PHYSICS

CHAPTER ONE
Reflection on curved surfaces

Lesson 1: Types of curved mirrors

Competence:
In this lesson, you will be able to:
- Identify the types of curved mirrors
- Explain the features of curved mirrors

Materials you need:
- A spoon
- An orange
- A motorcycle/car side mirror

Introduction

In S1, you learnt about reflection at plane surfaces. Plane mirrors reflect light to our eyes for an image to be formed. In this lesson you will look at different type of mirrors.

Part 1
Look at the shape of a spoon or fold your palm so that it forms a shape of a spoon. What do you notice?
The folded palm of the hand has two surfaces: the inner one and the outer one. If light falls on the inner face and is reflected, you have a concave mirror and if light is reflected on the outer face, then you have a convex mirror. Curved surfaces are shown in Figure 1.

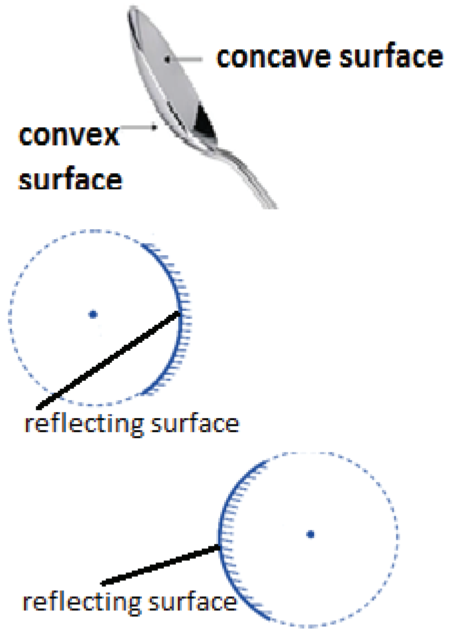


Figure 1: Curved surfaces

Now you are able to identify the two types of curved surfaces. These are the ones that form curved mirrors. So what are the types of curved mirrors?

Project: Try to make models of concave and convex mirrors using an orange.

Part 2: Identifying the features of curved mirrors
You will need a compass, a pencil, a ruler and a piece of paper for this part.
Procedure:
- Draw a circle in the middle of the paper and mark its centre, C.
- Draw a line that passes through the circle through the centre C.
- Mark the point, P at which the line touches the circle. Obtain the mid-point of the line PC and label this point F.
- Now cut off some section of the circle to remain with a part that represents the curved mirrors. Label this curved section M.

In this way you can identify features of the curved mirrors as shown in Figure 1 below:

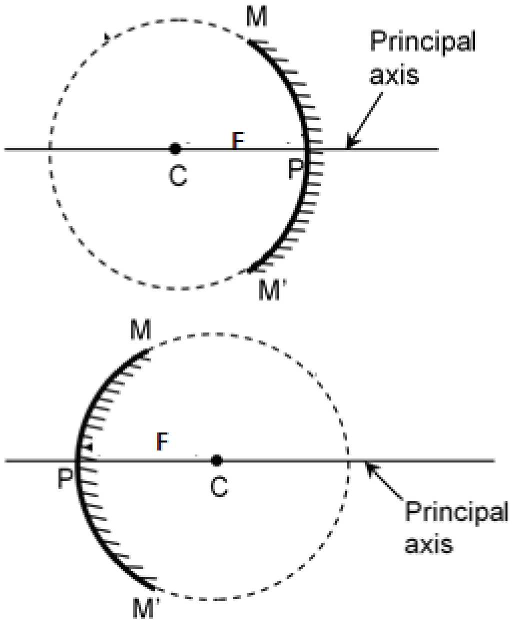


Figure 2: Features of a curved mirror

Now that you have identified the key features of the curved mirrorsas indicated on the figures above, can you explain the meaning of each feature?

Lesson 2: Drawing images in curved mirrors

Competence:
In this lesson you will be able to:
- Draw diagrams to show how curved mirrors form images
- Describe images formed by curved mirrors

Introduction:
In the previous lesson, you saw the different types of curved mirrors and their features. In this lesson you will use the features of the mirrors to show how the curved mirrors form images. You will also describe the nature of images formed by the curved mirrors.

Procedure:
- Draw a curved mirror and the principal axis
- Draw a ray that is parallel to the principal axis that strikes the reflecting surface of the mirror and then show how it is reflected through the point F
- Draw a ray that is incident through the point F and is reflected parallel to the principal axis.
- Now mark the point where the reflected rays meet
- Connect this point to the principal axis, vertically to form the image.

Try to go through this procedure several times until you have clearly understood
Note: If the tip of the image faces upwards, the image is upright (erect) and if the tip faces downwards the image is inverted

Follow up activity: Now that you know the rays to use to draw images formed in curved mirrors, draw diagrams to show how images are formed by curved mirrors when the object is:

- Very near the mirror i.e. between F and P
- Between F and C
- Beyond C

In all these cases, describe the nature of the image.

Lesson 3: Construction of ray diagrams in curved mirrors

In this lesson, you will be able to:
- locate images in curved mirrors using scale drawing
- determine magnification in curved mirrors

Materials you need:
- A graph paper
- A long ruler

Procedure Now that you are able to draw images in curved mirrors, you should go ahead and try to construct images using accurate scale drawing.

In this lesson, a curved mirror will be represented by a vertical line with a cup at the top. This is to avoid the different forms of curving that can be drawn by different people.
Then you will use the rules in lesson 2 to draw an accurate diagram. You will use a graph paper and simple scales e.g 1:2, 1:5 and 1:10

Now try this activity:
An object 2cm high is placed at 10 cm from a concave mirror whose focal length is 8 cm. Using an accurate scale drawing find the height of the image and its distance from the mirror.

After this trial, divide the height of the image to that of the object. What do you obtain? What you obtain is called magnification.

Follow up activity:
An object 10 cm high is placed at 5 cm from a concave mirror whose focal length is 7.5 cm. by construction you need to find the magnification of the image formed.

Lesson 4: Applications of curved mirrors

In this lesson ,you will be able to identify the applications of curved mirrors

In the previous lessons, you have seen how curved mirrors form images. The nature of images formed by curved mirrors determines their applications.

Some of the applications of curved mirrors are indicated in Figure 3 below. Look at each picture carefully.

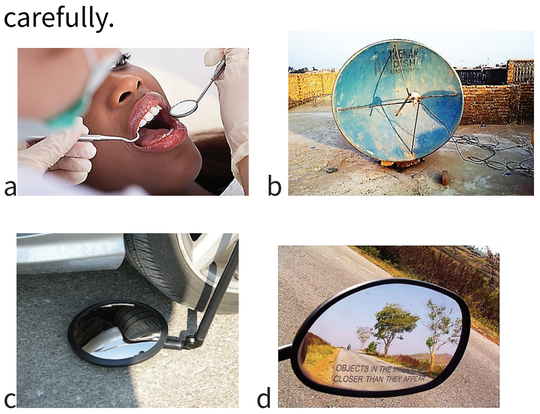


Figure 3: Applications of curved mirrors

Can you identify the applications ofcurved mirrors in each case?

Lesson 5: Determination of focal length of a concave mirror

This can only be done in a laboratory setting.

CHAPTER TWO

Turning effects of forces, Centre or gravity

Lesson 1: Explaining the moment of a force

In this lesson, you will be able to:

- Explain the meaning of a moment of a force
- State instances where moments are applied
- State the principle of moments

Materials you need

- A log of wood or stick
- Some sand or soil tied in a cloth or polythene
- A sharp edge

Introduction

Many times when we apply forces to objects, the force causes them to turn or spin about a fixed point (pivot/fulcrum).

Have you ever wondered what happens when children are playing on a seesaw?

Figure 2.1: Children playing on a seesaw

Look at the children in the above figure. What would happen if one of the children left or moved far away from the position where he/she is?

Activity /procedure

- Balance the log of wood on a sharp edge until it is balancing horizontally (Figure 4).
- Put one lump of sand/soil in a sack on one side of the wood using a string and the other on a different side of the sharp edge.
- Adjust the lumps of sand until the two sides balance
- Now slightly move one of the lamps of sand

What do you notice?

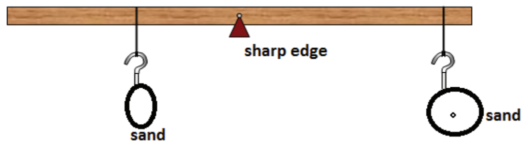


Figure 2.2: A balanced log of wood with loads

For your knowledge

If one of the children left or changes position, the other one would fall over from the other side or be raised upwards; i.e would experience a turning effect. This turning effect is also called moment of a force. It is obtained from: **moment of a force=force x distance of force from the fulcrum**

The direction of the turning (moment) is compared to the movement of the hands of a clock i.e clockwise or anticlockwise

Follow up activity:

Now that you know the meaning of a moment of a force:

1. State the units of moment of a force
2. Identify instances in everyday life where turning effects/moments occur or are applied
3. describe the ways of increasing the turning effect

Lesson 2: The Principle of Moments

In this lesson, you will be able to:

- State the principle of moments
- Apply the principle of moments to determine the mass of objects such as a log of wood

When a body balances, it is said to be in equilibrium. Equilibrium is very essential and is a situation where the resultant force on a body is zero.

Activity 1: To derive the principle of moments

Materials you need

- A sharp edge
- A log of wood or stick
- Ruler
- Two known masses such as a bottle of mineralwater completely filled with water is 500 g while a half filled mineral water bottle is 250 g

Procedure:

1. Balance thelog of wood on a sharp edge as shown in the figure 2.3 and note the balance point.
2. Suspend a mass m_1(bottle completely full of water=500g) at a distanced_1 less than 20 cm from the balance point.
3. Without changing the position of the balance point and the position of m_1 suspend a mass m_2=bottle half filled with water (250 g) the other side of the wood and adjust the mass slowly until the wood balances horizontally (Figure 2.3)
4. Measure the distance $d_2$between m_2 and the balance point

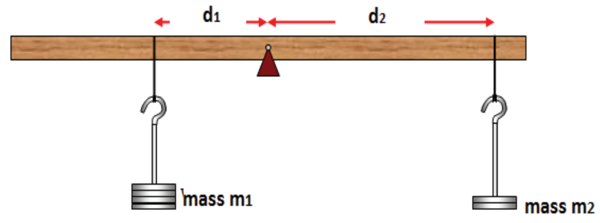


Figure 2.4

5. Record m_1, distance d_1, m_2 and distanced_2 as shown

m_1=…g	distance d_1=…….cm	m_1 x d_1=
m_1 =...g	distance d_2=…….cm	m_2 x d_2=

What do you notice about the values of m_1 x d_1 and m_2 x d_2?

The result verifies the principle of moments which states that:

"When a body is in equilibrium, the sum of clockwise moments about any point is equal to the sum of anti-clockwise moments about the same point".

Activity 2: To determine the mass, M of a log of wood using the principle of moments

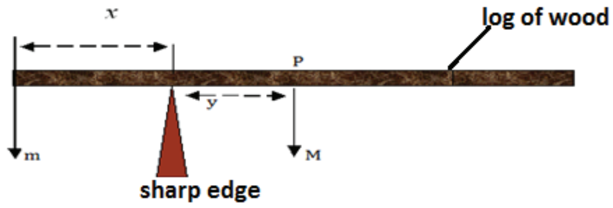


Figure 2.5

What you need:

- A sharp edge
- single mass m=500 g (a small bottle of mineral water completely filled with water)
- Log of wood

Procedure

1. Balance the log of wood on a sharp edge, until it balances horizontally and note the balance point P.
2. Suspend a mass m=500 g at the end of the log of wood as shown in the figure 2.5.
3. Without adding another mass, adjust the log of wood on the sharp edge slowly until it balances horizontally
4. Measure the distance x between the mass m and the sharp edge and the distance *y* between P and the sharp edge
   If **M** is the mass of the log of wood, then it acts at P.
   Using principle of moments, find the value of **M**.

Lesson 3: Centre of gravity

In this lesson, you will be able to:

- Determine the centre of gravity for regular and irregular objects
- Explain the importance of the position of the centre of gravity of objects

Introduction: In the previous lesson, you balanced a log of wood on a sharp edge until a balance point was obtained. There is only one balance point on each body. This balance point is where all the mass or weight is assumed to be concentrated and is the centre of gravity.

Activity 1: Determination of centre of gravity of regular objects.

Materials you need

- Log of wood
- Sharp edge
- Irregular cardboard from a used box
- String
- Small object like a stone

Procedure

Balance the log of wood on a sharp edge until it balances horizontally

Mark the balance point on the log of wood (Figure 2.6)

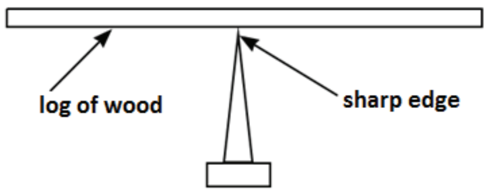


Figure 2.6

What do you say about the balance point of the log of wood?

Activity 2: Determination of centre of gravity of irregular objects

Materials you need:

Procedure (steps):

- Make three holes A, C and B at the edges of an irregular cardboard.
- Hung the cardboard through A so that it swings freely on a nail clumped in a stand.
- Tie the small object like a stone to the nail and trace a line where the string passes (Figure 2.7).
- Hung the cardboard at another hole, C and trace a line where the string passes.
- Locate a point where the two lines intersect.

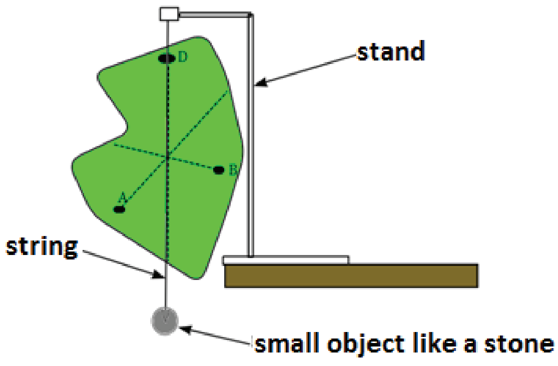


Figure 2.7

What do you say about the point of intersection of the two lines?

Lesson 4: Stability

In this lesson, you will be able to:

- Explain the three types of equilibrium
- Explain how position of centre of gravity affects the stability of objects

Introduction

Have you ever wondered why some bodies when displaced from their positions, the bodies come back to their original positions while others completely fall off to new positions? This is a result of the position of their centre of gravity.

Activity

Materials you will need

- A small ball (you can make one using waste papers, polyethene or banana fibre or grass)
- A short stem of a tree or short section of bamboo stem (each about 5 cm to 10 cm long)
- A small irregular object such as a plastic bottle filled with water

Procedure:

Slightly displace a bottle filled with water to one side and then release it. What do you observe?

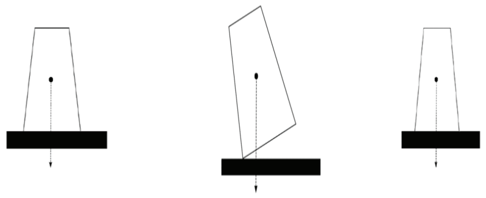
Slightly displace a short stem of a tree or the bamboo stem that is standingvertically upwards and release it. What do you observe?

Slightly displace the ball from its position and release it. What do you observe?

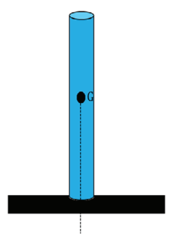
In the above three activities, you may have noticed that some of the objects come back to the original position, others acquire new positions and become stable while others may not appear to change positions, though they become stable in new positions.

This results from the change in the position of the centre of gravity.

(a) Now using the diagrams below, can you explain the behaviour in the above three activities in terms of the centre of gravity?



a



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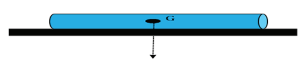

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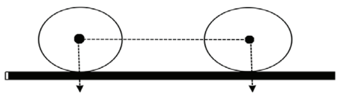


(b) Now using the three situations, can you explain the three types of equilibrium?

(c) How does the idea of centre of gravity affect the construction of cars/buses/lorries?

In summary, if the body returns to its original position, it is in stable equilibrium. If the body does not return to its original position but acquires a new position in which it settles, then it is in unstable equilibrium. If the body acquires a new position but without change in appearance, then it is in neutral equilibrium.

CHAPTER THREE

Machines

Lesson 1: Meaning of machines

In this lesson, you will be able to:

- Explain what a machine is
- Explain the terminologies related to machines

Materials you need

- A log of wood
- A knife
- Bottle opener

Introduction

Have you ever wondered why you can push two bags of cement using a wheel barrow but it is even difficult to carry one bag of cement without any other device? The wheel barrow simplifies the carrying of the cement. It is a machine. Many more things can be done more easily using these devices called machines. These machines are either simple or many simple machines put together to form complex machines. Can you identify some simple machines and complex machines?

Activity: Terms used in machines

Procedure 1:

Try to lift a heavy object such as a stone from the ground using a log of wood. The object like a stone is the load, L and you apply the effort, E using your hands.

For your knowledge: If the values of L and E are known, the ratio L/E is called mechanical advantage

Now try this: When using a certain machine a force of 250N must be used to raise a load of weight 1000 N. Calculate the mechanical advantage of the machine.

Procedure 2:

Try to measure the distance through which the load is moved and the distance through which the effort moves. What values do you get? Now divide the distance moved by the effort to the distance moved by the load.

For your knowledge: If the value of the effort distance is divided by the load distance, the value obtained is called the velocity ratio

Now try this: What are the units of mechanical advantage and velocity ratio? Try to explain this.

Now try out this example:

When using a certain machine, a force of 250N must be used to raise a 100kg mass through a distance of 1m. If the effort distance is 5m, calculate;

a. Mechanical advantage
b. Velocity ratio
c. Divide the mechanical advantage by the velocity ratio. What do you obtain? Express the answer as a percentage and comment on the answer. Try to ask whether this value can exceed 100 or not and why?

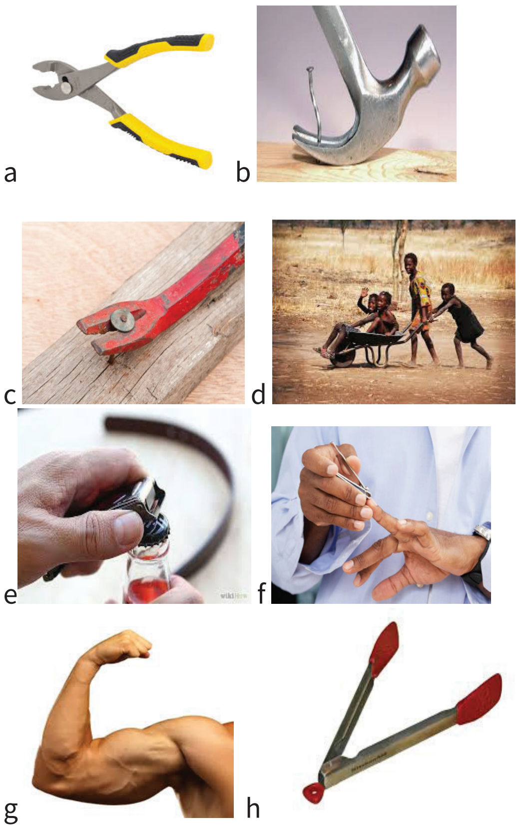
Lesson 2: Levers

In this lesson, you will be able to:
- Classify the three types of levers
- Explain the reason for the classification

Materials you need
- A log of wood
- A knife
- Bottle opener
- Hammer
- Pair of scissors
- Sea-saw
- Wheel barrow
- Your arm
- A hoe with handle
- Panga
- Nail cutter

Introduction
There are a variety of simple machines in the home which are used to simplify work. However, they are not the same. They are not constructed on the same plan. This brings about three categories of levers.

Now look at the following imagesin Figure 3.1below:



Now from the table, try to explain the reason for the classification of the levers

Lesson 3: Pulleys

In this lesson, you will be able to:
- construct a pulley
- Identify applications of pulleys

Materials you need
- A rope
- A tree/stick
- Two supports/stands whose tops the tree/ stick can easily rotate
- A piece of heavy material such as soil/sand tied in a cloth, or a bucket

Activity 1: To construct a pulley
Procedure
- Support a tree/stick between two supports. Ensure that the tree/stick can easily rotate between the supports/stands
- Tie the rope over the soil
- Run the rope over the tree or stick
- Pull the free end of the rope slowly but continuously

What happens to the soil or bucket?

In the above activity, you have formed a pulley. A common pulley looks like the one shown in Figure 3.2 below.

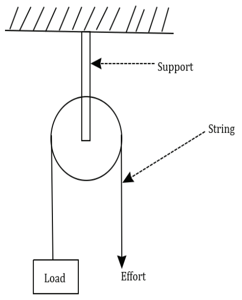


Figure 3.2: A common simple pulley

A pulley is a wheel with a grooved rim in which a rope passes.

Pulleys are also simple machines. The velocity ratio is equal to the number of wheels or pulleys. Look at the pulleys in Figure 3.3below. Try to re-draw each of the pulleys.

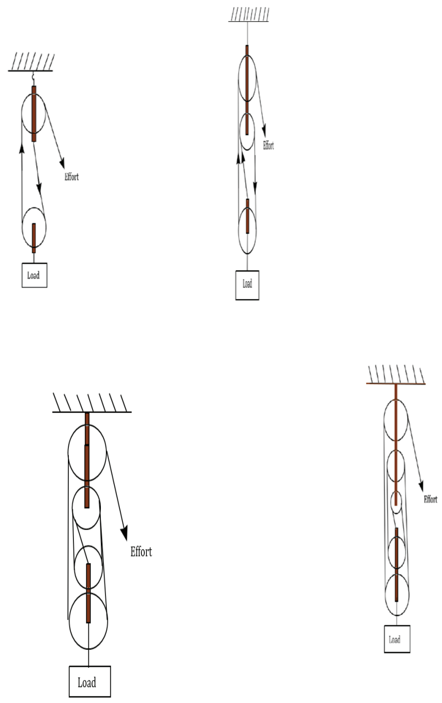


Figure 3.3: Different pulleys

What is the velocity ratio of each of the pulleys? How do you know?

Activity 2
In our ordinary life, pulleys can be applied in a number of ways. Some are indicated in the Figure 3.3 below. Look at each figure carefully.

Figure 3.3: Applications of pulleys

(i) Explain what the pulley is being used for in each case
(ii) Identify complex machine systems where pulleys are applied

Lesson 4: Other simple machines

In this lesson, you will be able to:
- Identify other simple machines
- Explain how these other simple machines simplify work

Materials you need
- A wedge (inclined plane)
- Used gear system of a bicycle
- Jack (if available)
- Screw (where possible)

Introduction
In the previous two lessons, you looked at the two types of simple machines, i.e levers and pulleys. In this lesson, you will look at the other different simple machines.

Activity
Look at the images of simple machines shown in Figure 3.4 below:

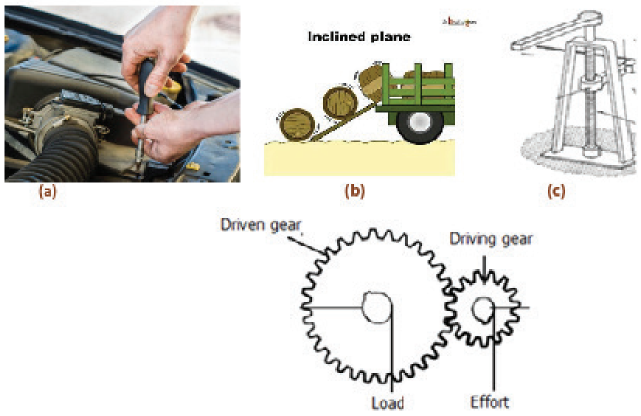


Figure 3.4: Different machines

(a) Where is each of the simple machines applied?
(b) How does each of the simple machines simplify work?

Project work: Now that you have learnt how simple machines work, design a machine that combines many simple machines and can be used to simplify work, for example a crane or excavator. You are allowed to use many components and explain how it works

CHAPTER FOUR
Work, Power and Energy

Lesson 1: Work

In this lesson, you will be able to:
- define work and state its units
- solve numerical problems related to work
- identify instances in everyday life in which work is done and explain why

Materials you need
- A brick or large piece of wood or a jerrycan containing water

Introduction
The word "work" is quite often used in our day to day lives to mean occupation or job.

But in physics, work has a different meaning. When you go to fetch water, you have done work, though it may not be your continuous job.
Look at the children in the Figure4.1 below.

Figure 4.1
Can you say that the children are doing work? Why or why not?
Now assume that the children are playing in the compound. Are they doing work?

Activity:
Procedure:
- Lift the brick or piece of wood or the jerrycan containing water
- Move five large steps while holding this object

Suppose the object you are holding has a mass of 5 kg and the distance covered in the five steps is 5 metres, then;
- convert the mass into weight i.e5x10=50 N
- multiply this weight by the distance covered i.e 50 x 5= 250

What you have obtained in this case is the value of work you have done while carrying the object through that distance.

For your knowledge: Work is done whenever force moves through a distance. Hence work is the product of force and distance in the direction of force. The SI unit of work is the Joule (J)

So human beings and machines do work when they move objects through distances. Do you do work when you move in the compound without carrying any object? Try to explain this.

Now try these problems and express the answer to the appropriate units: (g =10ms^{-1})
1. A body of mass 5kg is lifted through a distance of6m. Calculate the work done.
2. A man lifts a box of mass 3 kg vertically upwards through 2 m. Calculate the work done by the man in lifting the box.
3. Try to identify other instances in everyday life in which work is done.

Lesson 2: Power
In this lesson, you will be able to:
- define power and state its units
- solve numerical problems related to power
- identify instances in everyday life in which power is expended

Materials you need
- A brick or large piece of wood or a jerrycan containing water
- A watch

Introduction
In the previous lesson, you learnt the meaning of work. When a person or machine does a lot of work very quickly, such a person or machine is said to have power. So what does **power** mean in Physics? To understand the meaning of power, you are going to do the following activity.
Activity
Procedure:
- Lift the brick or piece of wood or the jerrycan containing water
- Move five large steps while holding this object. As you move the five steps, count and record the time (in seconds) it takes you to make the five steps (you may use a watch or the counting of figures 1,2,……. for seconds if you have no watch)

Suppose the object you are holding has a mass of 5 kg and the distance covered in the five steps is 5 metres, then;
- convert the mass into weight i.e5x10=50 N
- multiply this weight by the distance covered i.e 50 x 5= 250

What you have obtained in this case is the value of work you have done while carrying the object through that distance.
Now divide this work done by the time you measured i.e

What you have obtained is called power. Can you suggest a definition for power?
For your knowledge: The SI unit of power is the Watt(W).A watt is defined as the power developed when one joule of work is done in one second.

Now try out this problem. Do not forget to express the answer using appropriate units
A machine lifts a load of 2500N through a vertical height of 3m in 1.5s. Find:
(a) The power developed by the machine
(b) Using the same power, how long would it take to lift a body of 6000N through a vertical height of 5m.

Lesson 3: Energy
In this lesson, you will be able to:
- define energy and state its units
- identify the different sources of energy
- categorize energy resources as renewable and non-renewable resources

Materials you need
- pieces of paper or firewood

Introduction
In **lesson 1** you saw the meaning of work. People and machines are able to do work because they have the ability to do the work. This ability is the energy possessed by the person or the machine.

Did you know? The SI unit of energy is joule (J)

The energy of people and machines can be seen in a number of forms such as light, heat and mechanical or physical energy for lifting objects. This energy comes from different sources such as food, fuel and water.

Activity 1:
Procedure
- Burn small pieces of wood or small pieces of paper until they completely burn

(a) What do you observe?
(b) What forms of energy are produced during this activity?
(c) Can you get the wood or paper back or use it again?

From the above activity, you saw that some of the sources of energy are used only once while others can be used several times.

Activity 2:

Look at the images in the Figure 4.2 below

Figure 4.2

(a) Identify the energy source in each case
(b) Which of the energy sources can be used only once?
(c) Which of the energy source can be used several times without being exhausted?

Summary

If an energy resource can be used only once and is exhausted, it is a **non-renewable** resource while one that can be used several times without being exhausted is a **renewable resource**.
Can you identify other renewable and non-renewable energy resources in Uganda, apart from those in Figure 4.2

Lesson 4: Mechanical energy

In this lesson, you will be able to:

- Identify the forms of mechanical energy
- Solve numerical problems related to mechanical energy

Materials you need

- Two small stones

Introduction

In lesson three, you saw that there are different forms of energy. One of the forms of energy is mechanical energy. Mechanical energy enables us to do mechanical work such as moving and carrying objects. In this lesson, you will distinguish between the two types of mechanical energy.

Activity

Procedure

- Place one small stone on the ground or on the table
- Throw the other small stone upwards or drop it from some point towards the ground

Which of the two stones possesses energy?
Explain your answer
Now consider this.
A person sitting at one position and a person running, who of the two possesses energy?
Explain your answer.

In summary, all bodies possess mechanical energy. Bodies at rest possess potential energy due to their position and this energy is given by

Where we have g being the acceleration due to gravity, and h is the height above the ground.
On the other hand, moving bodies possess kinetic energy given by the expression
Where m is the mass of the body and v is the velocity of the body.
Hence all mechanical energy results from masses of bodies

Using the above equations, try out these problems:

1. A stone of mass 8kg is lifted through a height of 2metres.Find the potential energy the stone develops (Take g = $10ms^{-2}$)
2. Find the kinetic energy of a body of mass 2kg moving with a speed of $4ms^{-1}$

Lesson 5: Transformation and conservation of energy

In this lesson, you will be able to:

- Identify energy transformations in life
- State law of conservation of energy
- Describe energy transformations using a pendulum

Materials you need

- A torch
- A small stone
- A string

Introduction:
In lesson 3, you learnt the sources of energy. One of the sources of energy is the dry cell. Can the energy stored in a dry cell do something? Try this activity.

Activity 1

Switch on a torch. What do you observe?
Try to explain this observation.

The energy stored in the dry cells changes into light energy in the torch. The energy stored in the dry cell is chemical energy. Energy is transformed from one form to another. Transformation of energy is very useful to our lives.

Now identify as many instances/devices in everyday life where energy is changed from one form to another. State energy changes that occur.

Activity 2
Procedure

- Hold a small object such as a stone above the ground on a support
- Then release the body and let it fall to the ground (Figure 4.3 below)

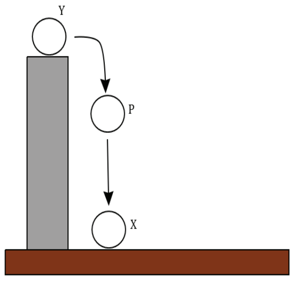


Figure 4.3

Now answer the following questions.
What form of energy does the stone posses when;

(a) It is held above the ground i.e at Y?
(b) It is falling to the ground i.e at P?
(c) It falls and rests to the ground i.e at X?

As you answer these questions, you may discover that same object may have different energy forms. But the total amount of energy is constant. This is summarized in the law of conservation of energy which states that'**energy can neither be created nor destroyed, but only changes from one form to another'**.

You can also explain different energy forms using a pendulum.

Activity 3

Procedure

- Tie a small stone on a string that is about 1 m long
- Suspend the stone from a support
- Set the pendulum into oscillations and observe how it swings (Figure 4.4 below)

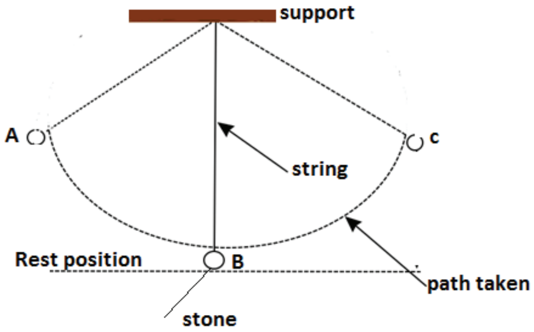


Figure 4.4

From Figure 4.4 above, identify the forms of mechanical energy at positions A, B and C.
Explain your answer.