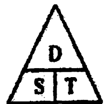
(1)

Topic 2 : Speed, Velocity and Acceleration

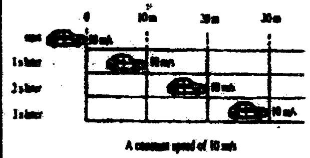


Speed is the change of distance moved per unit time.

Average Speed is the total distance travelled over the total time taken. It includes time taken for rests and stops.

Instantaneous Speed is the speed at any instant. The speedometer of a car indicates its instantaneous speed.

Constant Speed
e.g. a car moves steadily at a certain speed.

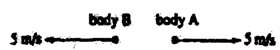


Speed
(a scalar quantity having only magnitude but no direction)
SI unit : metre per second (m/s)

Velocity
(a vector quantity having both magnitude and direction)
SI unit : metre per second (m/s)

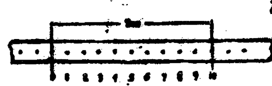
Velocity is the speed of a body in a stated direction.

Two objects moving at the same speed but in different directions have different velocities.



If moving to the right is taken as positive, then
velocity of body A = 5 m/s.
velocity of body B = −5 m/s.

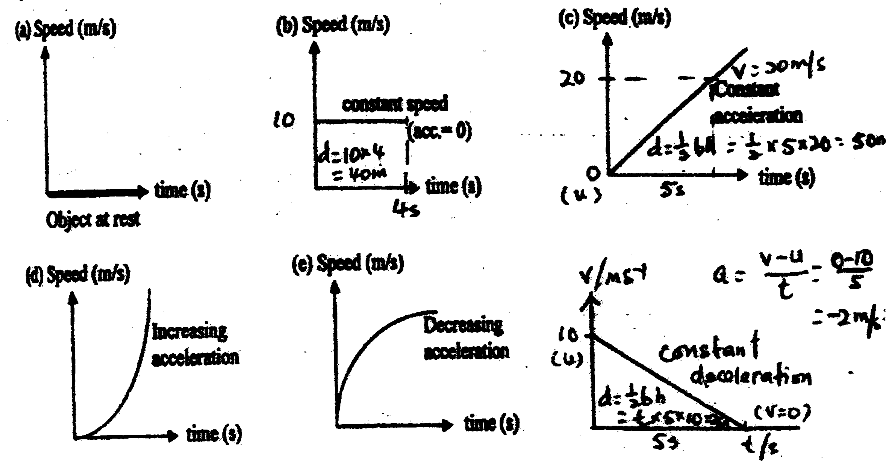
Velocity Measurement Using a Ticker-Tape Timer :



- From Chapter 1, we know that the time interval between 10 successive dot-spaces (1 dot-space = distance between 2 dots) = 10 × 0.02 s = 0.2 s
- the velocity is then calculated :

$V = \frac{8}{0.2} = 40$ cm/s

Speed (Velocity) - Time Graph



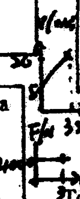
u - starting vel. v - final velocity.

$a = \frac{v-u}{t}$ (m/s^2)

Acceleration is the rate of change of velocity.

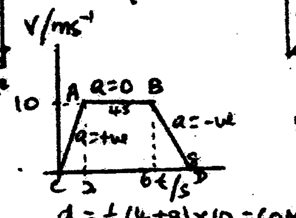
Acc. = $\frac{\text{change of velocity}}{\text{time taken for the change}}$: 5m/s

v - final vel = 20m/s   u - starting vel

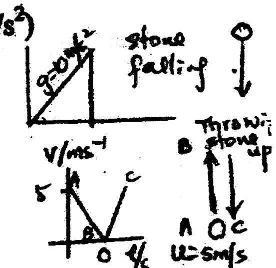


$a = \frac{V-u}{t} = \frac{20-5}{3} = 5 m/s^2$

$F = ma = 800kg \times 5m/s^2 = 4000N$



$d = \frac{1}{2}(4+8) \times 10 = 60M$



Topic 3 Mass and weight

Mass	Vs	Weight
• a measure of the amount of substance in a body. • constant throughout the universe. • SI unit : kilogram (kg)		• force of gravity acting on a body. • changes everywhere. *e.g. On the moon, the weight of a body is only 1/6 of its value on earth.* • SI unit : newton (N)

~~Weight~~ W = mg   Weight is a force

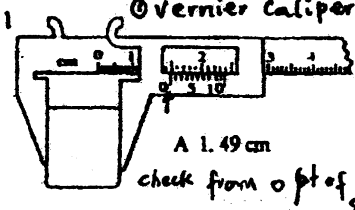
m = 1kg   weight = mg = 1×10 = 10N

m = 200g = 0.2kg   wt = 0.2×10 = 2N

Earth.	Moon.
g = 10m/s²	1.6m/s²
10kg	10kg
Wt = 100N	Wt = 16N

Topic 1

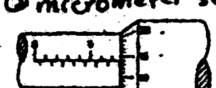
① Vernier Calipers



A 1.49 cm

check from 0 pt of vernier scale

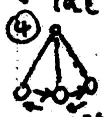
② micrometer screw gauge



7.64 mm

③ Density = mass/vol

④ T∝ℓ   T∝√ℓ



Period = 0.2×4 = 0.8s

2

Centre of gravity

Moments

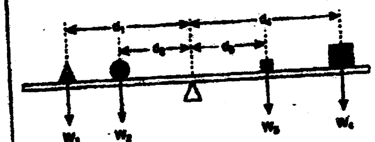
SI unit: newton metre (Nm)

- The turning effect of a force is called its moment.
- Moment = force × perpendicular dist. from the line of action of the force to the pivot

Work done = Fd

Principle of Moments

- When a body is balanced on a pivot, the sum of the clockwise moments about the pivot is equal to the sum of the anti-clockwise moments about the same pivot.

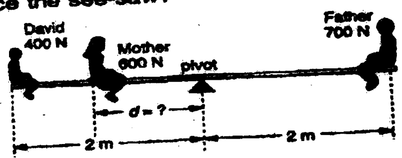


- In the diagram shown above, according to the Principle of Moments,

sum of anticlockwise moments = sum of clockwise moments

$W_1d_1 + W_2d_2 = W_3d_3 \times W_4d_4$

David and his father sat at the ends of a see-saw, 2 m from the pivot (see Figure 5.6). Where should David's mother sit in order to balance the see-saw?



When the see-saw is balanced, taking moments about P,

Anti clockwise moments = clockwise moments

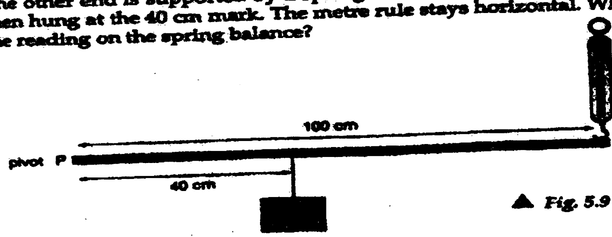
$400\text{ N} \times 2\text{ m} + 600\text{ N} \times d = 700\text{ N} \times 2\text{ m}$

$600\,d = 700 \times 2 - 400 \times 2$

$= 1400 - 800$

$d = 600/600 = 1\text{ m}$

A light metre rule is allowed to pivot freely at the zero end (Fig. 5.9). The other end is supported by a spring balance. A weight of 200 N is then hung at the 40 cm mark. The metre rule stays horizontal. What is the reading on the spring balance?



▲ Fig. 5.9

Taking moments about pivot P

antidockwise moment = clockwise moment

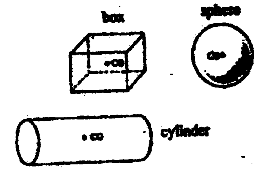
$F \times 1\text{ m} = 200\text{ N} \times 0.4\text{ m}$

$F = \dfrac{200 \times 0.4}{1}\text{ N} = 80\text{ N}$

Centre of Gravity

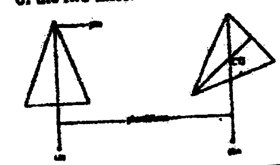
The centre of gravity of a body is the point through which its weight acts.

Regularly shaped objects have their centre of gravity (C.G.) exactly in the middle.



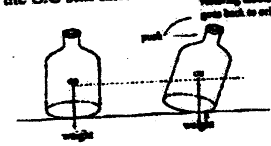
Irregularly shaped objects, when hanging freely, will have their (C.G.) hanging vertically below the pivot.

E.g. A triangle lamina is hung loosely by a pin just below an apex. A weight attached to a string (a plumbline) is also suspended from the pin. The vertical line made by the plumbline is drawn on the triangle. The triangle is then hung on another apex and the vertical line is also drawn. The C.G. of the triangle is the point of intersection of the two lines.

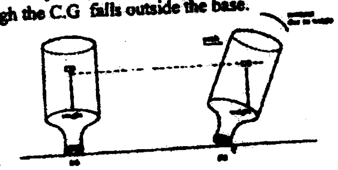


Stability refers to a body's ability to keep its original position.

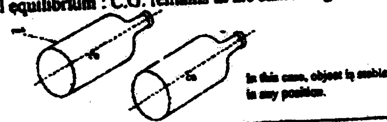
(a) Stable equilibrium : C.G. is raised but the vertical line through the C.G still falls within the base.



(b) Unstable equilibrium : C.G. is lowered and the vertical line through the C.G falls outside the base.



(c) Neutral equilibrium : C.G. remains at the same height.



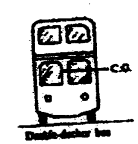
The stability of an object can be increased by :

(i) lowering its centre of mass

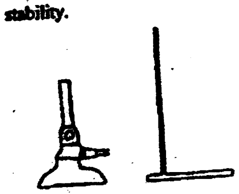
(ii) increasing its base area

Everyday examples :

- a tight-rope walker crouches low on the tight-rope when he is in the danger of falling-off. (lowering his C.G.)
- Passengers in a double-decker bus are advised to fill the lower deck before going up to the upper deck. (lowering the C.G.)



- Laboratories instruments e.g. bunsen burner, retort stand, etc, have a broad base to enhance stability.



Topic 6 : Work, Energy and Power

Work

- SI unit : joule (J)
- No work is done if an object does not move when a force is applied.
- Work done = force × distance moved in the direction of the force

$\Rightarrow W = F \times d$

Power

- SI unit : watt (W)
- Power is the rate of doing work.
- Power = $\frac{\text{work done}}{\text{time taken}} = \frac{W}{t}$

  $= \frac{\text{energy change}}{\text{time taken}} = \frac{E}{t}$

Energy is the ability to do work.

Energy
SI unit : joule (J)

Potential Energy (P.E.)

- the energy a body possesses due to its arrangement or position.
- an object of mass *m* at a height *h* has gravitational potential energy given by :
  P.E. = *mgh*
  (where *g* is the acc. due to gravity)

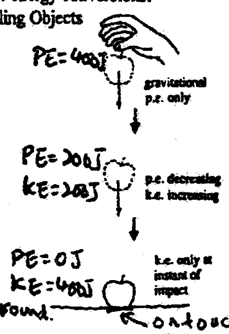
Kinetic Energy (K.E.)

- the energy a body possesses due to its motion. [The motion may be either translational (a moving car) or rotational (a ceiling fan).]
- an object of mass *m* moving at speed *v* has kinetic energy given by :
  K.E. = ½ mv^2

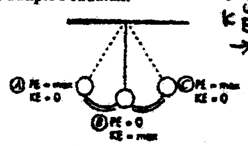
$P_E = mgh$
$K_E = \frac{1}{2}mv^2$

The Law of Conservation of Energy states that energy cannot be created or destroyed, but changes from one form to another.
Examples of energy conversions:

- Free-falling Objects

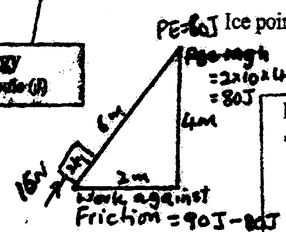


- A Simple Pendulum

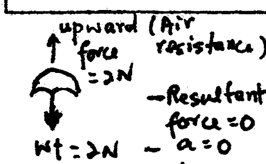


- Photosynthesis
  light energy → chemical energy
- Dry cell
  chemical energy → electrical energy
- Electric iron
  electrical energy → heat energy
- Braking motion of a car
  kinetic energy → heat & sound energy

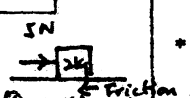
~~Hydraulic Power station~~
PE → KE → EE



W = Fd
Work: 15N × 6m = 90J



– Resultant force = 0
– a = 0
moving downwards at const speed

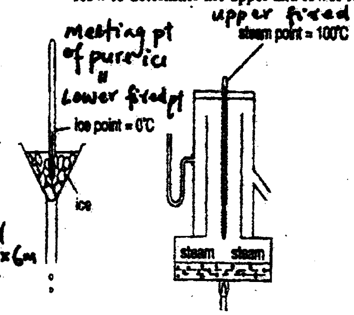


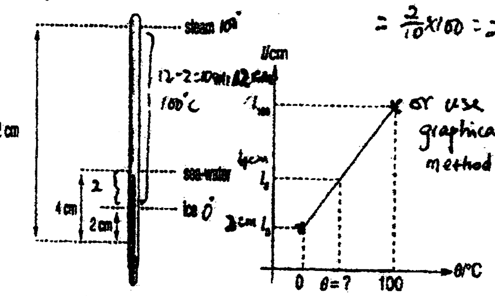
① moving at const speed of 0.5 m/s
② Friction = 5N
③ a = 0
④ If 10N force is used, Net Force = 10N − 5N = 5N
F = ma a = F/m = 5N/2kg = 2.5 m/s²

Topic 7 : Measurement of Temperature

Temperature

- SI unit : kelvin (K).
  But degree Celsius (°C) is commonly used.
- Definition : Temperature is a measure of the hotness or coldness of a body.
- A **thermometer** is used to measure temperatures.
- To put the correct markings on the scale of a thermometer, there must be at least two known temperatures. The ice point (lower fixed point 0°C) and the steam point (upper fixed point 100°C) are usually allocated on a thermometer after which the length between them is divided into 100 **equal** divisions.
- How to determine the upper and lower fixed points :



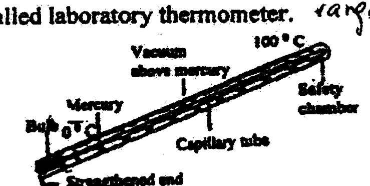


Calc'n Temp = $\frac{4-2}{12-2} \times 100°C = \frac{2}{10} \times 100 = 20°C$

Ice point – 0°C Steam point- 100°C Find the temperature of sea water. Temp. of sea water, = 20°C

Mercury Thermomter

- Use in the lab. Also called laboratory thermometer. range −10°C to 11[?]°C



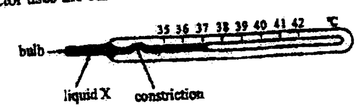
- Increased sensitivity by
  - narrow bore of capillary tube
    (a small rise in temperature will cause a big change in mercury thread)
  - thin glass bulb (heat exchange rate is increased)
  - round glass stem (acts as a magnifying glass)
- Thermometric properties : (For mercury)
  - linear expansion
  - quick response
  - range of −39°C to 357°C
  - does not stick to glass; visible mensicus
  - expensive and poisonous liquid

CLINICAL Thermometers

Range : 35°C to 42°C

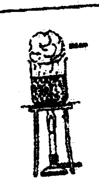
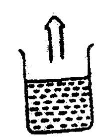
- Same structure as the laboratory thermometer except for two modifications :
  - short range of 35°C to 42°C.
  - constriction in the capillary tube just above the bulb.
- The constriction allows the temperature of a patient to be read at leisure.
- The clinical thermometer is given a few flicks to return the mercury to the bulb.

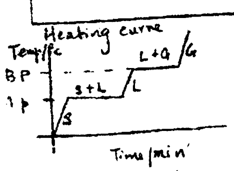
C8. A doctor uses the clinical thermometer shown below to take your temperature.



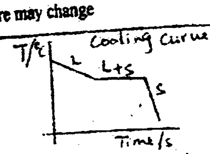
(a) Name a suitable liquid for X. __mercury__
(b) What is the range of the clinical thermometer? __35°C to 42°C__
(b) What is the purpose of the constriction?
__To prevent mercury from flowing back to the bulb so that the temperature of the patient can be read accurately.__
(c) Where would the doctor place the thermometer to take your temperature? __under the tongue__
(d) Does the heat pass through the bulb by conduction, by convection or by radiation? __conduction__

Boiling Vs Evaporation

Boiling	Evaporation
	
• Quick ✓• Takes place at a fixed temperature (boiling point) ✓• Takes place throughout the liquid • Source of energy needed • Bubbles formed throughout the liquid • Temperature remains constant during boiling	• Slow ✓• Takes place at any temperature below boiling point ✓• Takes place on the surface only • Energy supplied by surroundings • Nothing visible happens • Temperature may change

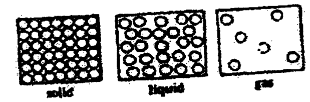


No Temp. change at melting point. Heat is supplied to break the bond between the solid particles to become liquid



TRANSFER OF THERMAL ENERGY

1. The three ways by which heat is transferred are:
   (i) conduction (occurs mainly in solids),
   (ii) convection (occurs mainly in liquids and gases),
   (iii) radiation.



__Conduction__ is the process by which heat is transmitted through a medium from one particle to another.

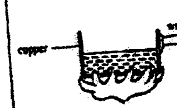
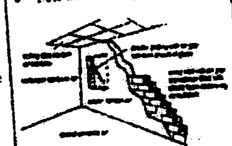
- Conductivity rate :
  Solids > Liquids > Gases

Examples & Uses of Good Conductors & Bad Conductors (Insulators)

Examples :

Conductors	Insulators
• Copper • Gold • Aluminium • Brass • Mercury • Iron etc.	• Air • Fibreglass • Water • Ice • Cotton • Plastic • Wood • Cork etc.

Uses :

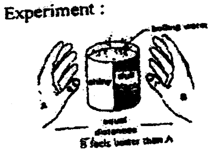
Conductors	Insulators
• Pans, kettles, cooking utensils, etc, are made of conducting materials like aluminium, steel. 	• Handles of cooking utensils. • Double-glazed windows. • Felt used to trap air. 

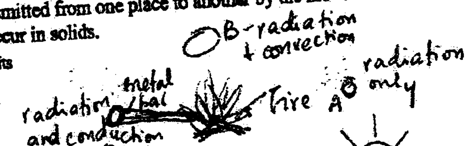
Convection is the process by which heat is transmitted from one place to another by the movement of heated particles of a gas or liquid. It does not occur in solids.

__Radiation__ is the process by which heat source transmits infra-red electromagnetic waves.

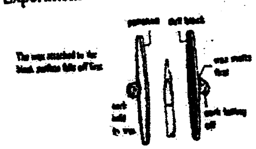
Emission of Radiation – infra-red radiation

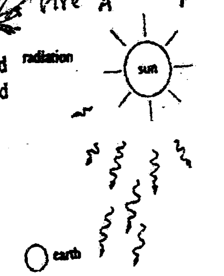
- All hot objects emit (radiate) heat. The hotter the object, the more heat it radiates.
- Black and rough surfaces are good radiators of heat; white and polished surfaces are poor radiators of heat.
- Experiment :

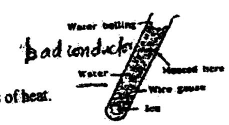


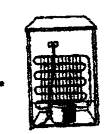


- Black and rough surfaces are good absorbers of heat; white and polished surfaces are poor absorbers of heat.
- Experiment :









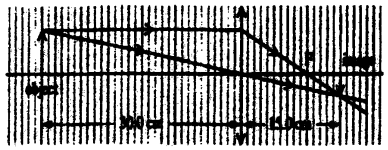
Hence, we can have a conclusion :

Black surfaces are good emitters, good absorbers of heat.
White and shiny surfaces are poor emitters, poor absorbers of heat.
i.e. A good emitter is a good absorber.

Example : Two cars, one white and one black, are both parked in the sun. After some hours one is much hotter to touch than the other. Which car is this? Explain your answer.
__The black car feels hotter as black absorbs heat more readily than white. The white car reflects most of the heat and light energy that falls on it.__

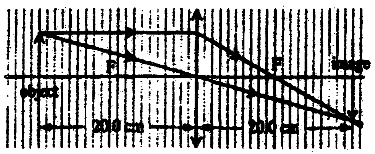
Set up the apparatus shown in the above diagram. Place the converging lens in front of an open window and place a white screen on the other side of the lens. Adjust the screen until a sharp, inverted image of the scenery outside is formed on the screen. Measure the distance between the lens and screen to obtain the focal length (f) of the lens.

(a) Object distance = 30.0 cm > 2f



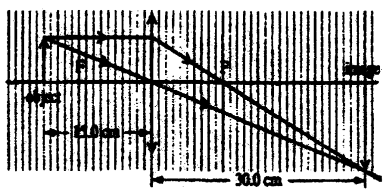
smaller, real and inverted image is formed when object distance is more than twice the focal length

(b) Object distance = 20.0 cm = 2f



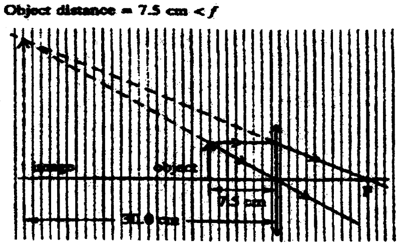
Same size, real and inverted image is formed when object distance is equal to twice the focal length

(c) Object distance = 15.0 cm.



larger, real and inverted image is formed when object distance is between 1f and 2f.

(d) Object distance = 7.5 cm < f



larger, virtual and upright image is formed when object distance is less than 1f.

(b) solutions : Any of a, b, or c and d.

15. CG and stability

15 (a) (i) Explain what is meant by the centre of mass of an object.

(ii) Describe an experiment to find the centre of mass of an irregularly shaped plane laminar.

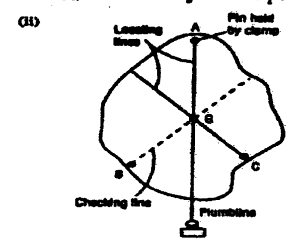
(b) What is meant by the moment of a force about a point? [2]

(c) A rectangular block of wood is initially resting on its smallest face on a table. A horizontal force is applied to the block near its top, and it begins to tilt. Draw a diagram to show how far the block can tilt before it falls over. Explain your diagram in terms of the position of the centre of mass of the block and the moment of its weight about the pivot. [3]

Solution

(a) (i) The centre of mass of an object is the point at which its weight appears to act.

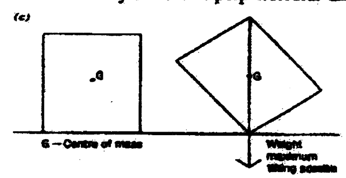
(ii)



1. Make three holes along the edge of the given lamina.
2. Suspend it freely about one of the holes and suspend a weight tied to a string (plumbline) from the same support.
3. The centre of mass is vertically below the point of support. Draw the vertical line representing the plumbline.
4. Repeat the experiment changing the hole at which the lamina is suspended. The point of intersection (G) of these vertical lines is the centre of mass of the lamina.

(c) The moment of a force is the turning effect it causes on the body about the point and is calculated by force x its perpendicular distance from the point.

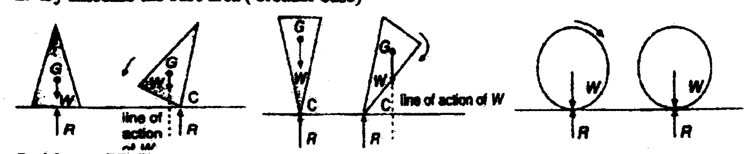
(c)



Up to the tilting position shown, the moment of the weight of the block causes it to return to its original position. When the tilting is more, the anticlockwise moment of the weight, causes the block to topple.

Two ways to make a body more stable :

1. By lowering the centre of gravity (adding more weight at the base)
2. By Increase the base area (broader base)

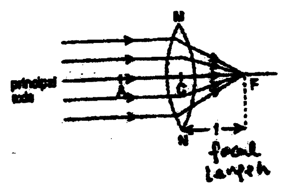


Stable equilibrium
The CG is raised, it will return to its original position

Unstable equilibrium
The CG is lowered, it will topple to take a new position

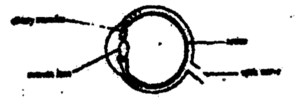
Neutral equilibrium
The CG remains at the same height

Thin Converging Lenses

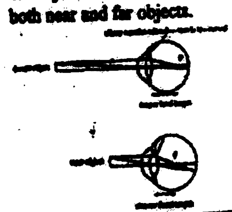


- The point through which all parallel rays of light converges is called the **principal focus** (F).
- The **optical centre** is the centre of the lens (C).
- The **focal length** is the distance between the optical centre and the principal focus (*f*).
- The **principal axis** is the straight line joining and extending through the optical centre and the principal focus (ACF).
- The **optical axis** is the straight line through the optical centre and perpendicular to the principal axis (MCN).

HUMAN EYE

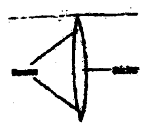


- The eye has the same working principle as the camera.
- An image of an object is formed on the retina, which sends the image to the brain via the optic nerve.
- The ciliary muscles can contract or relax, depending on the distance of the object. That is why we can see both near and far objects.



Thin Converging Lenses :

Structure :



Rays Diagrams

Please refer to the next page.

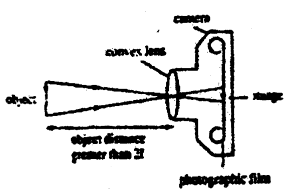
Applications

Magnifying Glass

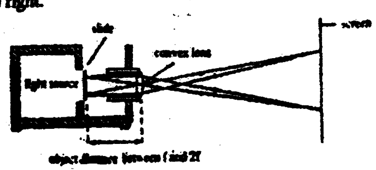
- used to see small objects
- The glass is held very near the object so that the distance between the lens is less than the focal length, hence the image seen will be magnified, virtual, up-right and behind the object.

Camera / Slide Projector

- The image formed in a camera is real and diminished.



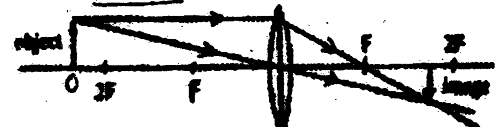
- The image formed in a slide projector is real and magnified but is inverted and laterally inverted. Therefore, the slide is placed top to bottom and left to right.



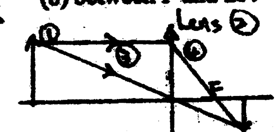
Applications of convex lens

1. Camera / Human eye (small : image, real, inverted image)

Object beyond 2F – smaller

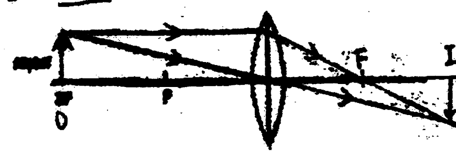


The image is
(a) real, inverted and diminished.
(b) between F and 2F.



2. photocopier (same size, real, inverted image)

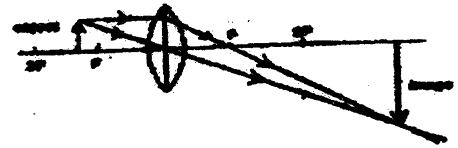
Object at 2F



The image is
(a) real, inverted and same size as the object.
(b) at 2F.

3. Projector (enlarged size, real, inverted image)

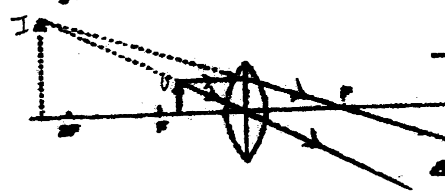
Object between F and 2F

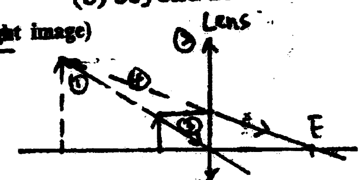


The image is
(a) real, inverted and magnified
(b) beyond 2F.

4. Magnifying glass (enlarged, virtual, upright image)

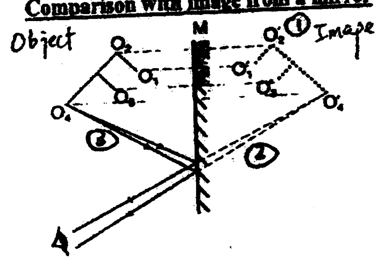
Object less than F





The image is
(a) virtual, upright and magnified
(b) behind the object.

Comparison with image from a mirror



Characteristics of image formed by a plane mirror:

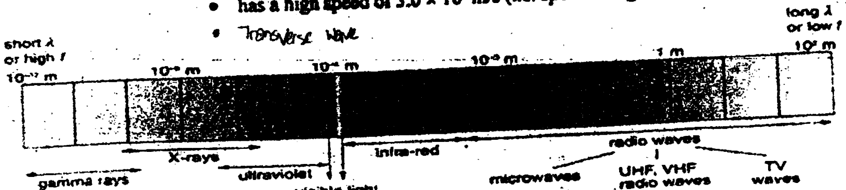
The image formed is :

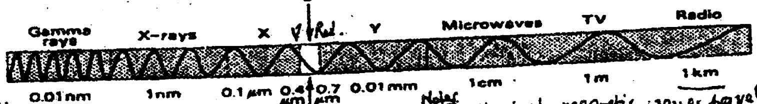
- the same size as the object,
- laterally inverted,
- upright, virtual,
- image formed is as far behind the mirror as the object is in front of the mirror.

(7)

Topic 13 : Electromagnetic Spectrum

Electromagnetic waves
- are electric and magnetic in nature.
- can travel through a vacuum.
- has a high speed of 3.0×10^8 m/s (i.e. speed of light).
- Transverse wave





Note: (1) All electromagnetic waves travel at the same speed of 3×10^8 m/s

(i) Which wave has the longest wavelength? Radio waves

(ii) Name a wave in region X. ultra violet ; Name a wave in region Y. Infra red

2 The sun transmit heat to the Earth by Infra red radiation

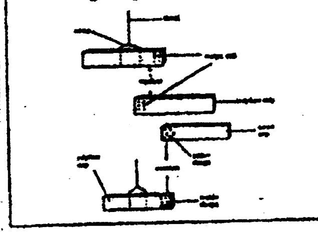
Types of Electromagnetic Waves and Their Uses

Radiation	Sources	Uses
Gamma Rays	• Radioactive substances • cosmic rays (rays from the sun)	• killing cancer cells • checking welds
X-rays	• X-ray tubes	• medical / dental inspections • analysis of crystal structure
Ultra-violet Radiation	• mercury vapour lamps • the Sun	• suntanning (production of Vitamin D in our body) • forgery detection • sun lamps • disinfectants as it destroy bacteria and other organisms such as viruses, fungi and algae
Visible Light	• hot bodies • lasers • the Sun • fluorescent screens	• chemical spectral analysis • fibre optics • photosynthesis
Infra-red Radiation	• warm bodies • the Sun	• TV remote controls • night navigation systems • infra-red photography • radiant heaters
Microwave	• klystron tubes	• microwave cooking (these waves are easily absorbed by water in food substances) • satellite communications • analysis of atomic and molecular structures
Radio Wave	• TV and radio transmitters	• radio and television broadcasting • navigation • radio telescope • police / taxi radio communications

Topic 15 : Electric Charge

Electrostatic Charges
(positive and negative charges)

Like charges repel, unlike charges attract.

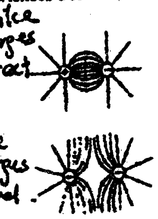


Electrostatic Materials

Negative Charges	Positive charges
• Polythene rubbed with wool / duster / cloth • Ebonite rubbed with fur • plastic with cloth	• Cellulose acetate rubbed with wool • Glass rubbed with silk • perspex with silk

An **electric field** is a region where an electric charge experiences a force.

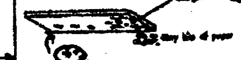
unlike charges attract



like charges repel

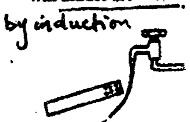
Electrostatic Effects

(a) Tiny scraps of paper are attracted to a charged body.
Induction followed by attraction

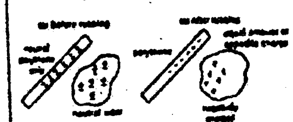


(b) Strands of hair is attracted to a charged polythene strip.

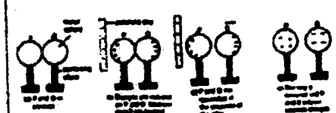
(c) A charged acetate strip placed near a thin continuous stream of water will attract the water.
by induction



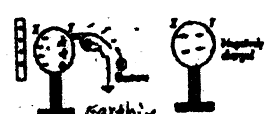
Methods of Charging :
- Charging by friction – rubbing polythene rod with cloth.



- Charging by contact
- Charging by induction



- Earthing process



+ve charges are neutralised. e^- flow from hand to sphere.

Charge on one electron is -1.6×10^{-19} C
Charge on one proton is $+1.6 \times 10^{-19}$ C

1. Negatively-charged polythene rod has more electrons than protons (electrons flow to the polythene rod)
2. Positively-charged glass rod has more protons than electrons (electrons flow out of the glass rod)

Negatively charged – polythene, plastic comb, ebonite rod (rubbing with dry cloth, wool or duster)
Positively charged – glass, cellulose acetate, Perspex (rubbing with silk)

(8)

16 : Current, Emf, P.d., Resistance, V/I Graphs

Electric Current & Charge

Electric Charge

Types of Charges

Positive charges
- Positive ions

Negative Charges
- electrons
- negative ions

Symbol : Q
SI Unit : Coulomb (C)

Charge of 1 electron
i.e. = 1.6×10^{-19} C

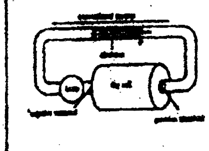
Electric Current
SI Unit : Ampere (A)

Electric current is the rate of flow of charge.

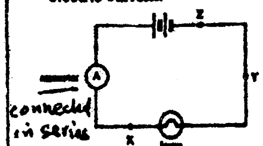
$\therefore I = \frac{Q}{t}$ $Q = It$

where I : electric current
Q : electric charge
t : time taken in s

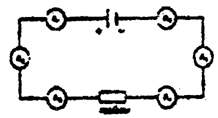
- Charge is carried by electrons from the negative terminal to the positive terminal.
- Conventional current flows from the positive terminal to the negative terminal.



- An ammeter connected in series in a circuit, measures electric current.



- In a series circuit, the same current flows through the different components of the circuit.
i.e. $A_1 = A_2 = A_3 = A_4 = A_5 = A_6$



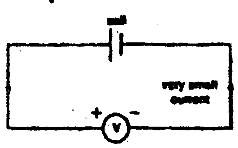
Potential difference (p.d.) and Electromotive force (e.m.f.)

emf
p.d.
voltage } in V

Electromotive force
SI Unit : volt (V)

The e.m.f. of a cell is the total amount of work done in moving a unit charge around a complete circuit.

To measure the e.m.f of a cell, a voltmeter is connected directly across its terminals.

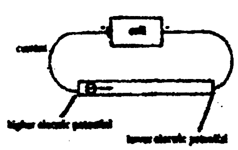


But usually the e.m.f. is indicated on the cell itself.
e.g. 1.5 V battery, 3 V battery

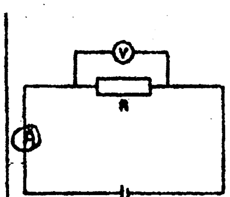
Potential difference (p.d.)
SI Unit : volt (V)

The p.d. between two points in a circuit is 1 V when it gives off 1 J of energy for 1 C of charge going through it.
1 V = 1 J/C

The potential difference (p.d.) is the difference in potential between two points in a circuit.
Symbol : V



The voltmeter connected in parallel in a circuit, measures p.d. (in V) .



Resistance and V/I Graphs

Resistance
SI Unit : ohm (Ω)

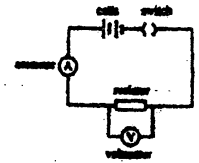
The resistance, R, of a conductor is the ratio of the p.d. across its end to the current flowing through it.

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

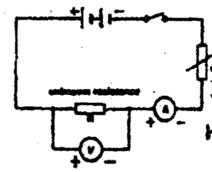
V / R | I

$V = IR$

Determining Resistance
- It is important to measure p.d. across the resistance and the current flowing through it.



- The values of the p.d. (V) and current (I) are substituted into the equation R = $\frac{V}{I}$ and the resistance (R) is calculated.
- The number of cells can be varied to give suitable readings of the voltmeter and ammeter. A rheostat, connected in series, may also be used.



Resistivity
- depends on the material of the conductor.
- SI unit : Ωm
- Good conductors : low values
- Poor conductors : high values
- $R = \frac{\rho l}{A}$ where R : resistance of a conductor
  ρ : resistivity
  l : length of conductor
  A : cross-sectional area of conductor

1m 4Ω   2m 8Ω

Factors Affecting Resistance
- length of conductor : length α resistance $R \propto l$
  i.e. a longer wire has a larger resistance
  Take for example : A long battalion of soldiers
  A commander will take a longer time and more effort to break through the long line of soldiers
- thickness of conductor : thickness α $\frac{1}{\text{resistance}}$ $R \propto \frac{1}{A}$
  i.e. a thicker wire has a smaller resistance
  Take for example : A fire in a room full of people and only a small exit.
  There will be lots of pushings and squeezings because the small exit serves as a resistance to the push and flow of the crowd.

1cm² 8Ω   4cm² 2Ω

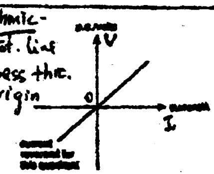
V/I Graphs (Ohm's Law)

Ohm's Law states that the current flowing through a conductor is directly proportional to the p.d. across its ends provided the temperature remains constant.

V/V	I/A	R = V/I Ω
0.4	0.2	2
0.6	0.3	2

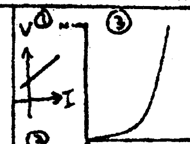
Ohmic Conductors Vs Non–Ohmic Conductors

Ohmic
- st. line
- pass the origin



e.g. Pure metals, copper sulphate solution with copper electrodes

Non-ohmic
- curve
- may not pass thru origin



e.g. Filament bulbs, Vacuum diode, solid state diode, dilute sulphuric acid with platinum electrodes

9

Topic 17 : Electric Circuit

Electric Circuits

Series Circuits

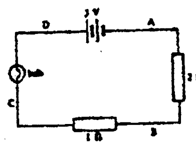
- Ammeters placed at different positions in a series circuit gives the same reading.

  e.g. Whether the ammeter is at A, B, C or D, the ammeter reading will be :

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

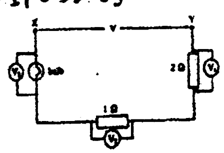
  $= \frac{3}{2+1}$

  $= 1\ A$

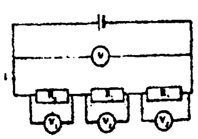


- Voltmeters connected across different components give different readings. However, their sum is equal to the source.
- e.g. $V = V_1 + V_2 + V_3$

  $I = I_1 = I_2 = I_3$



Resistors in Series

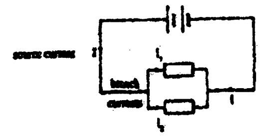


- $V = V_1 + V_2 + V_3$
- Effective Resistance

  $R = R_1 + R_2 + R_3$
- Current I is the same through each resistor.

Parallel Circuits

- Ammeters placed at different positions in a parallel circuit does not give the same reading. e.g.

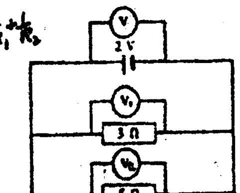


The current, I, splits up into I_1 and I_2. Therefore, $I = I_1 + I_2$

Note : I_1 and I_2 may or may not be equal, depending on the resistance of each of the resistors.

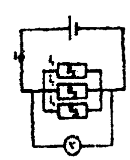
- Resistors or other circuit components connected in parallel will have the same p.d. across them
- e.g.

  $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$



$V_1 = V_2 = V_3$

Resistors in Parallel



- Voltage across each resistor = V
- Effective Resistance

  $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- Current $I = I_1 + I_2 + I_3$

Topic 18 : Practical Electric Circuits

Practical Electric Circuits

Uses of Electricity

Electric Power

- Power is the rate of work done

  SI unit : watt (W)

  where 1 W = 1 J/s
- Power is related to the basic quantities of electricity by the formula,

  ✓ $P = VI$ where V : p.d.

  ✓ $E = Pt$ I : current
- We have learnt that

  energy = p.d. × charge

  ✓ $E = VQ$

  ∴✓ $E = VIt$ (since $Q = It$)

The kilowatt hour

- Use of electrical energy in the home is measured in terms of the kilowatt hour (kWh) where

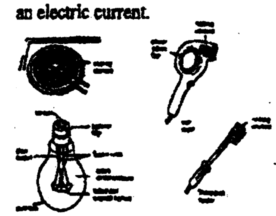
  1 kWh

  = 1 kW × 1 h

  = 1000 W × (60 × 60) s

  = 3 600 000 J

- As current is the rate of flow of charge and charge carries energy, current is directly related to energy output.
- This energy is released as heat and light.
- Appliances that make use of the heating effect of a current are electric irons, cookers and ovens. Lights make use of lighting effect of an electric current.



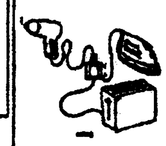
- Lightings in households are connected in parallel because if one lamp is removed, the others will still light up. Parallel circuit allows each lamp to draw its maximum current, therefore maximum brightness.

Dangers of Electricity

Overheating

Hazard :

Insulation melting and electrical fires.



Damaged Insulation

Hazard :

Electrical shock can occur

exposed wires come into contact with the metal casing of an electric appliance.

Damp conditions

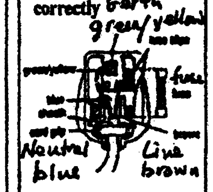
Hazard :

Water molecules may form a tiny circuit between the conductors in a switch and your hand, resulting in an electric shock.

Safe Use of Electricity in the Home

Earth
NEL
Neutral Live

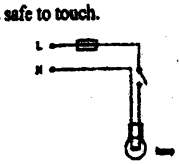
Wiring a plug correctly



A fuse protects the appliance

- A fuse is a device which prevents large amounts of current from entering a circuit. It consists of a short thin piece of wire which melts at a certain temperature. The thicker the wire, the higher its melting point.
- A fuse should have a rating of slightly higher than the current drawn by the appliance.

- Switches and fuses are connected along the live wire so that when the switch is off or the fuse has "blown", the live wire is safe to touch.



Earthing and Double Insulation Earth wire to metal casing

- Earthing an appliance means connecting a wire from the appliance to the earth. The earth wire carries excessive charges (or current) down to the earth safely, prevent the user from electrical shock.

- The internal components of the appliance from the electric cable is insulated. The internal metal parts are also insulated from the casing of the appliance.

Topic 14 : Simple Phenomena of Magnetism

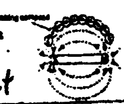
Magnetism

... of Magnets

A magnet has two poles. The poles of a magnet is the region where its magnet strength is the strongest.

- A freely-hanging magnet points in a north-south direction. The pole that points towards the earth's north pole is called the north-seeking pole (north pole). The other pole pointing towards the earth's south pole is called the south-seeking pole (south pole).
- Magnets obey the laws of magnetism
  (a) like poles repel ;
  (b) unlike poles attract
- A region of magnetic lines surround a magnet is known as the magnetic field.
- The magnetic field can be plotted by using a compass as shown :

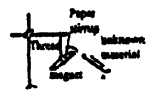
magnetic substance
Ni c S- steel
Nickel iron cobalt



- **Magnetic and Non-magnetic Materials**

Magnetic Materials	Non-magnetic Materials
Materials that are attracted by a magnet. e.g. iron, steel, nickel, cobalt	Materials that are not attracted by a magnet. e.g. copper, brass, aluminium, tin
Magnetic materials can be made into magnets.	Non-magnetic materials cannot be made into magnets.

- To identify magnets and magnetic materials :



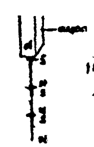
Effect on A	Conclusion : A is
attracted	magnetic material or a magnet
repelled	a magnet
remain stationary	a non-magnetic material

Iron and steel are two common materials used for making magnets.

Iron	Vs Steel
Magnetically soft material. It is easy to magnetise but loses the magnetism easily.	Magnetically hard material. It is difficult to magnetise but retains its magnetism longer.
Induced magnetism is stronger and almost instantaneous.	Induced magnetism is weaker and slower.
Induced magnetism is lost when the permanent magnet is removed.	Induced magnetism is retained, though weaker, when the permanent magnet is removed
Used to make electromagnets. Used in electric bells, magnetic relays	Used to make permanent magnets. Used in loudspeakers, electric meters

Magnetic Induction

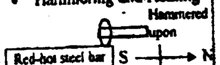
When a magnet is brought close to an iron bar, the magnet causes the iron bar to behave like a magnet. The bar magnet is said to have induced magnetism into the iron bar. The end of the iron bar closer to the bar magnet is of an opposite polarity to that of the bar magnet. Unlike poles attract and hence, a force of attraction is set up.

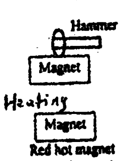


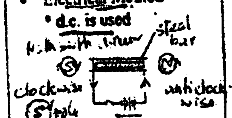
induction followed by attraction

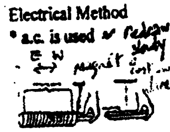
Magnetisation and Demagnetisation

Magnetisation	Demagnetisation
• Hammering and Heating	• Heating and Hammering
• Stroking Method	Red hot magnet allowed to cool
• Electrical Method • d.c. is used	• Electrical Method • a.c. is used

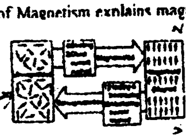








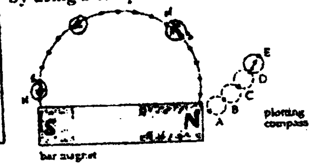
The Domain Theory of Magnetism explains magnetism in magnetic materials.

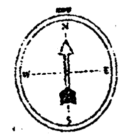


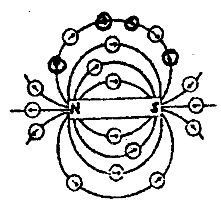
close chain Not magnetised
magnetised straight chain

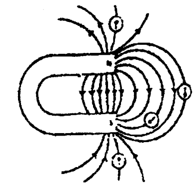
14.4 Magnetic field P. 219 Experiment 14

A region of magnetic lines surrounding magnet is known as the magnetic field. The magnetic field can be plotted by using a compass as shown :

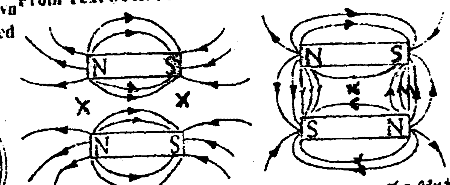






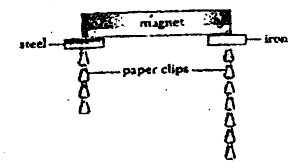


From Text book P220. - Add in the extra lines of force



X - neutral point
no magnetic effect

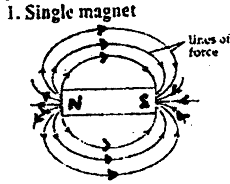
14.5 Magnetic Properties of Iron and Steel

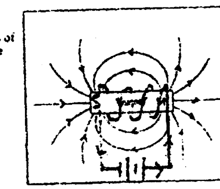


14.21 Iron attracts more paper clips than steel

Drawing of magnetic lines of force (magnetic field)

1. Single magnet



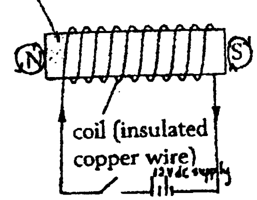


Magnetic field pattern round a bar magnet

14.5 Differences between properties of iron and steel:

(a) Iron is more easily magnetised and demagnetised. It can be magnetised by a weak magnetic field.
(b) Iron is known as a soft magnetic materials because it loses its magnetism easily so it is used as a temporary magnet such as an electromagnet and transformer cores.
(c) Steel is harder to magnetise and demagnetise than iron but retains its magnetism. It requires a strong magnetic field to magnetise.
(d) Steel is a hard magnetic material as it retains its magnetism, so it is used as a permanent magnet.

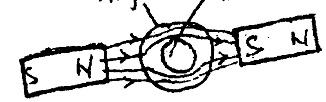
Electromagnet [permanent magnet - steel]
Soft iron core -



An electromagnet is a magnet that operates on electricity. It consists of a solenoid wound on a soft iron core. When a current is passed through the solenoid, the iron core is magnetised and therefore produces a strong magnetic field. When the current is switched off, the iron core loses its magnetism. The larger the current, the stronger is the electromagnet. The larger the number of turns of the solenoid, the stronger is the electromagnet.

14.6 Uses of magnets:

1. Permanent magnets - Magnetic door catch
2. Permanent magnets are essential in the operating of numerous electrical machines such as d.c. motors and a.c. generators.
3. The needle of a compass is a permanent magnet.



Soft-iron ring enhanced magnetism
copper ring - no effect

Uses of Electromagnets:

1. Electromagnets are used to lift scrap iron and steel.
2. Electromagnets are used in electrical appliances and bells.