UNIT 1

PHYSICS AS A SCIENCE

DEFINITION OF SCIENCE

It is the systematic study that uses observation and experimentation to describe and explain natural phenomena.

BRANCHES OF SCIENCE

1. Social science
   It deals with the study of human behavior and society
2. Natural science
   It deals with the study of natural phenomena
3. Formal science
   It deals with mathematical concepts and logic.

BRANCHES OF NATURAL SCIENCE

1. Physical science
   This contains physics and chemistry
2. Life science
   This has a combination of functional biology and cellular biology.
3. Earth/space science
   This looks at astrology and geosciences.

DEFINITION OF PHYSICS

It is a natural science that is concerned with the study of matter and natural forces.

HISTORY OF PHYSICS

Physics started when first people attempted to ask "why" questions. For example; why do objects fall downwards instead of going upwards when released in air? Why some objects floats in water while others do not?

This questions required explanation. The first people to attempt answering some of these questions are the Greeks around 400BC. In 320 BC, Aristotle developed a comprehensive explanation of motion. Around 1543 AD, Nicolas Copernicus explained that the earth goes around the sun. Then came Isaac Newton in 1727 AD to explain why objects fall towards the earth. The list is endless.

BRANCHES OF PHYSICS

Physics is a wide body of knowledge which is divided into the following branches.

1. Mechanics
2. Oscillation and waves
3. Properties of matter
4. Electricity and magnetism
5. Electronics
6. Nuclear physics

MECHANICS

Mechanics is the study of mechanical movements and forces on bodies especially machines. It is associated with forces, work and energy.

OSCILLATION AND WAVES

An oscillation is a to and fro and up and down movement of a particle from its equilibrium position. A wave is a form of energy.

PROPERTIES OF MATTER

It is a branch of physics that explains the behavior of the three states of matter under different conditions.

ELECTRICITY AND MAGNETISM

It is the study of electricity, magnets and magnetism and how these interact.

NUCLEAR PHYSICS

It is the study of the behavior that explains the behavior of the three states of matter.

PHYSICS AND OTHER SUBJECTS

Various branches of natural science are inter-dependent. Here are some of the examples.

a. A physicist needs to have the knowledge of chemistry in order to understand chemical cells.
b. The concept of magnification using microscopes was developed by physicists and a biologist uses a microscope to study living things.

c. In weather forest, a geographer uses barometer, wind gauge, etc. which are instruments developed by a physicists.
d. In agriculture, irrigation uses physics principles
e. In history, the ages of fossils are determined using principles of physics.
f. The theatrical setup, the audio and visual arrangements are the creation of physicist.
g. A physicists needs knowledge of biology to keep him/her health and strong.
h. Measurement of time, distance, weight etc. In sports, use instruments develop by physicists.

CAREER OPPORTUNITIES IN PHYSICS

Physics can lead someone into laboratory technology, mapping and surveying, civil engineering, electrical engineering, mechanical engineering, instrumentation technology, electronics and telecommunication engineering, meteorology, architecture, environmental engineering, etc.

CONTRIBUTION OF PHYSICS TO DEVELOPMENT

The laws and principles developed by physicists, engineers and technologists are using these principles to design and develop devices that make our lives comfortable. In general, physics has played a very important role in:

a. Transport, where high speed cars, electrical trains, ships, etc have been developed.
b. Manufacturing sector where labour efficient robots have been developed.
c. Communication using radio waves and earth and space satellites.
d. Medicine where development of better equipment in surgery and use of diagnostic techniques have been developed.
e. Recreation and sporting where better equipment has been developed.

Application of physics principles have also led to development of the follow:

Computers, the internet, GPS, digital sound, digital video, jet engines, nuclear energy, solar power, TV, space craft and electronic microscope.

UNIT 2

SCIENTIFIC INVESTIGATION

Scientific investigation is a systematic process of testing ideas or finding out answers to questions and observations.

All scientific investigations are carried out using a common process. The processes are observations, questions, hypothesis and explanation.

OSBERVATION

Scientific make observations every day, for which they want to get answers and explanations. This is done by critically looking at a natural phenomenon.

The following is an example of an observation:

"An insect is able towalk on the surface of water without sinking."

QUESTIONS

Scientists ask questions from observations they make. The questions may be of the forms like why, how, what and when.

For example: What is the relationship between the mass of an object and its density?

HYPOTHEIS

It is the guessed answer to the question. And it must be testable in order to prove its validity. This is where scientists try to answer their own question after critically looking at a natural phenomenon.

For instance: Wood floats on water because its density is lower than that of water.

EXPERIMENT

This stage tests the validity of hypothesis. One variable is chosen which will be measured (dependent variable). This variable is contained in the hypothesis. Another variable must also be present which the scientist will be changing (independent variable) in order to get the values of the dependent variable.

An experiment always takes the following format:

1. Title

This gives the aim of experiment clearly stating what the experiment is set to investigate.

2. Materials or apparatus
   This gives the list of materials to be used.
3. Procedure
   This is a step by step description of what need to be done. It may have well labeled diagram, quantities and instruments to be used for each quantity.
4. Observation
   This is where presentation of results is done. This can be done using table or pie chat.
5. Analysis of results
   This way involve drawing of graphs and calculating some quantities
6. Conclusion
   This stage evaluates the analysis and gives a statement of eth findings showing whether the original hypothesis has been supported. Sources of error are also discussed in this stage.
7. Explanation
   This is the statement that justifies the answer. Have the results agree or disagree the hypothesis?

UNIT 3

LABORATORY SAFETY MEASURES

These are the safety set rules or regulations that guide the daily activities in the laboratory.

The general rules and regulations fall under seven categories. Here is the table that summarizes the categories.

FIRST AID

The purpose of first aid is to make the victim secure and comfortable. Therefore, physics laboratory should have a fire extinguisher and a first aid kit containing the following:

a. A pair of blunt-ended scissors
b. An assortment of bandages
c. Adhesive plaster
d. Sterilized cotton wool and gauze
e. Mild antiseptic solution
f. Safety pins
g. Forceps
h. Gloves

HAZARD SYMBOLS AND THEIR MENAINS

These help us identify risks we are likely to be exposed to when handling equipment, apparatus and chemicals.

Hazard symbols are used for the labeling hazardous substances according to the Ordinance on Hazardous Substances.

The following are the hazard symbols and their meanings and their interpretation.

a) Flammable substance

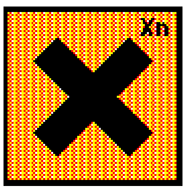
Meaning: the substance catches fire easily hence they should not be brought

Near fire.

b) Poisonous or toxic substance

Meaning: they can cause death hence avoid direct contact

c) Harmful substance



Meaning: they can cause harm hence avoid direct contact

d) Harmful to the environment

Meaning: they can kill destroy the environment hence a void careless disposal

e) Corrosive substance

Meaning: these chemical burn the skin hence avoid direct contact

The following are some of the laboratory safety measures:

- Do not enter the laboratory without the teacher's permission
- Enter the laboratory in an orderly manner
- Do not rush as you enter in the laboratory or scramble for the front bench
- Avoid unnecessary movements in the laboratory
- Do not perform unauthorized experiments in the laboratory
- Do not taste any chemical in the laboratory
- Do not tamper with electrical, gas or water fittings
- Do not smell gases directly
- Read the label on the reagents before you start using them
- If the chemicals get in contact with your skin, eyes or clothes, wash the affected part with plenty of water
- Avoid entering the laboratory bare -footed
- All experiments that produce dangerous gases should be performed in a fume chamber or open space
- Always clean all the apparatus and bench tops after use
- Wash your hands after each laboratory session.
- Do not move anything out of the laboratory unless authorized

APPLYING SAFETY MEASURES IN THE LABORATORY

The following are some of the accidents and their emergency responses.

1. Fire outbreak
    - Move to fire assembly points
    - Inform the teacher
    - Use the extinguishers to put off the fire
    - Switch off the main switch of the laboratory wiring system
    - Do not scream or run randomly.
2. Electric shock
    - Switch off the power at the socket first
    - Pull out the victim from the appliance
    - Give the victim first aid
    - If not breathing, give him/her a kiss of life
    - Seek medical assistance from a medical personnel
3. Suffocation
    - Take the victim out of the laboratory to open air for fresh air
    - Open all the windows and doors
    - Seek assistance from a medical personnel
4. Chemical spillage on the skin, flow, table etc

- Pour a lot of pure water to eh effected part to dilute the chemical
- In case the chemical is in contact with your eye, use the eye wash
- If you tasted the chemicals drink clean water.
- Seek medication immediately.

5. Breaking of equipment
    - Inform the teacher immediately
    - With the help of the teacher, collect all pieces of broken apparatus.

UNIT 4

MEASUREMENTS

FUNDAMENTAL (BASIC) QUANTITIES

The basic quantities are length, mass, time, temperature and current. All the other quantities are derived from the basic quantities.

The table below shows the basic quantities and their symbols.

SI UNITS AND SYMBOLS

In the past, physical quantities had many different types of units. Nowadays scientists have agreed to adopt one set of units. These units are called **Standard International Units**. These are unit that are internationally agreed on.

TYPES OF SI UNITS

1. BASIC SI UNITS

A basic unit is a unit of measurement of a basic quantity. This is chosen and not derived.

Table below shows the SI units of some basic quantities.

Quantity	**Symbol**	**SI Unit**	**Abbreviation**
Length	*l*	Meter	m
Mass	m	Kilometer	kg
Time	t	Second	s
Temperature	T	Kelvin/Degree Celsius	K or ^{0}C
Current electricity	I	Ampere	A

2. DERIVED SI UNITS

A derived quantity is defined based on a combination of base quantities. Its units are derived units. A derived unit is the exponent, product or quotient of base units.

EXAMPLES

1. Speed = $\frac{\text{length (distance)}}{\text{Time}}$

   SI Unit= m/s

2. Density = mass

Volume

SI Unit = kg/m3

3. Acceleration = $\frac{\text{velocity}}{\text{Time}}$

SI Unit = m/s^2

Some units for derived quantities are given special names.

EXAMPLES

1. Force = mass x acceleration
   Unit = kg x m/s^2
   $=kgm/s^2$ SI Unit = Newton (N)

2. Energy = force x distance
   Units = N x m = Nm
   SI unit = Joule (J)
3. Power = $\frac{\text{energy (work done)}}{\text{Time}}$

Units = J/s

SI Unit = Watt (W)

4. Pressure = force (N)
   Area(m2)

   Units = N/m^2
   SI unit = Pascal (Pa)

5. Resistance = $\frac{\text{voltage (V)}}{\text{Current (A)}}$

Units = V/A

SI units = Ohm (Ω)

PREFIXES

A given SI unit may be too larger or too small for convenience. For example, a meter is too large for measuring the thickness of a nichrome wire. Therefore, standard fractions and multiples of SI units are used and are written by placing a prefix before the unit.

For example; the millimeter (mm) is equal to one thousand of a meter.

$1mm = \frac{1}{1000}m = 0.001m$

Therefore, prefixes are useful for expressing units of physical quantities that are either too big or very small.

Some of the Greek prefixes and their symbols indicating decimals, submultiples and multiples of the SI units are shown in the table below.

Prefix	**Symbol**	**Factor**	**Explanation**
Terra-	T	1000 000 000 000	1000 000 000 000 = 1 Terra-
Giga-	G	1000 000 000	1000 000 000 = 1 Giga-
Mega-	M	1000 000	1000 000= 1 Mega-
Kilo-	K	1000	1000= 1 Kilo-
Hecto-	h	100	100= 1 hecto-
Cent-	c	0.01(1/100)	1 = 100 cent-
Milli-	m	0.001(1/1000)	1 =1000 milli-
Micro-	u	0.000001	1 = 1000 000 micro-
Nano-	n	0.000 000 001	1 = 1000 000 000 namo-

LENGTH

Length is defined as the distance between two points. The SI unit of length is the metre symbolized as **m**. Length is measured by a**tape measure** or a **metre ruler**. The following are the diagram for a tape measure

The tape measure

The SI unit is meter (m). various other units are related to the meter by either a multiple or sub multiple of 10_s.

For Example;

1000m = 1km

1m= 100cm

1m = 1000cm

A ruler and tape measures are used to measure length.

The following is the tape measure that is used to measure length.

MEASURING MASS

Mass is defined as the quantity of matter in an object. The SI unit of mass is the kilogram symbolized as**kg**. Note that mass can also be measured in grams,**g**.

The SI unit is kg. The table below shows some units of mass

Unit	**Symbol**	**Explanation**
Megaton	m	1000 000 000 000kg=1M
Tone	t	1000kg = 1 tone
Hectogram	hg	1kg = 10hg
Gram	g	1kg = 1000g
Centigram	cg	1kg = 1000 000cg
Milligram	mg	1kg = 1000 000mg

Mass can be measured using electronic balance, beam balance, spring balance.

The following are the instruments that are used to measure mass.

The triple beam balance

The digital balance

TIME

Time is defined as the measure of the duration of an event. The SI unit of time is the second symbolized as **s.** It is measured by an instrument called a **stop watch.** The following is a diagram of the stop watch.

The stop watch

The SI unit is second. Other units are shown in the table below.

Unit	Symbol	Relationship to seconds
Day	d	86 400s=1 day
Hour	h	3600s=1h
Minute	min	60s=1 min
Millisecond	ms	1s = 1000ms

Time is measured using watch (clock) and stop watches during experiments.

MEASURING TEMPERATURE

The **SI unit is Kelvin (K).** In school laboratories, temperature is measured in ^{0}c. and**0^{0}c=273K**

Thermometers are used to measure temperature in degrees Celsius. These thermometers are basically liquid-in-glass. Liquid used in most thermometers are alcohol and mercury.

The thermometer

VOLUME

Volume is the quantity of space occupies by an object. It is measured in metre cubed or cubic metre (m^3). Smaller volume in a science lab can be measured in cm^3.

Below are some units of volume

Unit	**Relationship to m3**
km_3	1000 000 000 m^3=1km^3
cm_3	1m^3=1000 000 cm^3
mm_3	1m^3=1000 000 000 mm^3

The internal space occupied by an object or substance can be expressed in form of capacity. The SI unit for capacity is the litre(I). The table below shows some units of capacity.

Unit	**Symbol**	**Relationship to litre**
Kilolite	kl	1000l =1 k*l*
Centiliter	cl	1*l* – 100cm
millilitre	ml	1*l* = 1000m*l*

Volume and capacity can be related as shown below;

1m*l* =1cm3

1000m*l* = 1litre = 1000cm^3

1000 000m*l* = 1000litres = 1000 000cm^3 = 1m^3

Volume is measured by the measuring cylinder

MEASURING VOLUME OFA LIQUID

The volume of a liquid can be found by pouring it to a measuring cylinder and reading the volume of the liquid from the scale.

MEASURING THE VOLUEM OF AN IRREGULAR SOLD

AN IRREGULAR solid (e.g. a stone), does not have sides that can easily be measured.

Its volume can be followed by a liquid and the measuring cylinder as follows,

a. Pour water in the measuring cylinder and record its initial volume as VI.
b. Drop in an irregular solid and record the new volume of water plus a stone as V2.
c. Volume of an irregular solid = **(v2 – V1)**

UNIT 5

PARTICULATE NATURE OF MATTER

Matter is defined as anything around us that has mass and occupies space.

EXAMPLES OF MATTER

The following are the examples of matter;

- ***Piece of chalk***
- ***Water***
- ***Air***
- ***Grain of maize***
- ***Groundnuts***
- ***Stone***

COMPOSITION OF MATTER

Matter is made up of small invisible particles called molecules. There molecules are made up of even smaller particles called atoms. Each single type of matter is called a substance

A substance is defined as a single type of matter that has constant composition and properties that differ from those of other substances for example; piece of chalk differs completely from the stone.

EVIDENCE THAT MATTER IS MADE UP OF SMALL MOLECULES

Evidence for the existence of matter are proofs that indicate that really matter exists.

The following are the evidence that Matter up of small molecules.

A. **SMELL OF SUBSTANCES**
   When paraffin has been placed at one corner of the classroom, after a few minutes the whole classroom feels the smell of paraffin. It is not possible to see the colour of paraffin molecules as paraffin enters the nose.
   This is so because as soon as the paraffin was poured into a container at one corner of the classroom, it started disappearing forming a paraffin gas which was able to move freely in the air.
B. **DISSOLVING OF SUBSTANCES IN WATER**
   When a coloured soluble solid has been placed in water, it starts spreading evenly thereby changing the colour of the water gradually until all the water in the beaker takes the colour of the soluble solid. This means that the

individual molecules of the soluble solid have been spread evenly all over the water.

THE STATES OF MATTER

The States of Matter are the forms in which matter exists. There are three main states of matter.

a) Solids
b) Liquids
c) Gases

SOLIDS

In solids the particles are tightly packed together in fixed positions. The particles in solids have no freedom of movements from place to place but they just vibrate within their fixed positions when they gain energy.

These particles in solids are held by strong attractive forces which make these particles to be held firmly in position. Examples of solids are chalk, stone, duster, etc.

LIQUIDS

In liquids the particles are fairly close together but not closely packed together as in solids. These particles have little freedom of movement by sliding or slipping over one another.

They are held by fairly strong intermolecular forces which are not so strong as compared to those of solids.

Examples of liquids are ; water, cooking oil, paraffin, petrol, etc.

GASES

In Gases, the particles are far apart from one another. These particles move freely in all directions and in straight lines. The intermolecular forces in gases are negligible that it is almost zero. Air is the common example of gases.

The following is the molecular arrangement of gases

PROPERTIES OF THE THREE STATES OF MATTER

Properties are the distinguishing qualities or attributes of matter. The following are the properties of the three states of matter.

a) Compressibility
b) Shape
c) Volume
d) Flow

COMPRESSIBILITY OF THE THREE STATES OF MATTER

Compressibility is defined as the measure of the relative volume change of matter when the pressure is applied.

Compressibility differs in all the three states of matter.

COMPRESSIBILITY IN SOLIDS

Generally solids cannot be compressed, that is their volume cannot be reduced by squeezing.

In simple terms all solids are incompressible because the particles in solids are tightly packed together and there are spaces between particles in solids which make it difficult to compress solids.

COMPRESSIBILITY IN LIQUIDS

Like solids, liquids are also incompressible that is liquids cannot be squashed into smaller volumes.

In simple terms liquids cannot be compressed because their molecules are still close together making it difficult to reduce their volume by squeezing.

COMPRESSIBILITY IN GASES

Gases are compressed easily when external pressure is applied on them.

Therefore, the volume of Gases can easily be reduced by squeezing because the particles in Gases are far apart from one another thereby making it easier to reduce their volume by squeezing.

SHAPE OF THE THREE STATES OF MATTER

Shape simply defined as the form of matter.

SHAPE OF SOLIDS

All solids have definite shapes or fixed shape. This means that the shape of solids cannot be changed easily. This is so because the particles in solids are held by strong attractive forces which make solids to maintain their shapes when subjected to outside force.

SHAPE OF LIQUIDS

All liquids have no definite shape or have no fixed shape.

Liquids take the shape of their containers in which they are kept.

Note that liquids have no definite shape because their molecules are held by weak intermolecular forces hence making the liquids to reduce their tendency to maintain their shapes when subjected to outside forces.

SHAPE OF GASES

All Gases have no definite shape that is Gases have no fixed shape.

This is so because the intermolecular forces in Gases is almost Zero thereby making these molecules to be free to move randomly in all directions thereby making it difficult to maintain their shapes. Gases also take the shapes of their containers.

VOLUME OF THE THREE STATES OF MATTER

Volume is defined as the measure of the extent of an object. In simple terms volume is defined as the amount of space occupied by an object.

VOLUME OF SOLIDS

All solids have definite volume or fixed volume. This means that the volume of all solids cannot be changed when subjected to outside force.

All solids have fixed volumes because their particles are closely packed hence it is difficult to change their volume by applying external pressure.

VOLUME OF LIQUIDS

All liquids have a definite volume or a fixed volume because particles in liquids are still close together and are held by fairly stronger attractive forces.

VOLUME OF GASES

All Gases have no definite volume or have no fixed volume. That is to say, the volume of Gases can be changed easily when an external pressure has been applied.

Note that gases have indefinite or no fixed volume because their particles are far apart from one another and are held by negligible intermolecular forces hence an application of an external pressure shall mean to alter their volume.

FLOWING IN THREE STATES OF MATTER

Flowing is defined as a physical property that describes the steady and continuous movement of matter.

FLOWING IN SOLIDS

All solids do not flow. This is so because the particles in solids possess minimum or very low kinetic energy which makes these particles to have little freedom of movement by just vibrating within their fixed positions.

FLOWING IN LIQUIDS

All liquids flow. This is so because their particles have more kinetic energy than solids. These particles have freedom of movement by sliding around each other. Different liquids flow by different amounts due to their differences in their viscosity.

FLOWING IN GASES

All Gases flow easier and faster than liquids because their particles possess lightest or maximum kinetic energy. This makes all gases to flow at a faster rate in straight lines.

CHANGES OF STATES OF MATTER

HEAT AND TEMPERATURE

TEMPERATURE

Temperature is defined as the measure of the average kinetic energy of the molecules of the body.

When the body receives heat the particles of the body gain this energy and start to vibrate vigorously. This raises the temperature of the body.

In other words, temperature is defined as the measure of the ability of a substance to transfer energy to other substances.

- *The higher the temperature of the body, the greater is its tendency to transfer heat.*
- *The lower the temperature of the body, the greater is its tendency to receive heat.*

An object decreases its temperature by releasing energy inform of heat to its surroundings. This explains why we feel cold in winter and hot in summer.

In simple terms temperature is defined as the degree of hotness and coldness of a substance.

THE SI UNIT OF TEMPERATURE

The SI Unit of temperature is the degree celcius ($0^{o}c$) or the kelvin (k)

HEAT

Heat is defined as the form of energy that is obtained due to the random motion of the molecules of a substance.

The SI Unit of heat is the Joule symbolized by a capital letter J.

DIFFERENCES BETWEEN HEAT AND TEMPERATURE

i. Heat is the form of energy while temperature is the degree of hotness and coldness of substance.
ii. The SI unit of heat is Joule while the SI unit of temperature is the degrees celcius or kelvin.
iii. Heat depends on the mass, temperature and material of the body, while temperature depends on the average kinetic energy of the molecules of the body.
iv. Heat is measured by the principles of calorimetry while temperature is measured by the principle of thermometry.

THE EFFECTS OF HEAT ON MATTER

The following are the effects of heat on matter;

a) Melting and freezing
b) Evaporation and condensation
c) Boiling
d) Sublimation and deposition

MELTING AND FREEZING

Melting is the process in which a solid changes into a liquid at constant temperature.

It involves the transformation of a substance from solid to liquid.

Freezing is the process in which a liquid changes into a solid at constant temperature.

Melting is the reverse process of freezing.

MELTING AND FREEZING INTERMS OF PARTICLE

When a substance melts, its particles gain enough energy and vibrate vigorously within their fixed positions. This weakens the attractive forces and allows the particles of a solid to rearrange themselves and occupy the particle arrangement of liquids hence solids transform to liquids.

When a liquid is cooled, its particles lose enough kinetic energy. This strengthens the attractive forces and allows the particles of liquid to be brought more closely together and take the molecular arrangement of solids hence the liquid freeze.

MELTING AND FREEZING POINTS

Melting point is the constant temperature of a substance at which a substance changes state from solid to liquid.

The melting point of a substance describes the transition of solid states to liquid states.

The melting point of ice water is 0^{o}c. This means that when ice is heated, its temperature rises and when it reaches 0^{o}c it becomes constant. At this temperature all the ice changes into liquid water.

Freezing point is the constant temperature at which a substance changes from liquid to solid.

Freezing point describes the transition of a substance from liquid state to solid state.

The freezing point of liquid water is 0^{o}c. At 0^{o}c liquid water changes into ice.

When liquid water is cooled its temperature drops and when it reaches 0^{o}c it becomes constant until all the liquid water changes into ice.

This constant temperature is called Freezing point.

Note that the freezing point of a substance is always the same as the melting point.

For water, its freezing and melting point is 0^{o}c.

BOILING AND CONDENSATION

Boiling is the change of state of matter from liquid to Gas. It involves the transformation of a substance from liquid to Gaseous state at constant temperature.

Condensation is the change of state of matter from Gas to liquid at constant temperature. It involves the transformation of a substance from Gas to liquid.

BOILING AND CONDENSATION IN TERMS OF PARTICLES

When a liquid is boiling, its particles gain enough kinetic energy and move at a faster speed from place to place. This weakens the attractive forces between the particles and allows the particles of a liquid to move away from one another and rearrange themselves and take the arrangement of gaseous particles.

When a gas condenses, it becomes cooled and its particles lose kinetic energy and move slowly and closer to one another. This strengthens the attractive forces between the particles and allows particles to move more closer to one another, shortening their adjacent distances and rearrange themselves thereby taking the arrangement of liquid particles.

BOILING AND CONDENSATION POINTS

Boiling point is the constant temperature at which a liquid changes into Gaseous state.

This involves the transformation of a liquid into vapour at constant temperature.

The boiling point of water is 100^{o}c.

When water is heated, its temperature rises rapidly and when it reaches 100^{o}c, the temperature remains constant. This is the time that the molecules of water rearrange themselves to take the arrangement of gaseous molecules.

Condensation point is the constant temperature at which a gas changes into liquid state. This involves the transformation of a substance from gaseous state to liquid state. The condensation point of water is 100^{o}c.

When the gas is cooled, it condenses at 100^{o}c. this is the temperature at which a gas changes into liquid state.

Note that the boiling point of a substance is the same as its condensation points.

TEMPERATURE AND THE CHANGE OF STATE

When the temperature of matter is raised, its particles gain the kinetic energy and begin to vibrate vigorously within their fixed positions. When the temperature increases rapidly the particles gain enough energy that weakens the attractive forces due to the vibration of the particles in so doing, the molecules start to separate thereby changing the phase of a substance.

WHY THE TEMPERATURE REMAINS CONSTANT DURING THE CHANGE OF STATE

When matter is changing the state, its temperature remains constant. This is so because the heat energy supplied has to work against the force of attraction of the molecules in order to change the state. This involves arrangement of the molecules hence the heat energy supplied is used to rearrange the molecules so that the substance should switch from old state mode to the new state mode.

For example, when the temperature of liquid water increases from 0^oc, it will continue rising when much heat is supplied. When this temperature reaches 100^oc, it will remain constant for a few moment. At this temperature the molecules of liquid water rearranges themselves to take the molecular arrangement of gases so that it should switch from liquid state mode to gaseous state mode.

FACTORS THAT AFFECT THE BOILING POINT OF A SUBSTANCE

The boiling point of a substance may vary depending on a number of factors. The following are the factors that affect the boiling point of a substance.

a) Pressure

b) Altitude

c) Impurities

EFFECTS OF PRESSURE ON THE BOILING POINT OF A SUBSTANCE

The boiling point of a liquid increases with increase in pressure and decreases with a decrease in pressure.

This is why a pot with a lid cooks faster than a pot without a lid.

In a pot with a lid, the steam is not allowed to escape, this increases the pressure inside the pot. As a result the water boils at about 120^oc instead of its normal boiling point of 100^oc. tis makes the food to be cooked faster in a pot with a lid because the food have sufficient energy before the water boils.

In a pot without a lid, the water molecules on the surface are exposed to atmospheric pressure in the open which acts on these molecules. This makes the liquid molecules on the surface of liquid to experience a downward force. Therefore enough heat energy is needed in order to overcome this down force. Hence more time is needed to cook the food in a pot without a lid.

HOW THE PRESSURE COOKER WORKS

A pressure cooker is a sealed pot with a valve that controls the steam pressure inside the pot. In a pressure cooker, the steam is trapped inside the pot as it evaporates from the water.

As more steam forms inside cooker, the internal pressure increases.

The high steam pressure that develops inside the cooker raises the boiling point of water from its usual 100^oc up to around 121^oc, this makes the water to have higher temperature.

This high pressure forces the liquid into the food making the food to be cooked quickly.

EFFECTS OF ALTITUDE ON THE BOILING POINT OF A SUBSTANCE

- Altitude is defined as the height above the sea level.
- The boiling point of water at higher altitude is lower than the boiling point of water at sea level.
- This is so because at sea level, there are more air molecules with greater weight due to greater gravitational force acting on them, which increases the pressure.
- At higher altitudes the number of molecules decreases and the force that they exert is also reduced thereby decreasing the boiling point as well.

THE EFFECTS OF IMPURITIES ON THE BOILING POINT OF WATER

- The boiling point of a liquid increases by the addition of impurities to it because some of the dissolved particles of the impurities stay on the surface of the mixture. These particles exert down ward force on the molecules of the liquid. As a result these molecules require more heat energy to overcome the pressure so that they can escape in the air.
- In addition, some of the heat that is supplied is absorbed by the particles of the impurities.

EVAPORATION

Evaporation is the change of state of a substance from liquid to vapour.
This occurs from the surface of a liquid into a gaseous phase which is not saturated with the evaporating substance.

SUBLIMATION AND DEPOSITION

- Sublimation is the change of astate of a solid directly into its gaseous state without passing through the liquid state.
- For example, Iodine Ammonium Chloride undergo sublimation when heated.
- Sublimation also occurs when air saturated with water vapour is suddenly cooled below the freezing point of water.
- Deposition is the change of state of a gas directly into its solid state without passing through the liquid state.
- For example, first and snowflakes are examples of substance that undergo deposition.

UNIT 6

MECHANICS

FORCE

A force is defined as anything that can change the size, shape, speed or direction of motion of an object.

In simple terms, a force is defined as a pull or push.

A force is capable of doing many things. The things that a force can do are called the effects of force.

EFFECTS OF FORCE ON THE OBJECTS

The following are the effects of force.

i. A force may make an object move from rest. That is it makes things to start moving.
ii. A force may change the direction of moving objects.
iii. It can change the speed of a moving object.
iv. It may change the shape of an object.
v. A force can make things to stop moving.
vi. It may cause things to vibrate.
vii. It may make objects to repel or attract.

MEASURING FORCE

Force is measured by an instrument called a spring balance. This **Spring Balance** is calibrated in Newton.

The SI of force is the Newton which is symbolized by a capital letter N.

Note that, 1N=1000g

BALANCED AND UNBALANCED FORCES

Balanced forces are forces that are equal in size or magnitude.

Balanced forces have their resultant net force of zero. A body under the action of balanced does not change its position of rest.

Balance forces occur in different directions. Since balanced forces are equal in magnitude and in opposite directions, they are said to be in equilibrium hence the object under unbalanced forces maintain its state of rest. There is no change in motion.

When balanced forces act on the moving object, the object continues to move with uniform speed. There is no change in velocity of the object since the external forces acting on the object are equal in magnitude and act in opposite directions.

UNBALANCED FORCES

Unbalanced forces are forces which have different sizes or magnitudes but act in opposite directions.

When unbalanced forces act on the object, they produce a change in its state of rest or of uniform motion. This means that unbalanced forces can move a stationary object or they can stop a moving object.

In other words, unbalanced forces can change the speed or direction of motion of an object.

The resultant net force of unbalanced forces is not zero. The resultant net force is the difference between the two forces and the direction of motion is that of the larger force.

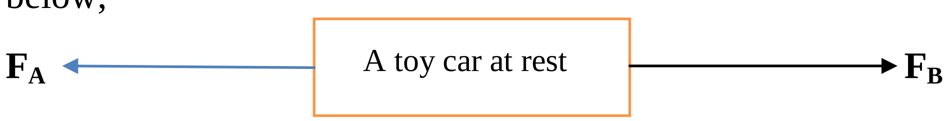
EFFECTS OF UNBALANCED FORCES

The following are the effects of unbalanced forces.

a) Unbalanced forces can make a stationary object to start moving.
b) Can cause a moving object to slow down of speed up.
c) They can cause objects to completely stop moving.

<u>Example 1</u>

Two forces F_A, of 20N and F_B of 20N act on a toy car that is at rest as shown below;



i. Calculate their net force.
ii. In which direction will the toy car move?

<u>Solutions</u>

i. Note that the forces on the toy car are equal in magnitude and act in opposite directions, therefore their net force is,
$\mathbf{F_N = F_A - F_B}$
$\mathbf{F_N = 20_N - 20_N = 0}$

ii. Since these are balanced forces and they act in opposite directions, there will be no movement in any direction. The toy car will still remain at rest.

Example 2

Consider the toy car below which is at rest and two unequal forces at on the toy car at the same time.

i. Find the net or resultant force.
ii. What will happen to the toy car and explain your observation.

Solutions

i. Their net resultant force F_N will be;

$$F_N = F_1 - F_2$$
$$F_N = 25N - 20N$$
$$F_N = 5N$$

ii. The toy car will move in the direction of F_1 because the two forces are unbalanced.

FRICTIONAL FORCE

Frictional force is the force that opposes the motion of an object. It is a force that opposes movement of an object. Frictional force always acts in the opposite direction to the moving object.

FACTORS WHICH AFFECT FRICTIONAL FORCE

The magnitude of the frictional force produced depends on a number of factors.

The following are the factors which can affect frictional force;

a) Nature of surfaces
b) Magnitude of the normal force
c) Area of contact between the surfaces
d) Speed or velocity of the moving object

NATURE OF SURFACES

Surfaces may be smooth or rough.

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Frictional force is greater on rough surfaces than on smooth surfaces.

MAGNITUDE OF THE NORMAL FORCE

Frictional force depends on the magnitude of normal forces holding the moving objects. The larger the normal force, the greater is the frictional force that will be produced. The less the normal force, the smaller the frictional force that will be produced.

AREA OF CONTACT BETWEEN THE SURFACES

The greater the contact surface area between surfaces, the larger the frictional force that will be produced. The less contact surface area, the smaller the frictional force that will be produced.

SPEED OR VELOCITY OF THE MOVING OBJECT

The greater the speed of an object, the greater the frictional force that will be produced. The less the speed of a moving object, the less the frictional force that will be produced.

FRICTION AND HEAT

When two contact surfaces are rubbed against each other, it causes both the surfaces to create energy between them. Once friction is created, heat energy is generated on the surfaces moving past each other.

For example, rubbing your hands together generates heat.

The greater the speed of the surfaces that are moving past each other, the greater is the heat that is generated.

ADVANTAGES OF FRICTIONAL FORCE

Frictional force is used greatly in our everyday lives.

a) **It helps in walking**
   - Friction helps in walking on the floor. We cannot walk without friction between our shoes and the ground. Friction holds the shoe to the ground allowing us to walk.
b) **It helps in writing**
   - For the pen to write on a paper there should be friction between the two.
c) **It helps to drive a car or ride a bicycle.**
   - For a car or bicycle to move, there should be friction between the tyres and

the ground. Without friction the tyres would just spin. Think of slippery surfaces with less frictional force.

d) **It helps to apply brakes on the tyres**
- Friction helps to apply brakes to the tyres so that the car or bicycle should stop moving.

e) **It helps to fix nails**
- Without friction nails cannot be fixed on the wood or wall. It is friction which holds the nails.

DISADVANTAGES OF FRCTIONAL FORCE

The following are the disadvantages of frictional force;

a) Frictional forces cause wearing and tearing of surfaces that are in contact and move past each other.
b) Frictional force opposes the movement hence it slows down the movement of an object.
c) It causes noise pollution when surfaces are moving past each other.
d) Frictional force reduces the efficiency of the machine.
e) It produces het in some parts of the machine that are moving past each other.
f) It leads to the wastage of fuel which further leads to the loss of money.S

WAYS OF MINIMISING OR REDUCING FRICTION

Frictional force can be reduced or minimized in the following ways;

a) Friction can be reduced by lubricating the parts of the machine that are moving past each other.
b) It can also be reduced by using rollers and ball bearings.
c) Frictional force can also be minimized by polishing surfaces which makes the surfaces to be smooth.
d) It can be reduced by using the cushions of air.

MASS AND WEIGHT

Mass is the quantity of matter in an object. It is measured in ***Kilograms*** by a ***Triple Beam Balance*** or a ***Digital Balance***.

Mass is related to how much stuff is there in an object.

Mass of an object does not change whether if it is taken to the moon, earth or in the outer space. Mass is always constant. It is independent of the location, the pull of gravity, speed or even the presence of forces.

Weight is defined the force of attraction on an object towards the centre of the earth.

It is measured in Newtons by a spring balance. It changes depending on the location. It changes with the change in acceleration due to gravity (g).

Note that weight is the product of mass and acceleration due to gravity.

DEFERENCES BETWEEN MASS AND WEIGHT

i. Mass is the quantity of matter in an object while weight is the pull of the earth.
ii. Mass is measured in Kilograms while weight is measured in Newtons.
iii. Mass does not change depending on the altitude while weight changes with changes in altitude
iv. Mass is measured by a beam balance while weight is measured by a spring balance.

RELATIONSHIP BETWEEN MASS AND WEIGHT

Mass and weight are closely related by the following;

1kg = 10N

This means that for every 1kg mass, there are 10N.

In other words, weight is the product of mass and acceleration due to gravity.

Therefore,

Weight = Mass x Gravity, where gravity (g) is the pull of the earth.

The value of gravity (g) differs depending on the location.

On the earth, g is 9.8N/kg or just 10N/kg.

On the moon, g is 1.7N/kg or just 2N/kg.

This relationship can be used to convert Mass into weight and back.

<u>**Example**</u>

a) A bag has a mass of 600kg. Find its weight in Newtons.
If 1kg = 10N
600kg = (more)
<u>600~~kg~~ x 10N</u>

1kg
=6000N

Example

b) A stone weighs 200g on the balance. Find its weight in Newtons.
Solution
First you should convert mass from grams to kilograms.

1000g = 1kg
200g =? (less)

$$\frac{200g \times 1kg}{1000g}$$

=0.2kg

If 1kg = 10N
0.2kg = (less)

$$\frac{0.2\cancel{kg} \times 10N}{1\cancel{kg}}$$

= 2N

Example

A concrete block weigh 3000N. Find its weight.

Solution

If 10N = 1kg
3000N = (more)

$$\frac{3000N \times 1kg}{10N}$$

= 300kg

But 1kg = 1000g
300kg = (more)

$$\frac{300kg \times 1000g}{1kg}$$

= 300, 000g

Example

A ball has a mass of 5kg and its weight is 49N. Find its acceleration due to the gravity (g)

Solution

Given, weight = 49N
mass = 5kg

Weight = mass x gravity
49N = 5kg x gravity

49N = 5kg x g

$\frac{49N}{5kg} = \frac{5kg \times g}{5kg}$

$\frac{49N}{5kg} = g$

g = 9.8N/kg

MASS AND WEIGHT OF AN OBJECT ON THE MOON

The gravitational force of the moon is about one-sixth that of the earth. Therefore the weight of the object on the moon will be about one-sixth of what it is on the earth.

The weight of an object on the moon is less than that of the earth because the mass and radius of the moon are less than that of the earth. But the mass of the object on the earth and moon are the same.

In general;

i. Weight on the moon = $^1/_6$ x weight on the earth
ii. Weight on the earth = 6x weight on the moon

Example

A book weighs 60N on the earth.

i. Find its weight on the moon.
ii. Find its acceleration due to gravity while on the moon.
iii. Find its mass.

Solution

i. Weight on the moon = $\frac{1}{6}$ x mass on the earth
weight on the moon = $\frac{1}{6}$ x 60N = 10N

ii. Mass of the book on earth and moon are the same.
10N = 1kg
60N = (more)

$\frac{60N \times 1kg}{10N}$

= 6kg

iii. Weight = mass x gravity
10N = 6kg x gravity

$\frac{10N}{6kg}$ = gravity

= 1.67 N/kg

WORK

Work is said to be done when a force is exerted upon an object to cause that object to be displaced or move in the direction of the force.

In simple terms, work is said to be done when a force produces a motion on the object in the direction of the applied force.

Therefore, work done is defined as the energy that is transferred when a force produces displacement or motion.

Mathematically,

Work done = Force x Displacement

When force is in Newtons and when displacement is in Meters, therefore, work done is in Newton meters (Nm)

Note that 1Nm = 1Joule

In simple terms, the SI unit of work is the Joule symbolized as J.

EXAMPLES OF SITUATIONS WHERE WORK IS DONE

Note that as said earlier on, work is done if and only if a force produces displacement on the object.

The following are examples of situations where work is done;

i. A man lifting a book from the ground to the top of a cabinet
ii. A boy climbing up the stairs
iii. An engine moving a train along the railway
iv. A horse pulling a cart

EXAMPLES OF SITUATIONS WHERE WORK IS NOT DONE

Note that when work is not done, then either there is no displacement of the object or there is no force to cause the displacement.

The following are the examples of situations where work is not done;

i. A man pushing a rigid wall
ii. A teacher standing in front of the classroom
iii. Reading or studying notes
iv. A woman carrying a bucket on her head.

CALCULATING WORK DONE ON THE OBJECT

a) <u>Example</u>

How much work is done by a force of 10N in moving the object through a distance of 4m in the direction of the force?

<u>Solution</u>

Work done = Force x Displacement

W = F x D
but D = 4m, F = 10N

W = 10N x 4m
W = 40Nm
W = 40J

<u>Work done = 40J</u>

b) <u>Example</u>

A force of 60N causes a block to move a distance of 200cm.

<u>Solution</u>

Force = 60N
distance = 200cm $= \frac{(200)}{(100)}$ m

Distance = 2m

Work done = Force x Distance
W = 60N x 2m
W = 120Nm
W = 120J
Work done = 120J

c) Example

If the workdone on pulling a block is 50J after applying a force of 10N on the block, determine the displacement or distance moved by the object in the direction of force.

Solution

Workdone = 50J
Force = 10N
Distance = ?'

Workdone = Force x Distance
50J = 10N x Distance

$\frac{50J}{10N}$ = Distance

$\frac{50Nm}{10N}$ = Distance

5m = Distance

The displacement is 5m on the direction of force.

WORKDONE AGAINST GRAVITY

Work is done against gravity when the objects are lifted vertically upwards against the gravitational force.

Whenever work is done against gravity, the amount of workdone is equal to the product of the height through which the object is lifted and weight of the object.

Mathematically,

Workdone = Weight x Height, against gravity
W = W x h
But Weight = mass x gravity
Workdone = mass x gravity x height, where ***g=10N/kg***
W = m x g x h

Example

A builder climbed a stair case of height 6m. If the mass of the builder is 40kg, find the workdone in raising himself.

Solution

Workdone = mass x gravity x height
Workdone = 40kg x 10N x 6m
Workdone = $\frac{40kg \times 10N \times 6m}{1kg}$

Workdone = 2400Nm
= **2400J**

ENERGY

Energy is defined as the measure of the ability at which work is done.

In simple terms, Energy is the ability or capacity to do work.

An object having capacity to do work is said to possess energy. The object that does the work loses energy and the object on which the work is done gains energy.

THE SI UNIT OF ENERGY

Since energy is the ability to do work, we can say that work and energy are related. The SI unit of energy is therefore the same as the SI unit of work.

Therefore, the SI unit of energy is the Joule symbolized as the capital letter J.

RELATIONSHIP BETWEEN WORK AND ENERGY

Work and energy are closely related because when an object does work it loses energy and the object onto which work is done gains energy.

In simple terms, when work is done, energy is transferred.

Both work and energy have the same SI units.'

SOURCES OF ENERGY

Energy can be obtained or classified through different sources. These sources of energy can be classified into two groups;

a) Renewable sources of energy'
b) Non-renewable sources of energy

RENEWABLE SOURCES OF ENERGY

Renewable sources of energy are the sources of energy that can be replenished or regenerated over a period of time.

These sources of energy can be replaced fairly fast. They include natural sources that will not get exhausted. They are non-conventional sources of energy. The well-known examples of renewable energy sources are the sun, wind, air and water.

SOME OF THE RENEWABLE SOURCES OF ENERGY

The following are some of the renewable sources of energy;

a) Solar energy
b) Hydropower or hydro-electric energy
c) Wind energy
d) Tidal energy
e) Geothermal energy
f) Biomass or biogas energy

a) SOLAR ENERGY

Solar energy is the energy that is obtained direct from the sun. It comprises of light and heat energy.

Sunlight energy is used by plants for photosynthesis. Sunlight energy is also trapped in the solar cells as electrical energy.

Sun's heat is used by animals for keeping their bodies warm. It is also trapped by the solar heater that are used to heat water.

b) HYDROPOWER OR HYDROELECTRIC POWER ENERGY

Hydro electric energy is produced from the kinetic energy possessed by the moving water.

Water is stored at some heights in the dams and then allowed to fall from a given height which turns the turbines to generate electricity.

c) WIND ENERGY

Wind energy is produced from the kinetic energy of the wind that drives the windmills that drives the water pumps and dynamos that generate electricity.

d) TIDAL ENERGY

Tidal energy is also called wave energy. This energy is produced by big waves on the sea that possesses kinetic energy which drives the turbines for producing electricity.

e) GEOTHERMAL ENERGY

Geothermal energy is the energy that is produced by high pressure vapour from the earth surface that generates electricity.

This vapour comes from the hot spins from the earth's surface.

f) BIOMASS OR BIOGAS ENERGY

Biomass or biogas energy is the energy that is obtained from the decayed/degradation of organic materials such as animal waste, organic waste and industrial effluents.

NON-RENEWABLE SOURCE OF ENERGY

Non-renewable source of energy are the sources of energy that cannot be regenerated or replenished after they have been used. They are the conventional sources of energy. They get completely exhausted after they have been used. The examples of non-renewable sources of energy are coal, mineral oil, petroleum and natural gas.

SOME OF THE NON-RENEWABLE SOURCES OF ENERGY

The following are some of the groups of non-renewable sources of energy;

a) Fossil energy
b) Nuclear energy

a) FOSSIL ENERGY

Fossil energy is the energy that is obtained from the remains of the dead plants and animals buried under the earth millions of years ago. Such type of energy is obtained in the form of coal, petroleum, natural gas, oil kerosene and diesel.

b) NUCLEAR ENERGY

Nuclear energy is the energy that is obtained when a heavy nucleus of radioactive elements disintegrates thereby releasing energy in the form of radiation.

There are three kinds of Nuclear radiations, Alpha x, Beta B and Gamma Rays Y.

This type of energy is used by the commercial power plants to generate electricity.

FORMS OF ENERGY

Energy exists in different forms. The following are the forms of energy.

a) Kinetic energy
b) Potential energy
c) Chemical energy
d) Electrical energy
e) Sound energy
f) Heat energy / thermal energy
g) Light energy
h) Nuclear energy

a) KINETIC ENERGY

Kinetic energy is the energy possessed by a body due to its motion.

Any moving object possesses kinetic energy. For example, a moving car has kinetic energy, wind has kinetic energy and flowing water has kinetic energy.

Kinetic energy is denoted by K.E in simple terms/

FORMULA FOR KINETIC ENERGY

Kinetic energy is the body that is directly proportional to the product of the mass of the body and the squares of its velocity.

Kinetic energy = ½ x mass x $(\text{velocity})^2$

K.E = $\frac{1}{2} mv^2$

<u>Example</u>

Determine the kinetic energy of a truck with a mass of 10, 000kg travelling at 20m/s.

Solution

Mass = 10, 000kg
V = 20m/s
K.E = ½ mv^2
K.E. = ½ x 10, 000KG x 20m/s x 20m/s
K.E = 5, 000kg x 20m/s x 20m/s
K.E = 5, 000kg x 40 x m/s x m/s

K.E = 200, 000J

Example

If the kinetic energy of a moving ball is 12J. Find its velocity when its mass is 1.5kg.

Solution

K.E = 12J
M = 1.5kg
K.E = ½ mv^2

12J = ½ x 1.5kg x V^2

24J = 1.5Kg X V^2

$V^2 = \frac{24J}{1.5\ kg}$

V^2 = 16J/kg

V = (√16) J/kg

V = 4m/s
the velocity of the ball is 4m/s

b) POTENTIAL ENARGY

Potential energy is the form of stored energy in the body when it is in a particular position or state.

Any object that is kept, a given height and could fall possesses potential energy to do the work. This energy in which the object possesses due to the gaining of height is called gravitational potential energy because it has been acquired by doing the work against gravity.

Potential energy is divided into two main categories;

a. Strain energy or elastic potential energy
b. Gravitational potential energy or Energy of height

STRAIN ENERGY OR ELASTIC POTENTIAL ENERGY

Strain energy or elastic potential energy is also called restoring energy.

Strain energy or elastic potential energy is the energy that is produced due to the change in shape of an object.

When you stretch a rubber, it goes back to its original shape when released. The workdone on stretching the rubber is called elastic potential energy that is used to restore the rubber and makes it regain its original shape when released.

Therefore, any elastic material that can be stretched from its original shape gains this elastic potential energy.

GRAVITATIONAL POTENTIAL ENERGY OR ENERGY OF HEIGHT

Gravitational potential energy is the energy that is gained by a body when it has acquired a given height from the ground.

Gravitational potential energy is also called energy of height. This is so because it is acquired by doing work against gravity.

When finding out the potential energy of a body lying at a given height, there is need to find out the work done in taking the body to that height.

Therefore, workdone = Force x Distance
W = m x g x h, where g = 10m/s

This workdone gets stored up in the body as potential energy.

P.E = mass x gravity x height
this formula helps to calculate the gravitational potential energy of an object.

Example

A boy has climbed a tree 20m high. If the mass of the boy is 30kg, calculate the potential energy gained by the boy.

Solution

Mass = 30kg
h = 20m
g = $10m/s^2$

P.E = m x g x h
P.E = $30kg \times 10m/s^2 \times 20m$

P.E = 6, 000J

Exercise

A boy is carrying a bucket of water of mass 5kg. If he does 500J of work, find the maximum height onto which the bucket should be raised?

CHEMICAL ENERGY

Chemical energy is the form of stored energy that is obtained through the conventional process called chemical reaction. Chemical energy is therefore a form of potential energy.

Food is the source of chemical energy that is used by human beings and animals to perform different tasks like, walking, talking, thinking etc.

Fossil fuels like coal, petrol, oil and natural gas are also sources of this chemical energy.

Fireworks contain chemical energy.

ELECTRICAL ENERGY

Electrical energy is the energy that is produced when the electrons are driven and move around the circuit. As the electrons move around the circuit they carry electrical energy from one point to another.

SOUND ENERGY

Sound energy is the form of energy that is produced through the mechanical vibrations of materials like ringing bells, hitting drums and other musical instruments.

HEAT ENERGY OR THERMAL ENERGY

This is the energy due to the differences in temperatures. When one part of an object receives heat, this heat is transferred to other parts until all objects get heated up.

LIGHT ENERGY

This is the energy that comes from the luminous objects like the sun, bulb, fires, candles which enable us to see.

Sunlight energy is used by the plants for which is further converted into chemical energy for photosynthesis.

NUCLEAR ENERGY

Nuclear energy is produced when heavy nuclear splits from daughter nuclear in a process called *Nuclear-Fission*. This energy is used in large commercial power plants to produce electricity.

THE LAW OF THE CONSERVATION OF ENERGY

The law of the conservation of energy states that energy cannot be created or destroyed but it just changes from one form to another.

Whenever there is a change in the form of energy, the total amount of energy remains constant or there is no loss or gain of energy.

ENERGY TRANSDUCERS OR ENERGY CONVERTERS

An energy transducer is a device that converts energy from one form to another.

An example of a transducer is a thermocouple which changes heat energy to electric energy.

ENERGY CHANGES IN PRACTICAL SITUATIONS

Note that energy exists in many different forms. One form of energy can be changed into another form. The change of energy from one form to another is called *Energy Transformation*.

For instance, if a stone is released from a given height and is allowed to fall and hit the ground, the following energy transformation occurs;

$$Potential\ energy \rightarrow Kinetic\ energy \rightarrow Sound\ energy \rightarrow Heat\ energy$$

Example

Write down the energy changes that take place when a cell is connected to a light bulb and the switch is closed.

Solution

Chemical → Electrical → Light → Heat

Example

Write down the energy changes that take place when a branch of a tree falls to the ground.

Solution

Potential → Kinetic → Sound

Example

Write down the energy changes that take place when a girl stretches a rubber band.

Solution

Chemical → Elastic potential → Kinetic → Sound

ENERGY LOST OR GAINED BY AN OBJECT

When an object has been lifted to a given height, then the object has gained gravitational potential energy. If the same object has been allowed to fall down to the ground, the potential energy changes into kinetic energy. This means that as the hammer is falling down its potential energy is decreasing because it is losing height but its kinetic energy keeps on increasing because of its velocity is increasing as it is falling down.

Just before the object hits the ground, all the potential energy changes into kinetic energy. This means that the object has lost potential energy and at the same time it has gained kinetic energy.

In general;
potential energy lost = kinetic energy gained

In simple terms, in all practical situations energy lost is equal to the energy gained.

CALCULATING ENERGY LOST OR GAINED

Example

A stone mass 2kg is thrown vertically upwards to a height of 6m.

a) Calculate the gravitational potential energy the stone has gained.
b) If the same stone is released from that height and fall down to the ground. Find the energy lost and give a reason for your answer.

Solution

a) Mass = 2kg
Height = 6m
g = $10m/s^2$
P.E = mass x gravity x height
P.E = $2kg \times 10m/s^2 \times 6m$
P.E = 120J

b) If the stone is allowed to fall to the ground, then;
Potential energy lost = Kinetic energy gained
Therefore, energy lost = 120J because energy cannot be created or destroyed.

UNIT 7

ELECTRICITY AND MAGNETISM

ELECTRIC CURRENT

Electric current is defined as the rate of flow of charge

In simple terms, electric current is the rate of the flow of electrons.

Electric current measures the rate at which charges pass a fixed point in a circuit.

Electric current flowing in a conductor is the amount of charge flowing per second through it.

So if the charge Q flows through the cross section of a conductor in the T, then the current I, through it is given as follows;

$I = Q/t$

Where I = Current

Q = Charge

t = Time

THE SI UNIT OF ELECTRIC CURRENT

The SI unit of electric current is the Ampere symbolized by a capital letter A.

The SI of charge is the coulomb, C.

One Ampere is defined as one Coulomb of charge passing through a given point in a wire in one second.

Therefore 1 Ampere = 1 Coulomb/1 Second

$1A = 1C/1s$

Example

A current of 9A passes through a point in a circuit in four minutes. Find the charge that is transferred.

Solution

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I = 9A
t = 4mins = (4x60) = 240 seconds
Q = ?

$$9A = \frac{Q}{240s}$$

Q = 9A x 240s
Q = 2160 Coulombs
Q = 2160C

Example

A current of 1.5A transferred a charge of 1800C. For what period of time did the current flow?

Solution

I = 1.5A
Q = 1800C
t = ?

$$I = {}^{Q}/_{t}$$

$$1.5A = \frac{1800C}{t}$$

$$t = \frac{1800C}{1.5A}$$

t = 1200 seconds

t = 20minutes

THE DIRECTION OF THE FLOW OF CURRENT IN AN ELECTRIC CIRCUIT

Note that electric current is the flow of electrons in a conductor.

In a complete circuit, electrons flow from the negative terminal of the cell towards the positive terminal of the cell, as shown below.

THE DIRECTION OF CONVENTIONAL CURRENT FLOW

Conventional current is the direction in which a positive charge would move in a conductor.

The direction of the conventional current is always opposite the direction of electrons in a conductor.

Therefore, if the electrons move from the negative terminal of the cell to the positive terminal of the cell, then the conventional current flows from the positive terminal of the cell towards the negative terminal of the cell.

MEASURING ELECTRIC CURRENT

Electric current is measured by an instrument called Ammeter.

An electric circuit is a path through which electric circuit flows.

It consists of various electrical components that forms part of the complete electric circuit.

The following are some of the electric components that form an electric circuit when connected one after the other in a wire.

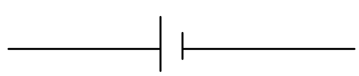
i. A cell or a battery
ii. A bulb
iii. A switch
iv. Connecting wires
v. Ammeter
vi. A Voltmeter
vii. Resistors

BASIC ELECTRIC CIRCUIT SYMBOLS

The following are some of the electric circuit symbols for the components:

<u>The Cell</u>

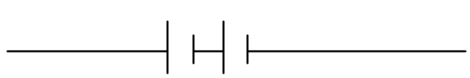
The symbol for the cell is



The cell provides the potential difference or voltage in the circuit which drives the electrons to form electric current.

<u>The Battery</u>

The symbol for the battery is

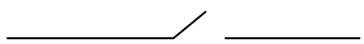


A battery is the combination of more than one cell. It provides a large potential difference or voltage.

The Switch

The switch is used to break or complete the circuit.

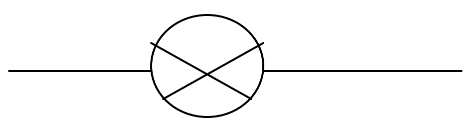
The symbol for the switch is



The Bulb

The bulb gives light when the charge passes through it. The magnitude of the brightness of the bulb indicates the strength of the potential difference in the circuit.

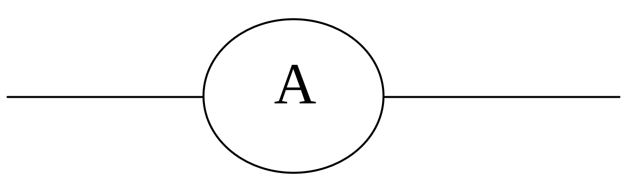
The symbol for a bulb is



The Ammeter

The Ammeter measures the electric current passing through a given point

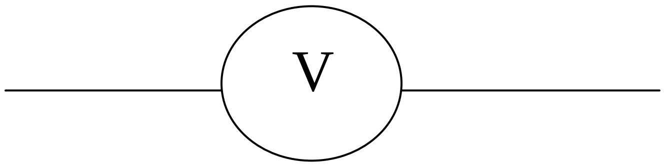
The symbol for an Ammeter is



The Voltmeter

The Voltmeter measures the potential difference across the device or electrical component.

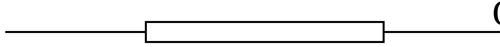
The symbol for the Voltmeter is



<u>The Resistor</u>

The resistor measures electrical resistance of the components or wires.

The symbol for a resistor is


Or


TYPES OF ELECTRIC CIRCUITS

There are two main types of electric circuits;

a) The series circuit
b) The parallel circuit

SERIES CIRCUIT

A series circuit is a circuit with one conducting path.

In a series circuit the current that is created by the voltage source passes through each circuit component in succession. The charge has a single path from the battery and it returns to the battery.

PARALLEL CIRCUIT

A parallel circuit is a circuit with more than one conducting path. In parallel circuit the current created by the voltage source branches, with some passing through one component while the rest passing through other electrical components.

In parallel circuit, alternative paths are provided for the current which splits. The current from the source is larger than the current in each branch

CURRENT IN SERIES CIRCUIT

Electric current in series circuit is the same at every point. This means that current passing through each component that is connected in series is the same.

Note that if the switch is closed, the Ammeter readings of A_1 and A_2 will be the same. This is an indication that the current in series is the same, it is not shared.

CURRENT IN PARALLEL CIRCUIT

Electric current, I, in parallel is shared amongst the components in parallel. Therefore, the current in parallel is different at different points in the circuit.

Therefore, in parallel circuit, the current is different in every path. The current in each path is smaller than the current in the entire circuit.

In general, in parallel circuit, the amount of the current arriving at the junction is equal to the sum of the current that is leaving the junction.

VOLTAGE

Voltage is the measure of the ability of electrical energy to do work. It is the difference in electrical potential energy per unit charge between two points in a circuit. It is the workdone in moving a unit charge from one point to another.

Note that voltage is also called the potential difference.

SI UNIT OF VOLTAGE

The SI unit of voltage is the Volt symbolized by a capital letter V.

Where 1V = 1J/C

Mathematically Voltage = $\frac{\text{workdone (J)}}{\text{charge (C)}}$

MEASURING VOLTAGE

Voltage or potential difference is measured by an instrument called Voltmeter.

Note that the Voltmeter is always connected in parallel, across the two points where the potential difference is to be measured.

Note that the negative terminal of the Voltmeter is connected to the negative terminal of the cell and the positive terminal of the Voltmeter is connected to the positive terminal of the cell.

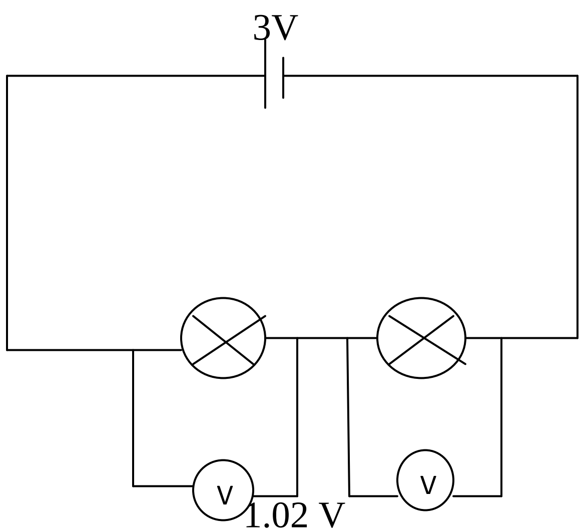
A Voltmeter is connected in parallel always because;

i. It has a very high resistance so that it does add another parallel pathway to the circuit for the current.

ii. The Voltmeter is used to measure the voltage between two points in the circuit, hence it must be connected in parallel to the position of the circuit you want to measure.

VOLTAGE IN SERIES CIRCUIT

Voltage in a series circuit is shared amongst the components. in series circuit, the voltage at the terminals of the battery is equal to the sum of the individual voltages across the devices in the external circuit.



if the voltage of the cell is 3v. Calculate the value of V_1

Solution

$V_c = V_1 + V_2$

$3V = V_1 + 1.02\ V$

$V_1 = 3\ V - 1.02V$

$V_1 = 1.98\ V$

VOLTAGE IN PARALLEL CIRCUIT

Voltage in parallel circuit is not shared amongst the components. The voltage across components is the same and is equal to the voltage of the battery.

milanzi chisi Aubrey Jeremiah (Target private) 0888341196 / 0993347461

THE EFFECT OF INREASING THE NUMBER OF CELLS ON THE BRIGHTNESS OF THE BULBS IN SERIES CIRCUIT

In series circuit, when the cells are added, the brightness of the bulbs increases.

In general, increasing the number of cells, increases the brightness of the bulbs in series because current increases.

Decreasing the number of cells decreases the brightness of the bulbs because current decreases as well.

THE EFFECT OF INREASING THE NUMBER OF CELLS ON THE BRIGHTNESS OF THE BULBS IN PARALLEL CIRCUIT

adding more cells in parallel has no any effect on the brightness of the bulbs, because in parallel circuit, the voltage remain the same across each bulb and is equal to the voltage of the cell. In so doing, the energy supplied by one cell in parallel is equal to the energy supplied by one cell.

THE EFFECT OF INREASING THE NUMBER OF BULBS ON THE BRIGHTNESS OF THE BULBS IN SERIES CIRCUIT

In series circuit, the brightness of the bulbs decrease as more bulbs are added because the voltage from the battery is shared amongst the bulbs, thereby decreasing the voltage as more bulbsare added. This decreases the current hence the brightness decreases as well.

THE EFFECT OF INREASING THE NUMBER OF BULBS ON THE BRIGHTNESS OF THE BULBS IN PARALLELCIRCUIT.

When bulbs are added in parallel, their brightness is the same because the voltage in parallel is the same at every point. Therefore, increasing the number of bulbs in parallel has no anyeffect on the brightness of the bulbs. As a result the brightness of the bulbs remain the same.

ELECTRICAL RESISTANCE

Electric resistance is the opposition to the flow of electric current in a conductor. It is the opposition to the flow of electrons in a conductor.

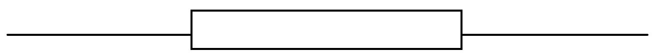
In simple terms, electrical resistance is the measure of the resistance that a conductor offers to the currentpassing through it.

SI UNIT OF ELECTRICAL RESISTANCE

TheSI unit of electrical resistance is the ohm symbolized by Ω.

MEASUARING ELECTRICAL RESISTANCE.

Electricalresistance is measured by a device called a resistor. The symbol for a resistor is



Mathematically,

Electrical resistance = $\frac{\text{potential difference (V)}}{\text{current (I)}}$

This is written in simple terms as follows, $R = \frac{V}{I}$

EXAMPLE

The voltage across a resistor is 6V and the current through it is 2A. Calculate the electrical resistance.

Solution

$R = \frac{V}{I}$

$R = \frac{6V}{2A}$

R = 3Ω

FACTORS AFFECTING ELECTRICAL RESISTANCE

Electrical resistance of a wire is affected by different factors. The following are the factors that affect electrical resistance.

- Length of the wire
- Thickness of the wire
- Temperature of the wire

- Nature of the wire

LENGTH OF THE WIRE

The resistance of a wire is directly proportional to the length of the wire, the longer the wire, the greater the resistance to current it will offer. The shorter the wire, the less the resistance it will offer.

THICKNESS OF THE WIRE

Thick wires provide less resistance to current than thin wires. Therefore increasing the cross-sectional are of the wire reduces electrical resistance

TEMPERTURE OF THE WIRE

Increasing the temperature of the wire increases the electrical resistance of the conductor

EFFECTS OF ELECTRIC CURRENT

The following are the effects of electric current

- The heating effect
- The magnetic effect
- The chemical effect

THE HEATING EFFECT

When current passes through a wire, heat energy is produced. A wire that has higher resistance will produce more heat energy than that which has a lower resistance.

THE MAGNETIC EFFECT

When current flows through a wire,it produces magnetic filed in the wire

THE CHEMICAL EFFECT

When current passes through the liquid, it breaks down the liquid into ions by the process called electrolysis.

WET AND DRY CELLS

Cells are the sources of electricity in powering radios, watches and torches. The electricity is produced from chemical energy, which is released from the cells by a chemical reaction. The type of electricity which is produced is in the form of direct current.

A WET CELL

Wet cell has a liquid electrolyte. The liquid covers all the internal parts

Zinc rod acts as the **negative electrode.** Copper rod acts as the **positive electrode** and sulphuric acid acts as the **electrolyte**

The zinc rod slowly dissolves in the acid, and loses electrons. These electrons flow in the external wire through the component (i.e. bulb) to the carbon plate.

Hydrogen ions in the sulphuric acid go to the copper rod and gain electrons coming from zinc rod to become hydrogen gas.

DISADVANTAGES OF WET CELL

- The disadvantage of this cell is polarization (the formation of bubbles of hydrogen on the copper rod)
- It produces low voltage of about 1v. Therefore it cannot be used for practical purposes.

DRY CELL

A dry cell contains a zinc container containing paste which contains ammonium chloride with a carbon rod at the center. This makes it more portable than the wet cell.

WAYS OF CARING FOR WET CELLS

Cells can be stored at low temperature. This slows the side reaction.

MAINTAINING OF WET CELLS

Wet cells can be maintained as follows

1. Water is added to make up for loss by evaporation.
2. the dissolving zinc negative electrode should be replaced regularly

DISPOSING OF DRY AND WET CELLS

Cells can be disposed by the following methods.

1. Incinerate (burn completely) the cell while it is wrapped in a plastic bag.
2. Recycling.

Cells are in the form of electronic waste (e-waste).therefore e-waste recycling services

IMPACT OF POOR DISPORSAL OF WET AND DRY CELLS

1. Cause environmental damage: most cell contain toxic materials which damage the environment.
2. Small button cells can be fatal if swallowed, mainly by kids

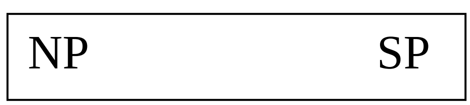
MAGNETS

Substances that are attracted to a magnet are called magnetic substances. Examples of magnetic substances are iron, steel and other metals and alloys. These metals are called ferrous metals and their magnets are called ferromagnets.

Substances that are attracted to the magnet are called non magneticsubstances .examples are aluminium, copper, zinc,brass tin, and all non metals.

MAGNETIC POLES

When a magnet is freely suspended, it always come to rest and one side points to the north while the other points to the south. The side that points to the north is called the north pole while other side that points to the south is called the south pole.



MAGNETIC FORCE
It is a force of attraction and repulsion provided by a magnet. This magnetic force has the following characteristics:

- It is either attractive or repulsive
- It attracts only magnetic materials
- It is greater at the poles
- It acts in all directions
- It increases when the separation distance decreases

MAGNETIC FIELD

This is a region around a magnet in which magnetic force can be experienced..Magnetic field is represented by magnetic lines of force. These lines of force are drawn from North Pole to the South Pole.

Magnetic field is strongest where the field lines are closest, that is, at the poles. This means those magnetic forces are strongest at the poles.

THE LAW OF MAGNETS

The law of magnets states that like poles repel each other while unlike poles attract each other.

USES OF MAGNETS

- Used in hospitals for removing iron pieces from the eyes of the patients
- Used in industries as stirrers, lifting iron scraps
- Used in weather stations for resetting the sixth thermometer
- Used in navigationfor showing the directionas in the campus needles
- Used in magnetic tapes that are used in audio and video recorders

CARING FOR MAGNETS

Since a bar magnet tends to become weaker with age. It is advised that magnets should be stored in pairs with opposite poles adjacent and with small pieces of iron called keepers placed across the ends.

UNIT 8

DENSITY

Density is defined as the mass of a substance per unit volume.**note** that the density of a substance is a measure of the amount of matter that is present in a given volume of it.

Mathematically,density$= \frac{\text{mass}}{\text{volume}}$

When mass is in kg and Volume is dm^3, then density is in Kg/m^3.
When mass is in grams and volume is in cm^3 then the density is in g/cm^3.
Thismeans that the SI unit of density is Kg/m^3 or g/cm^3.
Note that:
$1000Kg/m^3 = 1g/cm^3$

EXAMPLE 1

Given that the density of cooking oil is $800kg/m^3$. What is the density of cooking oil in g/cm^3?

SOLUTION

$1000/m^3 = 1g/cm^3$
$800kg/m^3 =$ (less)?

$$\frac{800kg/m^3 \text{ x } 1g/cm^3}{1000kg/m^3}$$

$\frac{8}{10}g/\ cm^3$

$0.8\ g/cm^3$

EXAMPLE 2

Given that the density of paraffin is $0.2g/cm^3$. Find the density of paraffin in Kg/m^3.

SOLUTION

If $1g/cm^3 = 1000kg\ /m^3$
$0.2g/m^3 =$ less

$\underline{0.2g\ /cm^{3\ x}\ 1000kg/m^3}$

$1g/cm^3$

$= \quad 200Kg/m^3$

Note that, density $= \frac{\text{mass}}{\text{volume}}$

But density is represented by the symbol ρ (rho)

Since density = $\frac{\text{Mass}}{\text{Volume}}$

Then $\rho = \frac{M}{V}$

EXAMPLE I

Given that the volume of cooking oil is $200cm^3$ and its mass is 500g. Find the density in g/cm^3

SOLUTION

Volume = $200cm^3$

Mass = 500g

Density $= \frac{\text{mass}}{\text{voluyme}}$

$= \frac{500g}{200cm^3}$

Density = $2.5g/cm^3$

$\rho = 2.5g/cm3$

EXAMPEL II

The density of paraffin is $800kg/m^3$ and its volume is $100m^3$. Find the mass of paraffin in g.

SOLUTION

Density = $800kg/m^3$

Volume = $100m^3$

Density = $\frac{\text{Mass}}{\text{Volume}}$

$800kg/m3 \quad = \quad \frac{\text{mass}}{100\ m^3}$

Mass = $800kg/m^3 \times 100m^3$

Mass = 80000 kg

EXAMPLE (IV)

The density of Gold is 19 300kg /m^3 and its mass is 1000kg. Find its volume in cm^3.

SOLUTION

Density = 19 3000/m3

Mass = 1000kg

Volume = $\frac{\text{Mass}}{\text{Volume}}$

$\frac{19\ 300kg/m^3}{1} = \frac{1000kg}{\text{volume}}$

Volume x 19 3000kg/m^3 = 1 x 1000Kg

$\frac{\text{Volume} \times 19\ 300kg/m^3}{19\ 300kg/m^3} = \frac{1000kg}{19\ 300kg/m^3}$

Volume = $0.0518m^3$

If $1m^3 = 1000\ 000cm^3$

Then, $0.0518m^3$ = less

$\frac{0.0518m^3 \times 1000\ 000}{1m^3}$

= 51 800cm^3

EXAMPLE

The density of cooking oil is 800g/cm^3. If its mass is 4kg. Find its volume in m^3.

SOLUTION

Density = $800g/cm^3$
Mass = 4kg

If 1kg = 1000g

4kg = more

$\frac{4kg \times 1000g}{1kg}$

4 x 1000g

= 4 000g as mass

Density = $\frac{Mass}{Volume}$

$\frac{800g/m^3}{1} = \frac{4000g}{Volume}$

Volume x $800g/m^3$ = 1 x 4000g

Volume x $800g/cm^3$ = 4000g

Volume = $\frac{4000g}{800g/cm^3}$

Volume = $\frac{40}{8}cm^3$

Volume = $5\ cm^3$

But $1000\ 000cm^3 = 1m^3$

$5\ cm^3$ = less

$\frac{5cm^3 \times 1m^3}{1000\ 000cm^3}$

= $0.000005m^3$

EXAMPLE

Given that the mass of petrol is 2000g and its volume is $20cm^3$. Find the density of petrol in kg/m^3.

SOLUTION

Mass = 2000g

If 1000 kg = 1kg

2000g = more

$$\frac{2000g \times 1kg}{1000g}$$

= 2kg

But $1000\ 000cm^3 = 1m^3$

$20cm^3$ = less

$$\frac{20cm^3 \times 1m^3}{1000\ 000cm^3}$$

= $0.00002m^3$

$$\text{Density} = \frac{2\ kg}{0.00002\ m^3}$$

Density = $1000\ 000kg/m^3$

MEASURING THE DESNITY IN SOLIDS

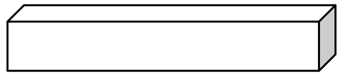
There are two kinds of solids.

a. Regular
b. Irregular solids

MEASURING THE DENSITY OF REGULAR SOLIDS

Regular solid isa solid that has clear dimensions of length, width and height.

The common example of regular solid is a brick which is shown below.



NOTE: that the mass of regular solid is found by weighing the solid on a triple beam balance or a digital balance.
The volume of the solid is found by multiplying the three dimensions of the solid.

MEASURING THE DENSITY OF IRREGULAR SOLIDS

An irregular solid is a solid that has no clear dimensions of length, width and height.In order to measure the density of an irregular solid, Firstly, measure the mass of an irregular solid by a triple beam balance andrecord.Then poor water in measuring cylinder andrecord its initial volume as V_1. Tie and irregular solid with a string and carefully drop it into a measuring and record the new volume as V_2.
Thereafter, calculate the volume of an irregular solid by subtracting $V_2 – V_1$

Finally, find the density of an irregular solid by the formula

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

MEASURING THE DENSITY OF LIQUIDS

In order to find the density of a liquid, firstly, Put the empty cylinder on the digital balance and record its mass as M_1.Then put the liquid into the cylinder at the required level and record the mass of cylinder plus liquid as M_2. Find the mass of the liquid alone by subtracting $M_2 – M_1$
Find the volume of the liquid by noting the level of the liquid in the cylinder.

Finally calculate the density of the liquid by the formula

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

DENSITY AND THE THREE STATES OF MATTER

DENSITY IN SOLIDS

Solids have high density because the particles are more closely packed which makes the mass to volume ratio to increase.
In simple terms, solids have high density because their particles are closely packed together; thereby occupying less volume as a result the mass to volume ratio increases.

DENSITY IN LIQUIDS

Liquids are less dense than solids because the particles in liquids are fairly spaced from one another thereby occupying a larger volume than solids as a results the mass to volume ratio decreases, thereby increasing the density.

DENSITY IN GASES

Gases are less dense as compared to solids and liquids because the particles in gases are far apart from one another, thereby making gases to occupy the largest volume. As a result the mass to volume ratio becomes so small, increasing the density.

DENSITY AND TEMPERATURE

When the temperature of a substance increases the particles gain enough energy to vibrate vigorously within their fixed positions. This weakens the force of attraction between particles thereby making the particles to move further away from one another. As a result this increases the volume and decreases the density.

When the temperature of a substance decreases the particles lose kinetic energy hence these particles move closer to one another thereby strengthening the forces of attracting making a substance to occupy less volume, thereby increasing the density.

In simple terms, when the temperature is high, density decreases and when the temperature is low density increases.

FLOATING AND SINKING IN RELATION TO DENSITY

Note that some substances float on water while other substances sink in water. More dense substances sink in water while less densesubstances float on water.When a substance sinks in water, it means its density is more than that of water.When a substance floats, it means that its density is less than that of water.

AVERAGE DENSITY

Average density is defined as the ratio of total mass to total volumes of a substance.

$$\text{Average density} = \frac{\text{Total mass of a substance}}{\text{Total volume of a substance}}$$

EXAMPLE 1

20kg of sand of volume $10m^3$ is mixed with 10kg of cement of volume $5m^3$, calculate the average density of the mixture.

SOLUTION

Total mass = mass of sand + mass of cement

Total mass = 20Kg + 10kg
Total mass = 30Kg
Total volume = volume of sand + volume of cement
Total volume = $10m^3 + 5m^3$
Total volume = $15m^3$

Average density = $\frac{\text{Total mass of substance}}{\text{Total volume of substance}}$

$= \frac{30Kg}{15m^3}$

Average density = $2kg/m^3$

EXAMPLE 2

If 50cm3 of paraffin with a density $0.7g/cm^3$ is mixed with $25cm^3$ of petrol with a density of $0.9g/cm^3$. Calculate the average density of the mixture.

WORKING

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

Mass = Density x Volume

Mass of paraffin = $0.7g/cm^3 \times 50cm^3$

= 35g of paraffin

Mass of petrol = $0.9g/cm^3 \times 25cm^3$

= 22.5g

Average density = $\frac{\text{Total mass of substance}}{\text{Total volumeof substance}}$

$= \frac{57.5g}{75cm^3}$

$= 0.77g/cm^3$

RELATING AVERAGE DENSITY TO SINKING AND FLOATING

A fresh egg sinks in water because its density is high than that of water.But a fresh egg floats on salty water because the average density of salty water is higher than that of a fresh egg.

A steel ship floats on water because the average density of steel and planks is less than the density of water.
Boats and canoes float on water because their average density is less than that of water.
A rotten egg floats on water because it has high accumulation of gases which reduces its average density.

APPLICATION OF AVERAGE DENSITY
Average density is applied in the following:

a. It helps to distinguish pure substances from impure substance
b. Average density helps the ships, canoes and boats to float on water.
c. It helps to separate mixtures of immiscible liquids

milanzi chisi Aubrey Jeremiah (Target private) 0888341196 / 0993347461

UNIT 9

SPECIFIC HEAT CAPACITY

HEAT CAPACITY

Heat capacity is defined as the amount of heat that is required to raise the temperature of a substance by1^0c.

SPECIFIC HEAT CAPACITY

Specific heat capacity is defined as the amount of heat required to raise the temperature of a 1kg mass of a substance by 1^0c.

Mathematically

$$\text{Specific heat capacity} = \frac{\text{heat energy}}{\text{Mass x temperature change}}$$

Note that

C = Specific heat capacity
Q = heat energy supplied
M = Mass
ΔT = Change in temperature

$$C = \frac{Q}{m \times \Delta T}$$

ΔT= Final temperature – Initial temperature
$\Delta T = T_2 - T_1$

EXAMPLE

The temperature of 40kg mass of water is raised from 25^0c to 40^0c , find the heat of water if its specific heat capacity is 4200J/Kg^{0}c.

SOLUTION

M = 40kg
ΔT = 40℃ – 25℃ = 15℃
C = 4200J/kg^{0}c

$$C = \frac{Q}{M \times \Delta T}$$

$4200J/kg^0c = \frac{Q}{40Kg \times 15^0c}$

$5200J/Kg^0c = \frac{Q}{600Kg^0c}$

$Q = 4200J/Kg^0c \times 600Kg^0c$

$Q =$ **2520 000J**

SI UNIT OF SPECIFIC HEAT CAPACITY

Note that the SI unit of specific heat capacity is J/Kg^0c

EXAMPLE

The temperature of a 20 000g mass raised from 5^0c to 19^0c, If the heat energy change is 200J Find the specific heat capacity of the substance.

SOLUTION

M = 20 000g = 20kg

$\Delta T = 19^0C - 50C = 14^0C$

Q = 200J

$\therefore C = \frac{Q}{m \times \Delta T}$

$C = \frac{200\ J}{20\ kg \times 14℃}$

C = 0.714 J/kg℃

EXAMPLE

The specific heat capacity of 3kg of water is $4200J/kg^0c$ If the heat energy change is 500J. Find the change in temperature of water.

SOLUTION

M = 3kg

$C = 4200J/kg^0c$

Q = 500J

T = ?

$C = \frac{Q}{M \times \Delta T}$

$4200J/Kg^0c = \dfrac{500J}{3Kg \times \Delta T}$

$\dfrac{4200J/Kg\ ^0c}{1} = \dfrac{500J}{3kg \times \Delta T}$

$3Kg \times \Delta T \times 4200J/Kg\ ^0c = 1 \times 500J$
$3Kg \times \Delta T \times 4200J/Kg^0c = 500J$

$\Delta T = \dfrac{500J}{3\ kg\ 4200J/kg℃}$

$\Delta T = 0.039^0c$

CALCULATING HEAT ENERGY CONTENT GIVEN SPECIFIC HEAT CAPACITY, MASS AND TEMPERATURE CHANGE

EXMAPLE
The specific heat capacity of water is $4200J/Kg^0c$. If the temperature of 5Kg of water is raised from 25^0c to 50^0c. Find the heat energy content.

SOLUTION
$M = 5Kg$
$Q = ?$
$\Delta T = 50^0c - 25^0c$
$\Delta T = 25^0c$
$C = 4200J/Kg^0c$

$C = \dfrac{Q}{M \times \Delta T}$

$\dfrac{4200J/kg^0c}{1} = \dfrac{Q}{5Kg \times 25^0c}$

$Q = 4200J/Kg^0c \times 5\ kg \times 25Kg^0c$
$Q = 4200J/kg\ ^0c \times 125Kg^0c$
$Q = 4200J \times 125$

Q = 525 000J = 525 kilojoules

APPLICATION OF SPECIFIC HEAT CAPACITY IN EVERYDAY

The following are the application of specific heat capacity in everyday life.

- Specific heat capacity is applied in engine coolants.Water is used to cool engines because water has high specific heat capacity of $4200J/kg^0c$.
- Specific head capacity is also applied in car radiators. This is so because water needs a great deal of Energy to change its temperature.
- Specific heat capacity is applied in body cooling; water is used to cool the body because of its high specific heat capacity
- Cooking pots have less specific heat capacity hence they are used to cook food.
- Specific heat capacity is also applied in land and sea breezes.

DIFFERENCES BETTWEN HEAT CAPACITY AND SPECIFIC HEAT CAPACITY

- Heat capacity is the amount of heat energy needed toraise the temperature of substance by 1^0c while specific heat capacity is the amount of heat energy needed to raise the temperature of a 1kg mass by 1^0c.
- The SI unit of heat capacity is $J/^0c$ while specific heat capacity is J/Kg^0c

UNIT 10

HEAT TRANSFER

Heat is transferred in substances in many ways.There are various methods in which heat is transferred.

METHOD OF HEAT TRANFER

There are three methods of heat transfer

i. Conduction
ii. Convention
iii. Radiation

CONDUCTION

Conduction is the method of heat transfer in solids.In conduction; heat is transferred from particle to particles until the whole substance is heated up. As the particles move from place to place due to temperature differences they transfer heat from particle to particle when they collide with each other.

Convection

This is the method of heat transfer in fluids, that is, in liquids and gases.
As the water is heat at the bottom of the pot, its density decreases hence it rise up. The cold water on top sinks because it is high dense. As this movement happens the water molecules collide with one another there exchanging heat energy.This movement continues on and on until the whole water gets heated up.

RADIATION

Is the mode of heat transfer which does not require a medium.In radiation heat is transferred through a vacuum.A vacuum is an empty space without matter.Therefore in a vacuum there is no solid, liquid and gases.Heat energy from the sun passes through a vacuum space to reach the earth.This energy is transmitted through radiation.

HEAT ABSORBERS AND EMITTERS

The radiation of heat from place to place depends on the nature of surface.

There are two categories of surfaces on which heat radiates.

a. Black or dull surfaces
b. White or shining surfaces

BLACK OR DULL SURFACES

Black surface is a good absorber or emitter radiator of heat. When sunlight shines on a black surface heat is absorbed strongly and is also emitted strongly to the surroundings.

WHITE OF SHINNING SURFACES

A shinny surface is a poor absorber or radiator of heat. When sunlight shines on a whiteIt is reflected black, hence a white surface is a bad absorber or emitter of heat.

When the front part of the wire is heated, the particles gain energy and hence they vibrate vigorously. In so doing they transfer heat from particles to particle until the whole particles becomes hot. This method of heat transfer is called conduction.

TYPES OF CODNDUCTORS

There are two types of conductors namely.

- Good conductors of heat
- Bad conductors of heat

GOOD CONDUCTORS

- A good conductors is a material that transfer heat easily.
- Example of good conductor are metals like copper Aluminium, Iron
- Good conductors of heat are also called pure conductors of heat.

BAD CONDUCTORS OF HEAT

Is a material that conducts heat poorly.

- Examples of bad conductors or poor conductors are
    i. Water
    ii. Air
    iii. Wood
    iv. Plastics
    v. Paper
    vi. Glass
    vii. Cloth
- Note that bad conductors of heat are also called poor conductors of heat.
- Bad conductors of heat can also be called improve conductors of heat
- Bad conductors of heat are generally known as insulators.

RATE OF CODNUCTION IN DIFFERENT METALS

- Note that different metals conduct heat at different rates.
- Silver metals has the highest conduction rate followed by copper metals
- Iron has the least conduction rate.
- Different metals have different conduction because they differ interms of the particles in their lattice structure.

HEAT TRANSFER IN LIQUID AND GASES

Note that both liquids and gases are known as fluids.

Generally fluids are substances which flow.
Convection is eth method of heat transfer in fluids.

MECHANISM OF CONVECTION

Convention takes place when the particles in a fluid move and collide with each other due to the temperature differences within the fluid.

THE EFFECTS OF WARING DARK COLOURED CLOTHES

In a cold day, heat radiates from your body and the dark cloth absorbs this heat thereby making you feel warm/hot.
In a sunny day, the dark coloured cloth absorbs heat thereby making the person feel an abnormal heat.
Therefore it is advised that in a sunny day you should not wear dark coloured clothes.

THE EFFECTS OF WEARING WHITE COLOURED CLOTHES

In a sunny day, white coloured clothes reflect sunlight energy thereby making a person feels less heat from the sun.

THE EFFECT OF PAINTING WALLS WHITE

Walls are painted white in order to reflect sunlight thereby protecting the walls from cracking due to heating.

A THERMAL FLASKS

A vacuum flask is used to keep hot liquids hot and cold liquids cold.

FUCNTIONS OF THE PARTS OF THE THERMOS FLASK

THE STOPPER OR CORK

The tight stopper prevents the air from entering or leaving the flask, thereby preventing heat energy loss b

THE VACUUM SPACE

The vacuum is an empty space without matter.
The vacuum space prevents heat loss by conduction.

DOUBLE SILVERED GLASS WALLS
The reflective double silvered glass walls prevent heat loss by radiation.
Furthermore, the thermos flask will heat slowly by the stopper or cork
The stopper loses heat by conduction.

THE COOLER BOX
A cooler box is an insulated box that is used to keep food or drinks cool.
The inside of the cooler box is made from foam or plastic lining
This plastic lining insulates the cooler box by preventing heat movement through it.
The lid prevents the circulation of air in and out thereby preventing heat transfer by convection.

HOW A GRASS THATCHED HOUSE FUNCTION
A grass thatched house keeps the inside of the house cool by insulation.
The grass on the roof acts as an insulator then preventing heat transfer from the sun by conduction.

USES OF ALUMINIUM FOIL
The following are the uses of alluminium foil.

- It is used for food storage and to wrap foods which provides insulation
- It is also used in cookers which prevents heat loss by radiation.

UNIT 11

PROERTIES OF MATTER

THERMAL EXPANSION OF MATTER

When matter is heated it expands, when matter is cooled it contracts.

Expansion is the increase in volume of a substance

Contraction is the decrease in volume of a substance.

EXPANSION OF SOLIDS

When a solid is heated it expands this means that the volume of a solid is increased.

WHY DO SOLIDS EXPAND WHEN HEATED

When a solid is heated its particles gain kinetic energy and vibrate vigorously. This weakens the attraction forces thereby making these particles move further away from one another occupying a large space.

RATES OF EXPANSION IN SOLIDS

Note that different solids expand at different rates.In simple terms, different solids expand by different amounts.
When different solids, are heated equally they expand at different rates.

WHY DIFFERENT SOLIDS EXPAND AT DIFFERENT RATES

Different solids expand at different rates because different solids have different forces between their molecules.Solids with weaker forces of attraction will expand by a larger amount while solids with stronger forces of attraction will expand by a smaller amount.

RATES OF EXPANSION IN LIQUIDS

Different liquids expand at different rates.This means that when two different liquids are heated equally, they will expand by different amounts.

WHY DIFFERENT LIQUIDS EXPAND AT DIFFERENT RATES

Different liquids expand at different rates because they differ in the strength of intermolecular forces.A liquid with strong forces of attraction will expand by a small amount.A liquid with weak forces of attraction will expand by a larger amount.

RATES OF EXPANSION IN GASES

All gases expand when heated. Different gases expand at the same rate when heated equally.

WHY DIFFERENT GASES EXPAND AT THE SAME RATE WHEN HEATED EQUALLY

Different gases expand at the same rate when heated equally because in all gases, the strength of intermolecular forces is Negligible (almost zero).In simple terms, all gases will expand by the same amount because the particles in gases are very far apart from one another hence the strength of intermolecular forces are almost zero.

Note the following:

i. Gases expand more than solids and liquids because the strength of intermolecular forces in gases is negligible.

ii. Liquid expand more than solid because the particles in liquid are fairly apart hence the forces of attraction are weaker than in solids.

iii. Solids expand by the least amount because their particles are tightly packed thereby making the intermolecular forces to be very strong requiring a great deal of energy to separate.

THE ANOMALOUS EXPANSION OF WATER

The anomalous expansion of water means the abnormal behavior of water at a certain temperatures.In simple terms, the anomalous expansion of water is an abnormal, property of water whereby it expands Instead of contracting when the temperature goes from 4^0c to 0^0c and it becomes less dense.

THE ANOMALOUS EXPANDION OF WATER AND DENSITY

Between 4^0c and 0^0c water expands hence its volume increases. This means that when water expands its density decreases.
Therefore, when water expands it becomes less dense due to increase in volume.
This is why ice floats on water since ice is less dense than water.

APPLICATION OF EXPANSION OF SOLIDS LIQUIDS AND GASES

i) Expansion and contraction is used to fit metals into other metals by shrink fitting.

ii) Expansion and contraction is used in bimetallic strips which controls the circuit in electric components.
iii) Expansion and contraction is used in thermometers. Alcohol expands and contracts in thermometers.
iv) Expansion and contraction is also used to open bottle tops that are tightly covered.

EFFECTS OF SUDDEN EXPANSION OF SOLIDS LIQUID AND GASES

Expansions of solids lead to the formation of cracks in walls and railway lines.Sudden expansion leads to the cracking stones in the hills. Expansion of water may lead to the breaking of the bottle.

UNIT 12

POWER AND MACHINES

Power is defined as the rate at which work is done.

Mathematically:

$$\text{Power} = \frac{\text{work done in joule}}{\text{Time taken in seconds}}$$

In simple terms

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$$

Note that work done is the energy transferred in joules

Therefore:

$$\text{Power} = \frac{\text{Energy transferred}}{\text{Time taken}}$$

In simple terms, power can also be defined as the energy transferred per unit time.

THE SI UNIT OF POWER

The SI unit ofpower is the joules/second symbolized as J/S. Note that the J/S is commonly known as the Watt symbolized by a capital letter W

Generally:

1 J/S = 1W

100J/S = 100W

1000J/S = 1000W

1000W = 1KW

CALCULATING POWER GIVEN RELEVANT INFORMATION

EXAMPLE 1

Tiyanjane used 600Jof Energy to lift a load in 10 seconds. Calculate the power she used.

Working

Energy transferred = 600J

Time taken = 10 seconds

$$\text{Power} = \frac{\text{Energy transferred}}{\text{Time take}}$$

Power = 600J

Timetaken = 10s

Power = 600J/S or 60W

EXAMPLE II
A man applied 200N to move load a distance of 2m in 40 seconds

i) Find the work done
ii) Find the power

Solution 1

Work done = Force x distance

Work done = 200N x 2m = 400Nm

Work done = 400J

Solution 2

Power = $\frac{\text{Energy transferred}}{\text{Time taken}}$

Power = $\frac{400J}{40\ s}$

Power = 100J/S

EXAMPL III
Mary lifted a 50Kg bag of cement 3m high in 3 minutes

i) Find the work done

Working

Work done = force x distance

Force = 50 x 10N

= 500N

Work done = Force x distance

= 500N x 3m

= 1500NM or 1500J

ii) Find the power

Power = $\frac{\text{work done}}{\text{Time taken}}$

Work done = 1500J

Time taken = 60 x 3 minutes
= 180s

Power = $\frac{1500J}{180s}$

Power = 8.33J/S

MACHINES

A machine is a device that makes the work to be done more easily and fast.
A machine changes the size and the direction of force.

EXAMPLES OF MACHINES

a. Wheel barrow
b. A nail cutter
c. A pair of scissors

ADAVANTAGES OF USING MACHINES

i. A machine enables the work to be done more faster
ii. It changes the magnitude and direction of the forces applied
iii. It enables the work to be more efficiently

GROUPS OF MACHINES

Machine are grouped into three categories

a. Inclined planes
b. Pulleys
c. Levels

INCLINED PLANES

An inclined plane is a flat slanted surface that is used to move heavy loads along it.

MECHANICAL ADVANTAGE

Note that

$$\text{Mechanical Advantage} = \frac{\text{Load (N)}}{\text{Effort (N)}}$$

EXAMPLE

A man lifted a 50Kg block with a force of 2N. Find the mechanical Advantage.

Working

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

Load = 50Kg

If 1Kg = 10N

50Kg = More

$\frac{50Kg \times 10N}{1Kg}$

=500N

Effort =25N

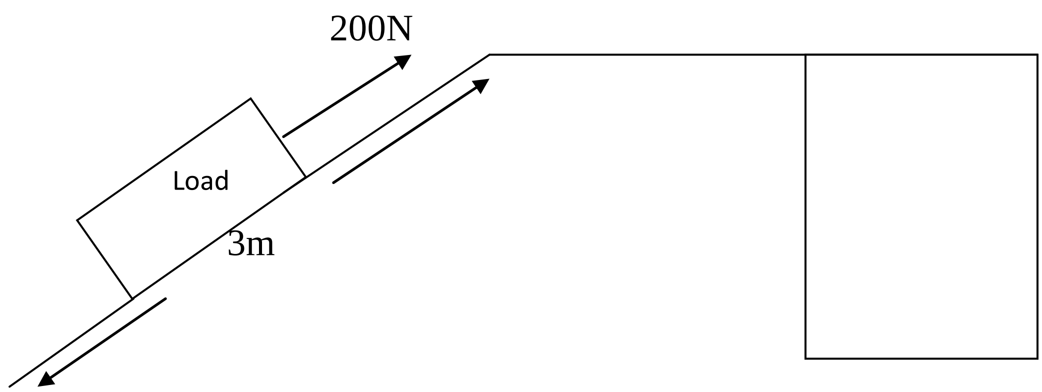
Mechanical Advantage = $\frac{500N}{25N}$

Mechanical Advantage = 20

Note that Mechanical Advantage has no units. This shows the machine has multiplied the force 20 times.

EXAMPLES

Study the inclined plane below.



If the mechanical advantage of the inclined plane is 50.

A. Calculate the work done

SOLUTION

Work done = force x Distance

Work done = 200N x 3M

= 600NM or

= 600J

B. Calculate the value of the load

SOLUTION

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

$$\frac{50}{1} = \frac{\text{Load}}{200N}$$

Load = 50 x 200N

Load = 10 000N

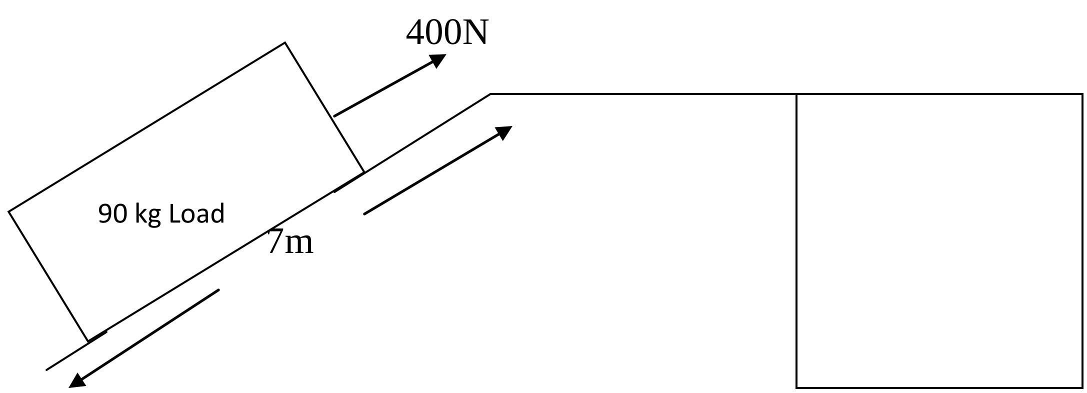
WAYS OF INCREASING THE MECHANICAL ADVANTAGE OF AN INCLINED PLANE

The following are the ways of increasing mechanical advantage of an inclined plane.

a. By using a smooth and long inclined plane
b. By using Rollers.

EXAMPLE

Study the inclined plane below



a. Calculate the energy given to the box by dragging

Working

Energy given to the box by dragging = work down by inclined plane

Work done = Force x Distance

Work done = 400N x 7m

Work done = 2800NM

Work done = 2800J

Energy given to the box by dragging

= 2800J

b. Calculate the energy gained by the box by lifting it vertically.

Working

Energy given to the box by lifting it vertically = Potential energy gained

Potential energy = weight of the box**x** vertical distance

P.E = (90 x 10N) x 3m

P.E = 900N x 3m

P.E = 2700NM

P.E = 2700J

c. Find the Energy lost

Working

Energy lost = work done against friction

Energy cost = 2800J = 2700J

Energy lost = 100J

d. What causes this lost of energy?
It is the Friction that causes this loss of energy

e. Where does this wasted Energy go?
It is converted to heat and sound energy

PULLEY SYSTEMS

Pulleys are wheels with a groove in their rims. A rope is put around the groove.

A pulley is a machine because it reduces the effort applied and changes the direction of force.

TYPES OF PULLEY SYSTEMS

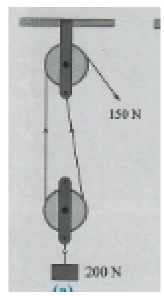
There are two types of pulley system

i). Fixed pulley

ii). Movable pulley

A movable pulley can move up and down while fixed pulley cannot move up and down.

A diagram showing how a fixed and movable pulleys look like.

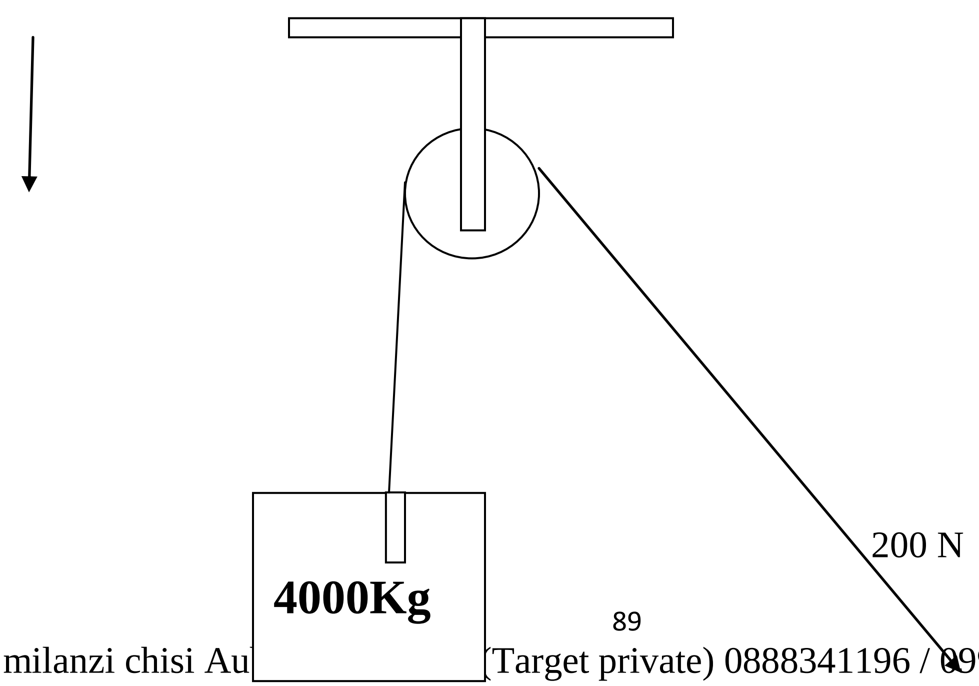


CALCULATING THE MECAHNICAL ADVANTAGE OF A PULLEY SYSTE,

The mechanical advantage of pulley system is found in the following ways

a. By dividing $\frac{\text{Load}}{\text{Effort}}$
b. By counting the number of sections supporting the load.

EXAMPLE

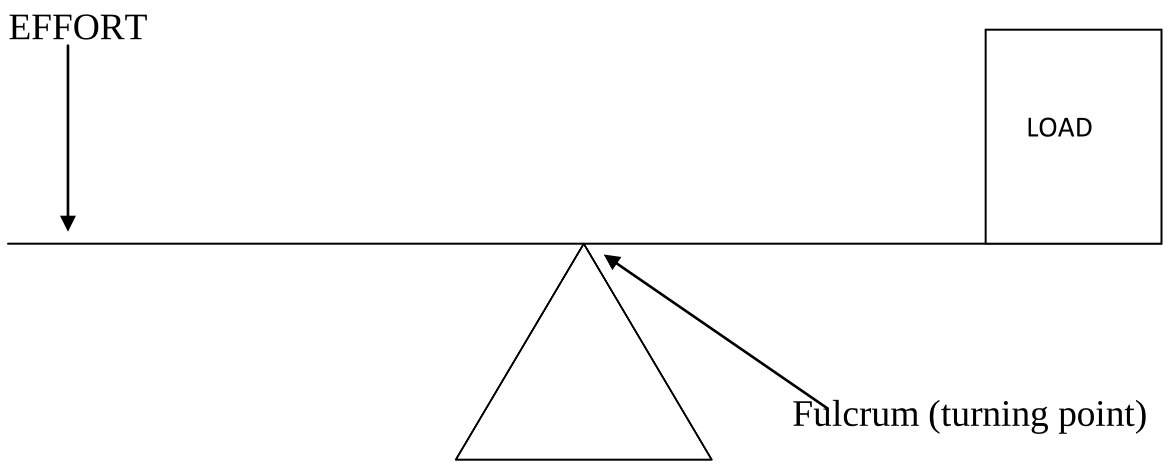


WAYS OF INCREASING THE MECHANICAL ADVANTAGE OF A PULLEY SYSTEM.

i). By increasing the number of pulleys
ii). By increasing the number of ropes supporting the load.
iii). By greasing the moving parts of the wheels which reduces frictional forces

LEVERS

A Lever is a machine that a turns about a fixed point
The turning point of a lever is called a fulcrum or a pivot
The following is a diagram of a lever



EXAMPLES OF LEVERS

a. A bottle opener
b. A see – saw
c. A pair of scissors
d. A wheel barrow
e. A plier
f. An Arm
g. A claw hammer

ORDER OF LEVERS

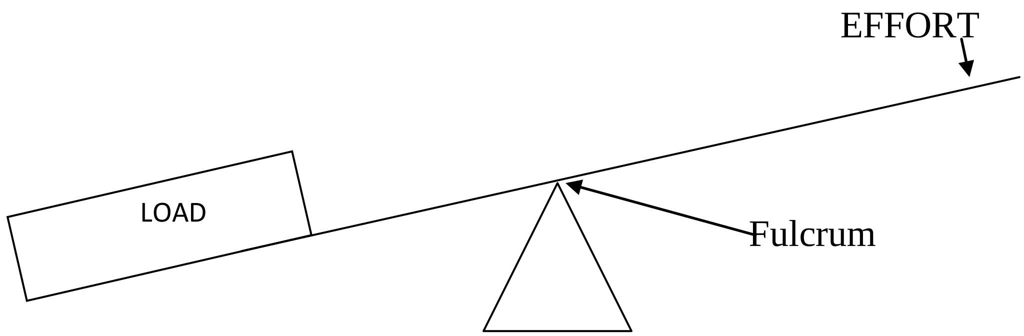
Levers are classified into three orders:

i) First order lever
ii) Second order lever

iii) Third order lever

FIRST ORDER LEVERS

In the first order of lever the fulcrum is in between the load and the effort.The following is the arrangement of the first order of levers



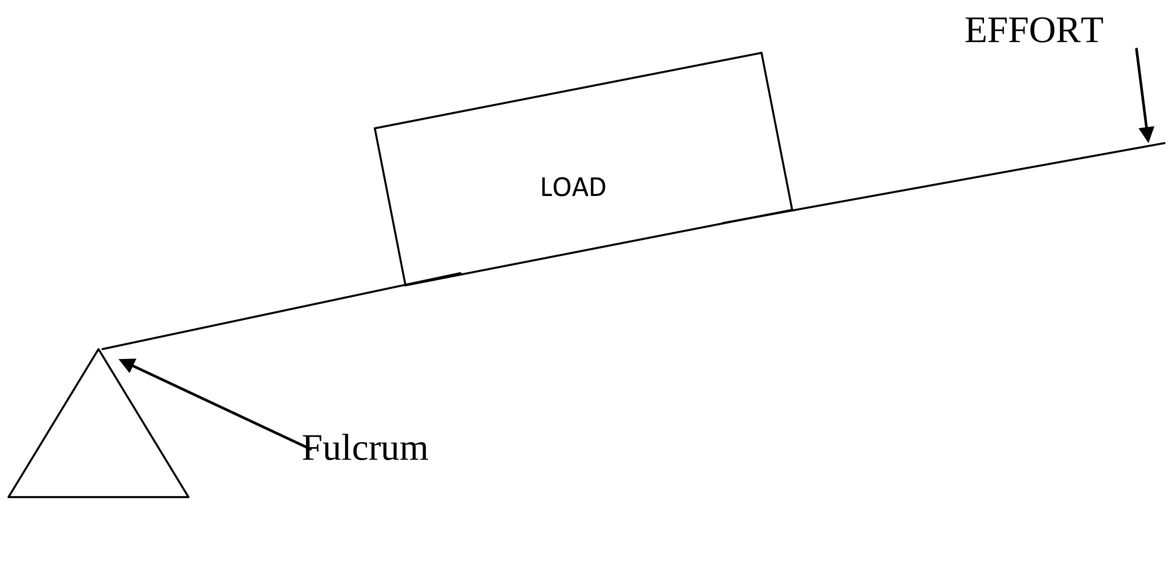
EXAMPLES OF FIRST ORDER

LEVER

i) A plier
ii) Scissor
iii) A craw bar

SECOND ORDER LEVERS

In second order levers, the load is in between the fulcrum and the effort.The following is the arrangement of eth second order class of Levers

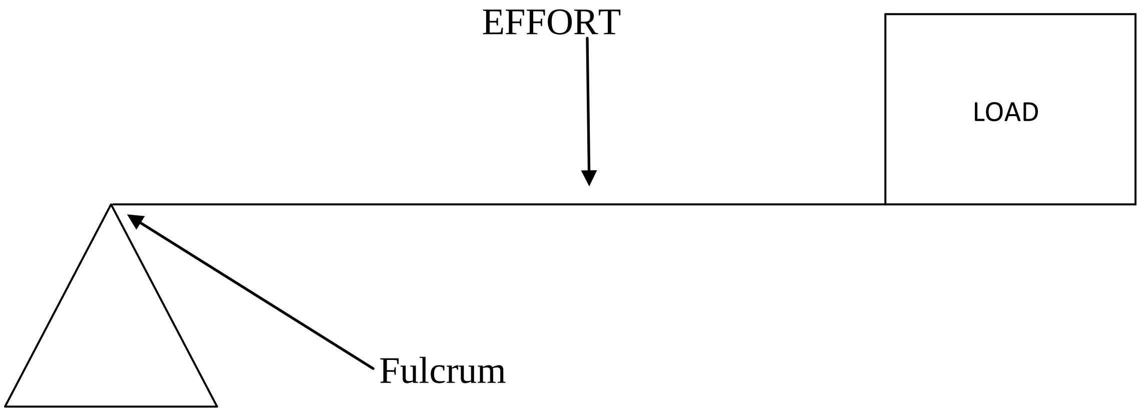


EXAMPLES OF SECOND ORDER LEVERS

a. A wheel barrow
b. A bottle opener

THIRD ORDER LEVERS

In the third order of lever, the effort is in between the fulcrum and the load.The following is eth arrangement of the third order lever.



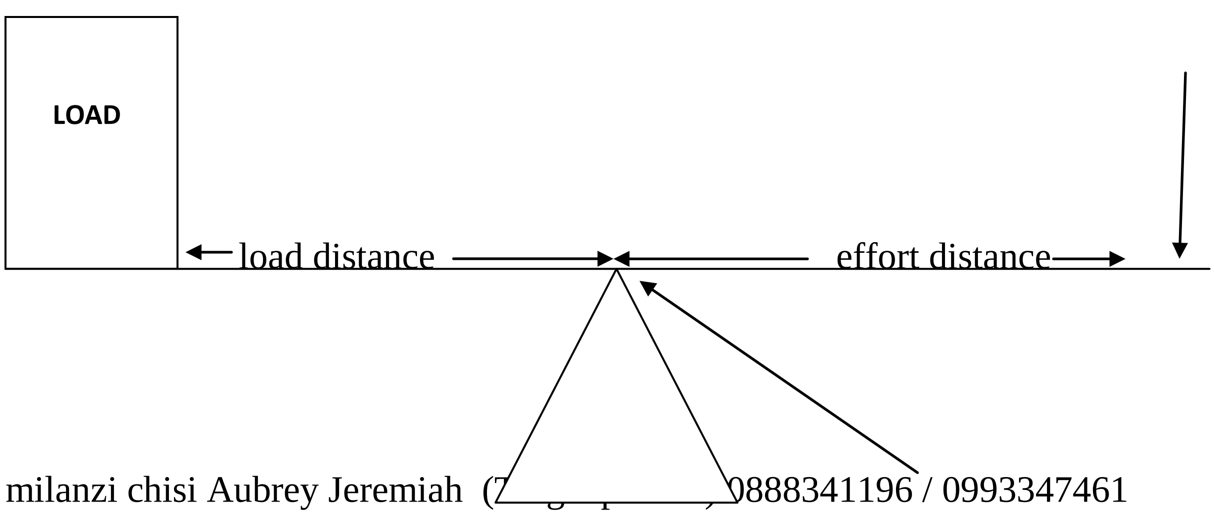
EXAMPLES OF THE THIRD ORDER

LEVERS

a). The Arm

THE PRINCIPLES OF MOMENTS IN LEVERS

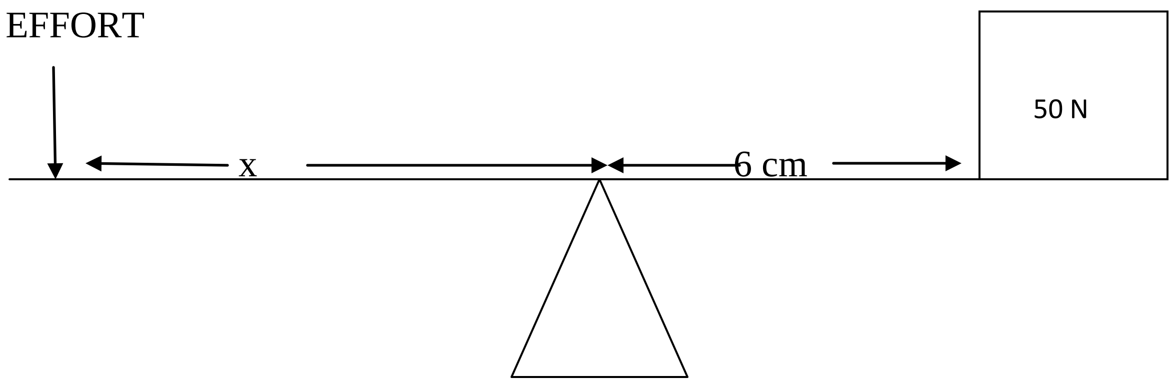
Consider the following diagram



The principle of moments in levers states that the product of load times load distance is equal to the product of effort times effort distance.

In simple terms; Load x Load distance = Effort x Effort distance

EXAMPLE



Find the value of x

Working

Load = 50N

Load distance = 6cm

Effort = 20N

Effort distance = X

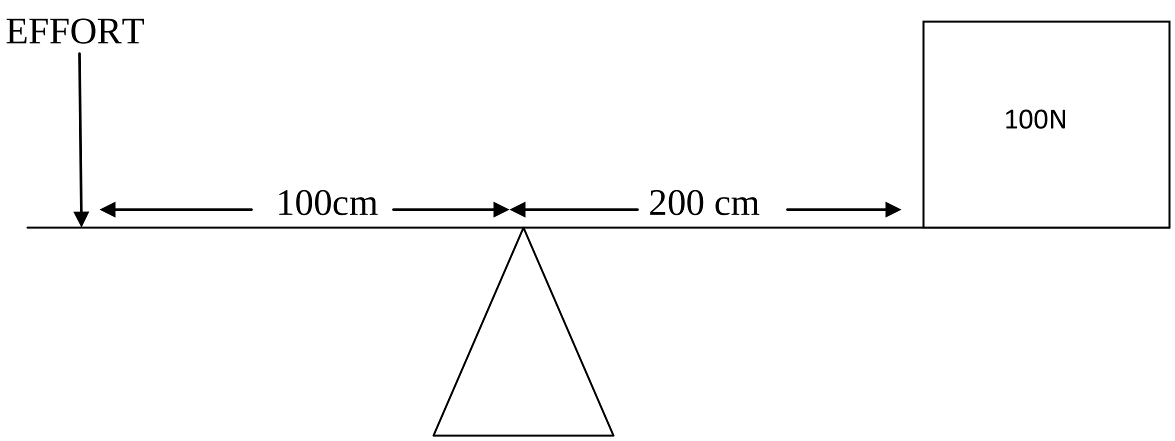
Load x Load distance = Effort x Effort distance

$$\frac{50N \times 6cm}{20N} = \frac{20N \times X}{20N}$$

15cm = X

Effort distance, X = 15cm

Example 2
Study the diagram below



Find the value of the effort
Working
Load = 100N

Load Distance = 20cm

Effort = F

Effort distance = 10cm

Load X load distance = Effort x Effort distance

100N x 20cm = F x 10cm

$\frac{20000cm/N}{10cm} = \frac{F \times 10cm}{10cm}$

2000N = F

Effort, F = 2000N

OR

Load x Load distance = Effort x Effort distance

100N x 20cm = F x 10cm

$\frac{100N \times 20cm}{10cm} = \frac{F \times 10cm}{10cm}$

200 N = F

Effort F = 200N

WAYS OF REDUCING THE EFFORT IN LEVERS

a. By reducing the load distance
This means that the effort can be reduced by putting the load closer to the fulcrum.

b. By increasing theeffort distance.
This means that the effort can be reduced by applying the effort at a longer distance from the fulcrum.

WAYS OF FINDING THE MECHANICAL ADVANTAGE IN LEVERS

a. By dividing load over effort that is $M.A = \frac{\text{Load}}{\text{Effort}}$

b. By dividing load distance over effort distance.
That is $M.A = \frac{\text{Effort distance}}{\text{Load distance}}$

APPLICATIONS OF MOVEMENTS OF LEVERS IN EVERYDAY LIFE

a. Levers are used to open bottle tops and lids e.g. bottle openers and lid openers.
b. They are used for playing games and comparing the weights of different objects e.g. see-saw and balances.
c. They are used as Hinges that are used to open doors and windows.
d. Levers are used as spanners for tightening Nuts and bolts.
e. They are used for cutting e.g. pair of scissors and Garden shears

UNIT 13

ELECTROSTATICS

Electrostatic is the branch of electricity that deals with charges at rest.
Electrostatics deals with stationary charges, that is, charges that do not move.
Electrostatics is also known as static electricity.

THE STRUCTURE OF AN ATOM

An atom is the smallest particles of an element that forms the building block of all matter.

An atom is composed of the following:

- protons
- Electrons
- neutrons
- Nucleus
- Shells

PROTONS
The protons are positively charged and live inside the nucleus of an atom.
ELECTRONS
The electrons are negatively charged and live outside the nucleus in the shell of an atom.
NEUTRONS
Neutrons have zero charge and live inside the nucleus of an atom.
In any neutral atom, the number of protons is equal to the number of electrons.
Therefore, a neutral atom has an overall charge of zero.

TYPES OF CHARGES

There are two main types of charges
These are:

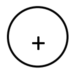
i. Positive charge
ii. Negative charge

THE POSITIVE CHARGE

A positive charge is a static charge that occurs when an object has lost electrons. This is achieved when the electrons are transferred to other bodies thereby leaving a deficit of electrons.

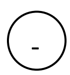
The symbol for a positive charge is a plus sign +

The positive charge is depicted as follows.

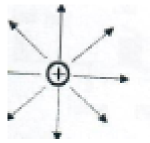


NEGATIVE CHARGE
A negative charge is a charge that achieved when a body has gained electrons.
A body is negatively charged when it has a surplus of electrons.
The symbol for a negative charge is a negative sign

The negative charge is depicted as follows:-

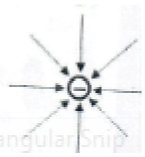


THE SI UNIT OF CHARGE
The SI unit of the charge is the coulomb symbolized by a capital letter C.
Sometimes the coulomb is symbolized by a capital letter Q
THE ELECTRIC FIELD OF A POINT CHARGE
Electric field is a region around a charged object where other objects can experience a force.This force may be an attractive force or a repulsive force.
The electric field is illustrated using straight lines with arrows
ELECTRIC FIELD OF A POSITIVE CHARGE
For a positive charge, the arrows are directed away from the source as shown below.



ELECTRIC FIELD FOR A NEGATIVE CHARGE

For a negative charge the arrows are directed towards the point source as shown below:



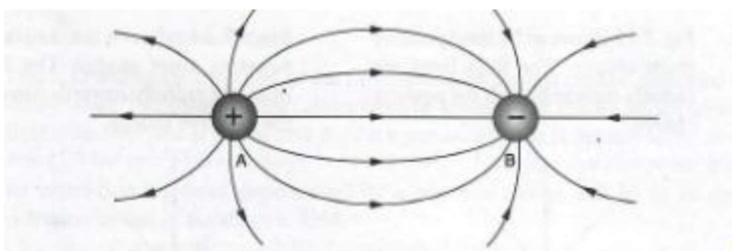
THE LAW OF CHARGES

The law of charges states that like charges repel each other while unlike charges attract each other. When like charges or same charges are brought closer to each other,they exert a repulsive or pushing force on each other.

For example, when two positive charges are meeting they repel each other.

When two negative charges are meeting they repel each other

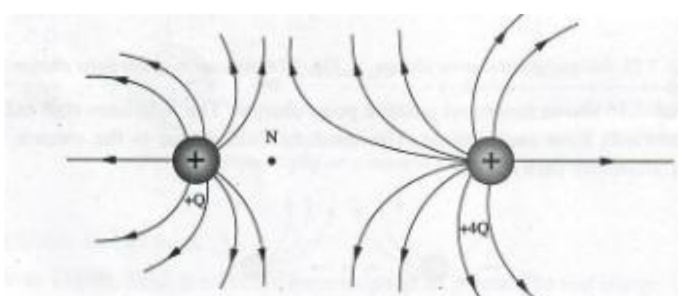
The diagram below shows the interaction of a positive and a negative charge



MEETING OF TWO NEGATIVE CHARGES

When two negative charges are interacting they repel each other since they are same type of charges

The diagram below shows the repulsion of two positive charges interacting



MEETING OF A POSITIVE AND A NEGATIVE CHARGE

When a positive meets a negative charge, they attract each other because they are unlike charges.

ELECTROSTATIC CHARGING

This is a method of making neutral objects to become charged.

METHODS OF ELECTROSTATIC CHARGING

There are three methods of electrostatic charging:

i. Charging by friction
ii. Charging by induction
iii. Charging by contact

CHARGING BY FRICTION

Charging by friction is also known as charging by rubbing.Charging by friction involves rubbing two neutral objects against one another. As a result one object loses electrons while the other object gains electrons.

The object that has lost electrons becomes positive charged while the object that gained electrons becomes negatively charged.

CHARGING BY CONTACT

Charging by contact is also simply known as charging by touching.

Charging by touching or contact touching a charged object with a neutral object. When this is done some of the charges from a charged object are transferred to a neutral object thereby making a neutral object to become charged.

Note that the neutral object attains the same charge as the charged object.

CHARGING BY INDUCTION

Charging by induction involves bringing a charged object closer to a neutral object but not touching them.

Charging by induction uses repulsion of like the charges and attraction of unlike charges.When negative charged object is brought closer to a neutral object, the electrons in the neutral object are repelled from the negatively charged object as a result; the neutral object becomes positively charged on one side and negatively charged on the other side.

ELECTRICAL CONDUCTORS AND INSULATORS

Electrical conductors are materials that allow electrons to pass through them. These are good conductors of heat electricity.

Most metals are examples of conductors because they have free electrons that carry electrical charge.

A metal cannot be charged by friction method or rubbing because the electrons are easily conducted away as they like charges will repel each other and spread out over the whole metal.

INSULATORS

These are materials that do not allow the electrons to pass through them.
Insulators are called poor conductors or non-conductors.

EXAMPLES OF INSULATORS

i. Rubber
ii. Plastics
iii. Glass
iv. Wood
v. Wool

An insulator is easily charged by friction method rubbing because once an insulator is charged the charge concentrate on the same area of the object. It is not spread over a larger area.

THE EFFECTS OF DISTANCE BETWEEN INTERACTING CHARGES ON THE ELECTROSTATIC FORCE

The electrostatic force between two interacting charges depends on the adjacent distances between the charges.
When the distance between interacting charges increases, the electrostatic force decreases.
When the distance between interacting charges decreases, the electrostatic force increases.
In simple terms, the longer the distance between interacting charges the less the electrostatic force. The shorter the distance between interacting charges the stronger the electrostatic force produced.

THE EFFECT OF MAGNITUDE OF CHARGES ON THE ELECTROSTATIC FORCE

The electrostatic force produced depends on the magnitude or size of the interacting charges.
When the sizes or magnitudes charges increase, the electrostatic force increases.
When the sizes or magnitudes of charge decrease, the electrostatic force decreases.
In simple terms, the greater the size or magnitudes of interacting charges the stronger the electrostatic force produced.
The smaller the sizes or magnitudes of interacting charges, the less is the electrostatic force that will be produced.

APPLICATIONS OF ELECTROSTATICSIN EVERY LIFE.

The following are the application of electrostatics.

a. **Used in air purification**
   Induction is used in buildings to purify air by taking the particles out of the air we breathe by the method of electrostatics.
b. **Used in paint spraying.**
   In paint sprayers electrostatic charging is used to spread the paint particles hence ensuring an even coat of paint.
c. **Used in photo copier & printers**
   For the image to be formed a paper, there is need for electrostatic attraction.
d. **Used in insecticide sprayers**
   Insecticide sprays uses static electricity by giving the spray a charge that is attracted to the earth.
e. **Used in Defibrillators**
   A defibrillator is a machine that is used to restart the heart if it stops. This machine uses the principles of electrostatics to restart the heart.

DANGERS OF ELECTROSTATICS

The following are the dangers of electrostatics

i. It leads to the formation of lightening that can kill people and cause fire in building
ii. It leads to the formation of sparks that ignite fuel when the air craft cars are being refueled.
iii. Electrostatics can electrocute people when they touch charge objects.

FORMATION OF LIGHTENING

Lightening is an extremely large spark of charge that jumps through the air.
Static electricity is produced by air molecules which rub against the water droplets.
The clouds become charged. Some attain both charges at once while some attain single charge.
The top of the clouds become positively charged while the bottom of the clouds becomes negatively charged.
The earth becomes positively charged by induction.Thejumping of charges from the earth to the clouds due to induction forms lightening.

EARTHING

Earthing is a method of discharging an object. Most houses are fitted with a metal rod called a lightening conductor that goes to the ground so that in event of lightening; the charges are conducted away to the earth preventing the building from damage

UNIT 14

LIGHT

RECTILINEAR PROPAGATION OF LIGHT AND IMAGE FORMATION

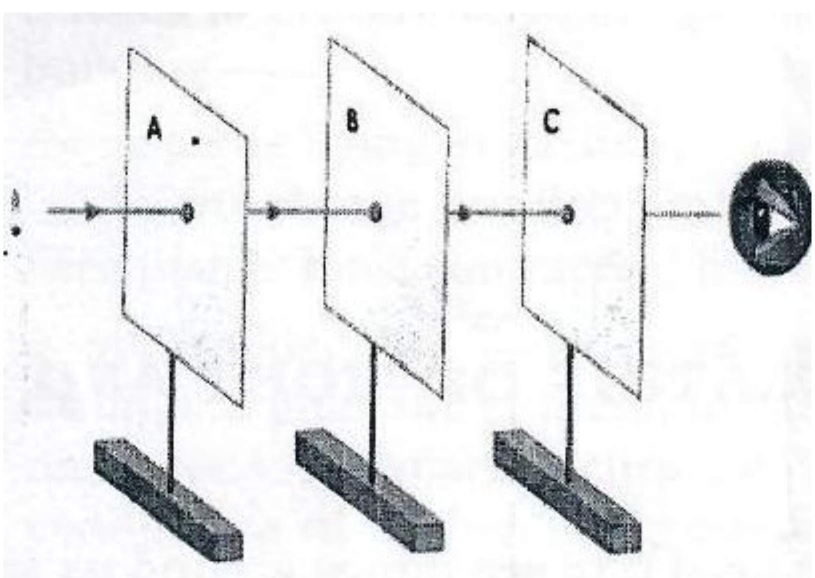
Light is very important in our daily lives. We need it to see things around us and crops wouldn't grow without light. And without crops, animals and human beings would be nothing. Therefore without light, there could be no life on Earth.

SOURCES OF LIGHT

A. Luminous source
   These are the objects that produce their own light. Examples are: sun; stars, a light candle, a light bulb, fire, etc.
B. Non-luminous source
   These are objects that do not produce their own light, But just reflect light from luminous source. Examples are: moon, a plate, a spoon, and so on.

THE RECTILINEAR PROPAGATION OF LIGHT

In a homogenous (the same) transparent medium, light travels in a straight line and this is called rectilinear propagation of light. This is shown in the figure below.



THE FORMATION OF SHADOW

In the universe there are three types of material. Namely; transparent, translucent and opaque materials.

Transparent materials allow light to pass through them (you can see through them). Examples are air, clear glass, etc

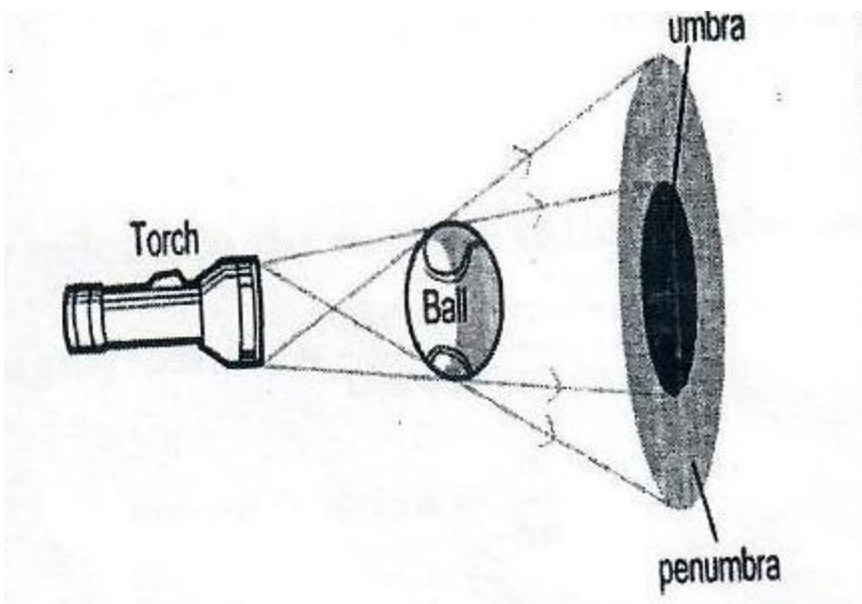
Translucent materials are those that partially allow light to pass through them (you can partially see through them). Examples are frosted glass, clear plastic, etc.

Opaque materials do not allow light to pass through them. Examples are our body, wood, wall or classroom, etc.

When an opaque object is placed in the path of rays(beams) of light, it blocks the passage of light. This results into the formation of a shadow of the object on the side where there is not light.

UMBRA AND PENUMBRA

A shadow can have two parts. One region can be completely dark and is called umbra region. While the other region may be partially dark and is called penumbra region. These are illustrated in the figure below.

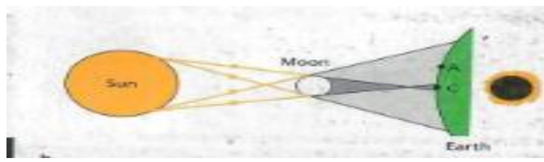


ECLIPSES

An eclipses is a phenomenon where shadow of the moon is cast on the earth or a shadow of the earth is cast on the moon.

There are two types of eclipses. These are:

1. **Eclipse of the sun (solar eclipse)**
   This occurs when the moon is between the sun and the earth, thus the shadow of the moon is cast on the earth. It occurs during the day.
   Figure below shows the eclipse of the sun.



2. **Eclipse of the moon (lunar eclipse**
   The eclipse occurs when the earth is between the sun and the moon, thus the shadow of the earth is cast on the moon. This eclipse occurs at night.

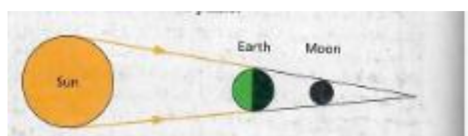


Figure 63.7 Eclipse of the Moon

THE PINHOLE CAMERA

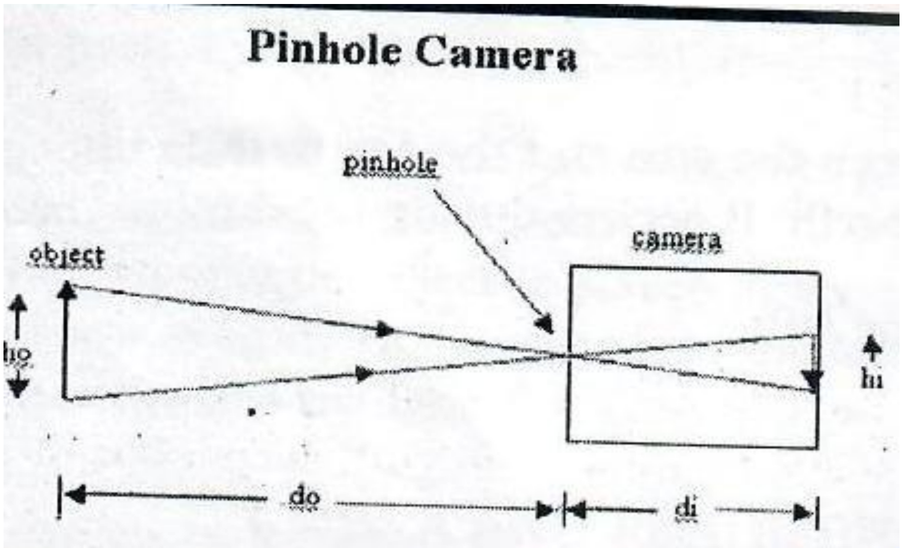
A pinhole camera is a small box with the tiny hole (pinhole) in from and the screen at the back. It is an instrument that can be used to observe light travelling in a straight line. Figure below shows a pinhole camera.

Parts of a pinhole camera

Object : this is the real things from where the image is formed.

Pinhole: this allows small amount of light from the object to pass through

milanzi chisi Aubrey Jeremiah (Target private) 0888341196 / 0993347461



Screen : This is where the image is formed.

Rays : these show how an image is formed on the screen.

Image: This is the picture of a real thing (object) which is formed on the screen

The image which is formed had the following characteristics.

a. It is real because it is formed on the screen by the real rays of light travelling from the object.
b. It is inverted (upside down) because it points to the opposite direction of the object

REFLECTION OF LIGHT

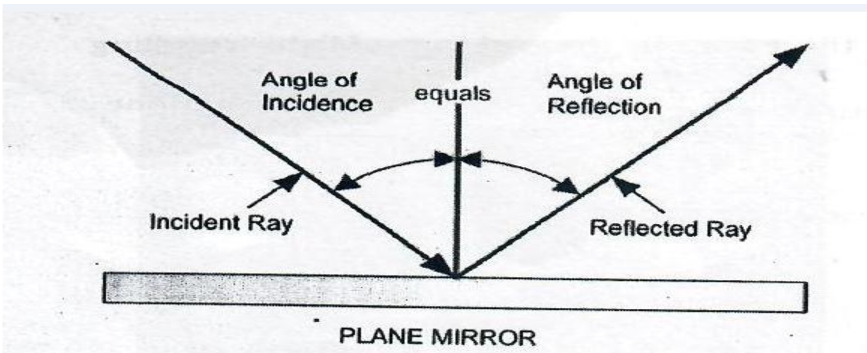
Reflection of light is the bouncing back of light.

The incoming ray that strikes the mirror is called **incident ray.**

They ray that moves from the mirror surface is called **reflected ray**.

The most interesting characteristic of the incident and reflection ray is their angles in relation to the reflecting surface. These angles are measured with respect to the **normal** of the surface.

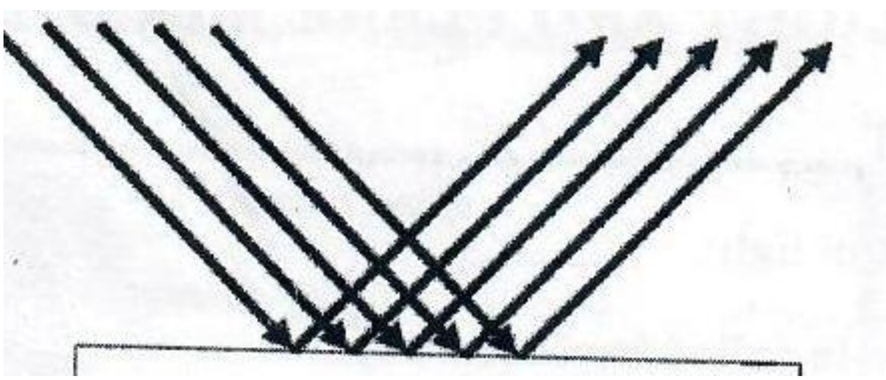
The normal is an imaginary line that is perpendicular to the surface at the point of incident (denoted by 0). This is shown in the figure below.



TYPES OF REFLECTION OF LIGHT

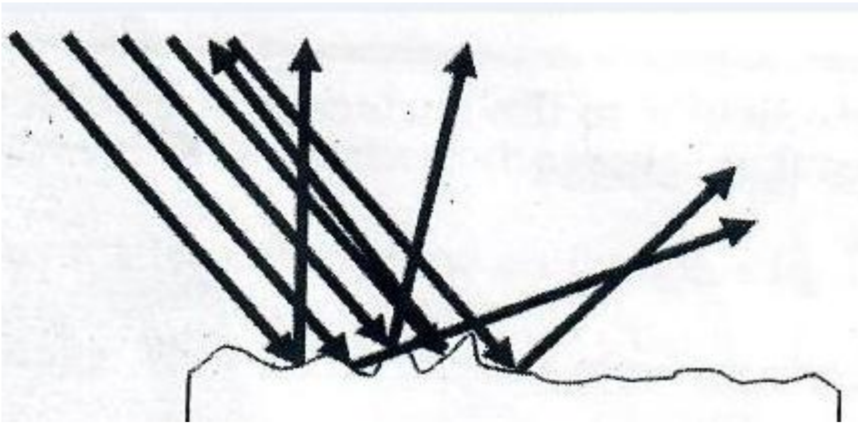
SPECULAR REFLECTION

In this type of reflection, the reflected rays are parallel to each other as shown below



DIFFUSE REFLECTION

In diffuse reflection, light is reflected in random direction. Diffuse reflection is produced by rough surfaces as shown below



THE LAWS OF REFLECTION OF LIGHT

The laws of reflection states that

a. The angle of incidence is equal to the angle of reflection.
b. The incident ray, the reflected ray and the normal all lie in the same plane.

PLANE MIRROWS AND IMAGE FORMATION

The property of light to reflect on surface enables us to see images of ourselves when we look into the mirror.

When light rays from an object strike the mirror, they are reflected away from the mirror while obeying the law of reflection. When the reflected light rays enter your eyes, you perceive the rays as if they come from behind themirror. As a result you view the image of the object as it is behind the mirror.

Characteristics of an image formed by plane mirror

An image formed by plane mirror has the following characteristics.

- It is upright
- It is the size as the objet
- The image is far behind the mirror as the object front of it
- It is reversed
- It is virtual (it is formed by imaginary light rays

MIRRORS ARRANGED AT AN ANGLE

When two mirrors are held parallel to each other, there is endless multiple reflections. Light rays from the object are reflected by one mirror and are project to the other mirror.

The second mirror reflects the light rays and projects them back to the first mirror. This process continues and leads to an infinite number of images being observed.

When the mirrors are held at an angle, say

60^0, multiple reflections occur but eventually cease, leading to a finite number of images being formed.

The number of images formed is given by the following formula:

Where θ is the angle between the mirrors.

APPLICATION OF REFLECTIONIN OUR DAILY LIVES

a. Reflection of light helps us to see our images in the mirror.
b. Periscopes use the property of reflection
c. Laser is essentially reflected light
d. Reflectors such as the type of bicycles, warning signs, etc. use the reflection of light.
e. We can see the moon because of reflection of light.

THE PERISCOPE

A periscope is a device that is used to see over the top of all objects, such as fences or walls and also to see around corners. A periscope uses the property of reflection of light.

Basically a periscope is just a long tube with a mirror at each end. The mirrors are fitted into each end of the tube at an angle of exactly 45^0, so that they face each other.

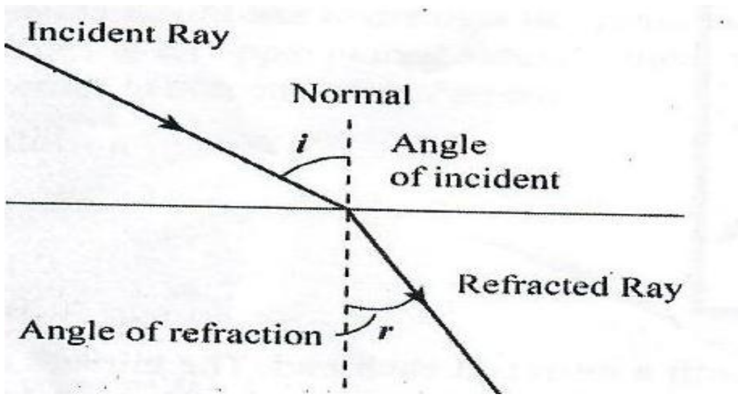
In a periscope, light hit the top mirror at 45^0 and reflects away at the same angle. The light then bounces down to the bottom mirror.

When that reflected light hits the second mirror, it is reflected again at 45^0, right into the eye of the observer. Light is always reflected away from a mirror at the same angle that it hits the mirror.

milanzi chisi Aubrey Jeremiah (Target private) 0888341196 / 0993347461

REFRACTION

Refraction is the bending of light when travelling from one medium to another. For example when light moves from air to water or from air to glass its direction of propagation changes. This is shown is the diagram below.



When light travels from a less optically dense to a more optically dense medium, e.g. from air to glass, it is refracted towards the normal.

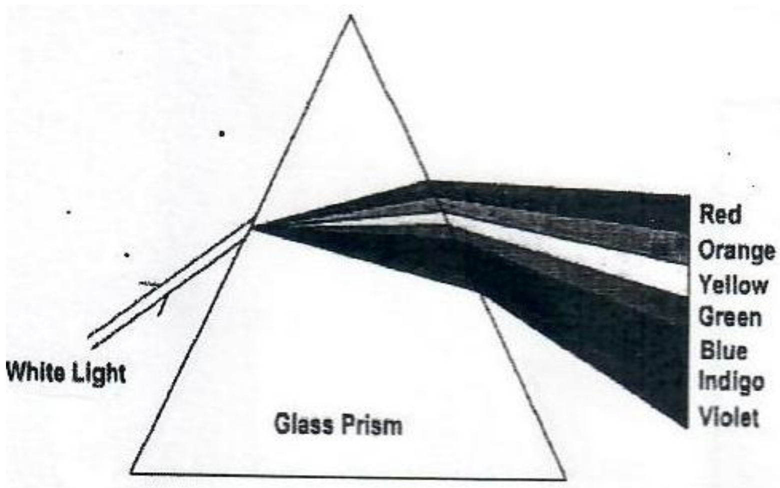
When it travels from a more optically dense to a less optically dense medium, e.g. from glass to air, it is refracted away from the normal.

The angle between the incident ray and the normal is called the **angle of incidence** and the angle between the refracted ray and the normal is called the **angle of refraction.**

A PRISM AND THE SPECTRUM

A prism is a glass object with five flat faces designed to split white light into its component colours.

Aprism uses the property of refraction of light to refract light components at different angles. This is shown in the figure below.



THE RAINBOW FORMATION

The rainbow has many colours just like to spectrum produced by a prism. The formation of a rainbow is similar to the formation of a spectrum by a prims.

A rainbow is formed by water droplets. The water droplets act like prism, to split the white sunlight that strikes them. The white light is split into different colours that form the rainbow.

For object to be see, light from the object has to enter the eye of an observe. Figure below shows light rays from the fish.

The light rays from the fish are refracted at the water –air boundary. Thus the direction of propagation changes.

The refracted rays from the fish then them enter the eye of the observer and the observer

In the eye of the observer, the refracted rays appear as if they come from the direction indicated by the dashed lines. So, the observer sees the fish at the shallower point than where the fish is.

The depth at which a fish is observed is called eh apparent depth, since it is not the actual depth of the fish.

REFRACTION OF LIGHT AND APPARENT DEPT

Objects that are placed in liquid, for example water, appear to be at a shallower depth than where they really are. The refraction of light explains why we see these things at such shallow depths.

The light from the fish are refracted at the water-air boundary. Thus the direction the direction of propagation changes.

The refraction rays from the fish then enter the eye of the observer and the observer.

In the eye of the observer, the refracted

Rays appear as if they come from the direction indicated by the dashed lines. So, the observer sees the fish at the shallower point than where the fish is.

The depth at which a fish is observed is called the apparent depth, since it is not the actual depth of the fish.

UNIT 14

INTRODUCTION TO NUCLEAR PHYSISC STRUCTURE OF AN ATOM

An atom is made up of two parts.

a. The central core called the nucleus where protons (+) and neutrons (n) are closely packed. Protons carry positive charge. Neutrons carry no change.
b. The outer orbit where electrons go round its nucleus. Electrons carry a negative charge (-)

Charge number or **atomic number (Z)**is the number of protons inside its nucleus.

Mass number or atomic weight (A) is the number of protons and neutrons inside the nucleus.

The composition of the atoms of an element is represented as:

Where X is a symbol for an element

A is atomic mass

Z is atomic number

Worked examples

1. Given the Lithium atom, Li. Identify the charge number, mass number and the number of neutrons

Solution

The charge number is 3, i.e. the number of protons inside the nucleus.

The mass number is 7, i.e. the number of protons and neutons and neutrons inside the nucleus. The number of neutrons is equal to 7-3 = 4

2. Given a Uranium atom, U, determine the charge number, mass numberand the number of neutrons.

Solution

Charge number is 92

Mass number is 238

Number of Neutrons is

238 – 92 = 146

ISOTOPES

Isotopes of an element are atoms which have the same number of protons but different number of neutrons i.e. isotopes are atoms with the same atomic number but different mass number.

RADIOACTIVE ISOTOPES AND RADIATION

Some atoms have nuclei that are unstable.

Stable nuclei have the following characteristics:

- Atomic number (Z) = number of nuetrons (n)
- Nuclides have even numbers of Z and n.

Nuclides that are unstable tend to break up, and in so doing tiny articles and energy are released from the atom. The emissions from the atom are called **radiation.**

Substances that emit radiations are said to be **radioactive.** The isotopes are called radioisotopes because they emit radiations.

Radioisotopes are important in many ways such as:

- Industries –some are used in industries to measure the thickness ad gauge of paper, thin sheet metal, rubber and textile. In other words, they are used as a quality control measure.
- Electricity generation plants-radioisotopes such as uranium-235 is used as fuel for nuclear power plants.
- Medicines-radioisotopes cobalt-60 is used in radiotherapy. That is, for cancer treatment, sterilization of surgical equipment.
- Tracing water leaks-radioisotopes sodium-s4 is used in detecting pipe leaks in industries.
- In agriculture, radioisotopes phosphorus-32 is used to trace fertilizer action in plants.
- In archaeology, radioisotopes carbon-14 is used in carbon dating (estimating how old things are).

RADIATION EMITTED BY RADIOACTIVE MATERIALS

Radioactive substances such as isotopes emit the following radiation:

- Alpha (*a*) particles

- Beat (B) particles
- Gamma (y) particles

When the radiations pass through a magnetic or electric field they are affected based on their charge.

DANGERS AND SAFETY AROUND RADIOACTIVE SUBSTANCES

Large and long exposure can lead to:

- ✓ Damage cells
- ✓ Stopping body organs from functioning property.
- ✓ Upsetting the chemical instructions to cells and as a result there us abnormal cell growth that causes cancer. This leads to death.

How to reduce the risk of radiation?

- Place radioactive materials in their containers after use.
- Limiting time of exposure to radioactive is also important.
- Avoid eating food that is contaminated with radioactive materials.
- Shielding workers with lead and concrete walls.
- Never held radioactive substance sin your hands.
- Wearing protective clothes.