, the current when the voltage is 3.5 V.

.....

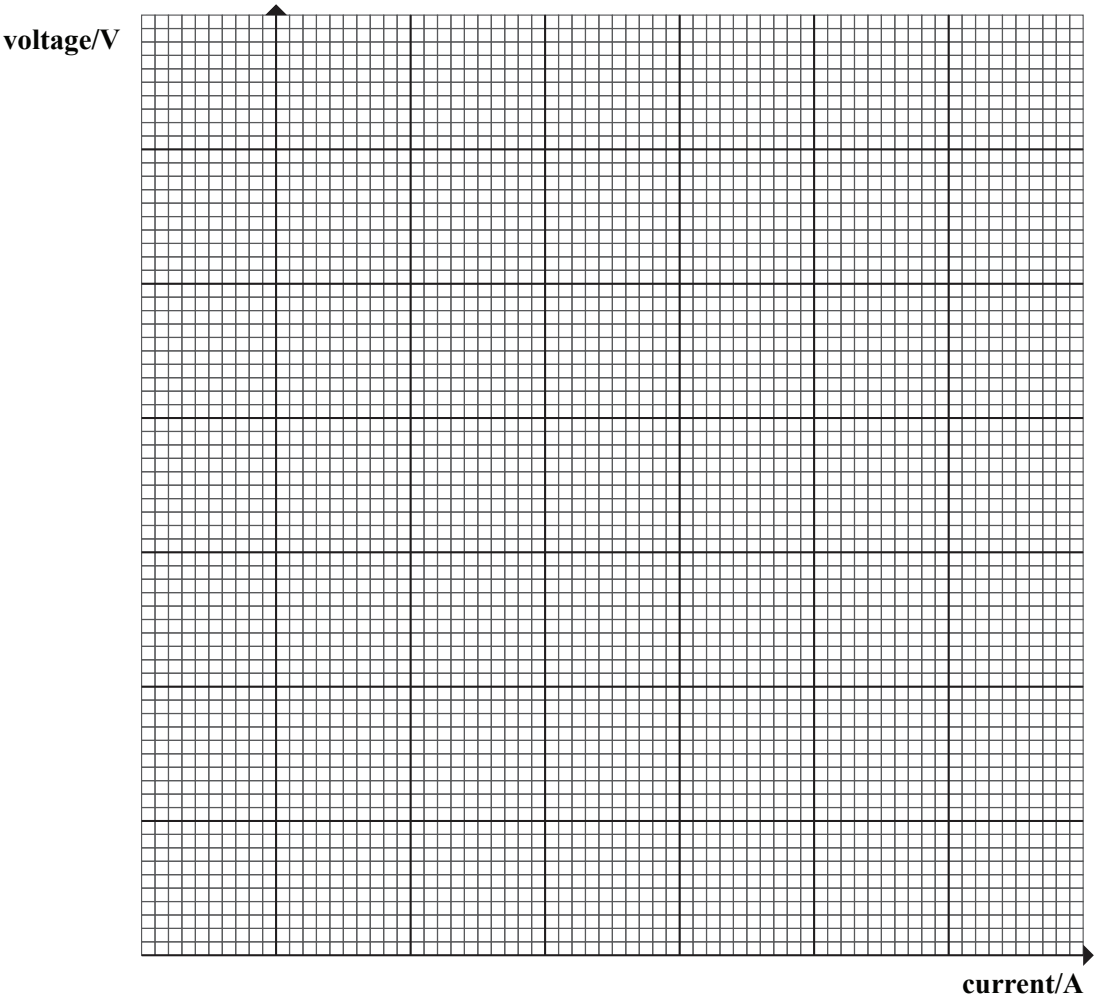
.....[2]

b) State any two sources of error in the experiment.

.....

.....[2]

ii) Plot a graph of voltage (y-axis) against current (x-axis).



[3]

iii) State the relationship between voltage and current.

..... [1]

.....