MECHANICS

1a (i) Force is a push or pull that changes the body's state of rest or uniform motion in a straight line.

(ii)

MASS	WEIGHT
• Constant in all places	• Varies from place to place
• Scalar quantity	• Vector quantity
• Measured using a beam balance	• Measured using spring balance
• Measured in kilograms	• Measured in newton's

(iii) The earth is oval shaped, it narrows at the poles and bulges at the equator.

The rotation of the earth about its axis makes acceleration due to gravity less at the equator than at the poles, hence the weight.

1b (i) Work input=Effort x Effort distance
=130X14
=1820J

Work output=Load X Load distance
= (30X 10) X 5; load =mg
= 1500J

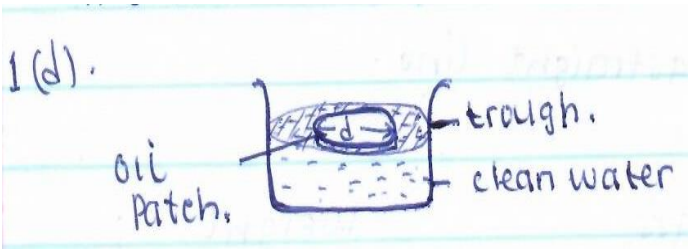
Work done against friction
= Work input-Work output
=1820-1500
=320J

Work done against friction = frictional force X Distance moved
F X 14 = 320
F =22.9 N

(ii) In clean water, there is a higher surface tension which supports the weight of the needle than in water with detergents where surface tension is weakened.

1 c (i) Brownian motion is the constant random motion of tiny particles of a fluid.

1 d



- A trough is filled with clean water
- Lycopodium powder is sprinkled on the surface of the water
- Oil of known volume, V is dropped on the surface of water from the burette.
- Oil spreads to form a circular patch whose diameter is measured and recorded.
- The thickness of the oil film is determined from $\mathbf{t=\frac{4V}{\pi d^2}}$

2

(a) Uniform deceleration is the constant rate of decrease of velocity.

(b) (i) A body moves with a constant velocity of $30ms^{-2}$ for 5s. It then decelerates uniformly to rest for 5s. The body then accelerates uniformly in opposite direction for 5s and attains a velocity of $30ms^{-1}$

(ii) Total distance covered by a body = Area covered by the graph

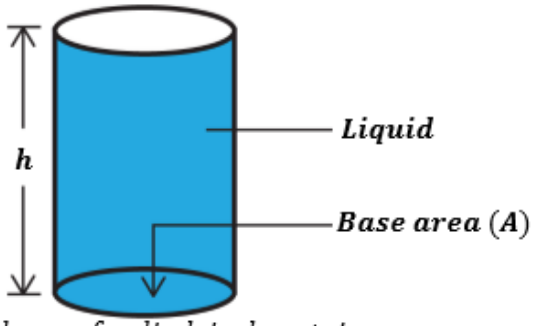
S = (30 X 5) + (½ X 30 X 5) + (½ 5 X 30)

S = 300m

2c (i) Pressure is the force acting normally per unit area.

(ii)

Consider a cylindrical container of cross-sectional area (base area), $\boldsymbol{A}$ filled with a liquid of density, $\boldsymbol{\rho}$ to a height, $\boldsymbol{h}$ as shown below.



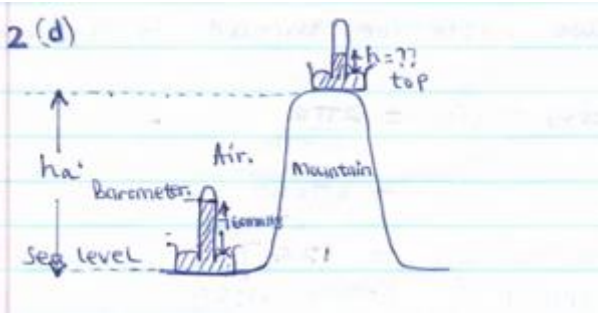
$$Volume\ of\ liquid = Volume\ of\ cylindrical\ container$$
$$= Area\ of\ circular\ base \times Height$$
$$= \boldsymbol{Ah}$$

$$Mass\ of\ liquid = Density\ liquid \times Volume\ of\ liquid$$
$$= \boldsymbol{\rho Ah}$$

$$Force\ exerted\ by\ liquid\ (Weight\ of\ liquid) = mass \times acceleration\ due\ to\ gravity$$
$$= \rho Ah \times g$$
$$= \boldsymbol{Ah\rho g}$$

$$Pressure = \frac{Force}{Area}$$
$$P = \frac{Ah\rho g}{A}$$
$$\boxed{\boldsymbol{P = h\rho g}}$$

(d)



Pressure at sea level- Pressure at top = Pressure due to air

760mmHg-Ptop= haρag

$\frac{760}{1000}$ X14600x10-Ptop=430x1.25x10

Ptop= 103360-5375

Ptop= 97985Pa

hx13600x10=97985

h= 0.720m

Barometer reading = 720mmHg

(e)

h= ½ gt^2

2000= ½ x10t^2

t^2 =400

t=20s

x = ut

=100x20

= 2000m

Vy= -gt; Uy=0

Vy=-10x20

Vy=-200ms^{-1}

V*x*= 100ms^{-1}

Velocity with which a bomb strikes the ground

3(a)(i) velocity ratio is the ratio of distance moved by the effort to the distance moved by the load at the same time.

(ii) pitch of the screw is the distance between successive threads of the screw

(b)(i)

$$Velocity\ ratio = \frac{2\pi R}{Pitch}$$

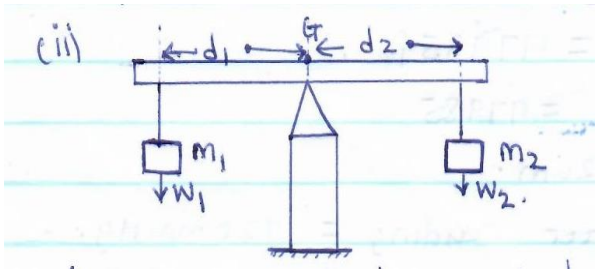
$$Velocity\ ratio = \frac{2\pi x40}{2}$$

$$Velocity\ ratio = 125.7$$

(ii)

- Applied in crane lifts
- Applied in elevators

c(i)the principle of moments states that when a body is in equilibrium , the sum of clockwise moments about a point is equal to the sum of anticlockwise moments.



- A metre rule is balanced horizontally on the knife edge and the balance point G is noted.
- Un equal known masses m_1 and m_2 of weights w_1 and w_2 are suspended from either sides of the metre rule.
- The position of mass m_2 is adjusted until the metre ruler balances again horizontally
- The distances d_1 and d_2 are measured and recorded
- The procedure is repeated by varying the distances d_1 and d_2, and each time the values of $w_1 d_1$ and $w_2 d_2$ are obtained i.e. sum of clockwise moments = sum of anti-clockwise moments about G hence verifying the principle of moments

d (i) A floating body displaces its own weight of a fluid in which it floats

(ii) Wight of a swimmer when fully underwater

= weight in air - weight of water displaced (upthrust)

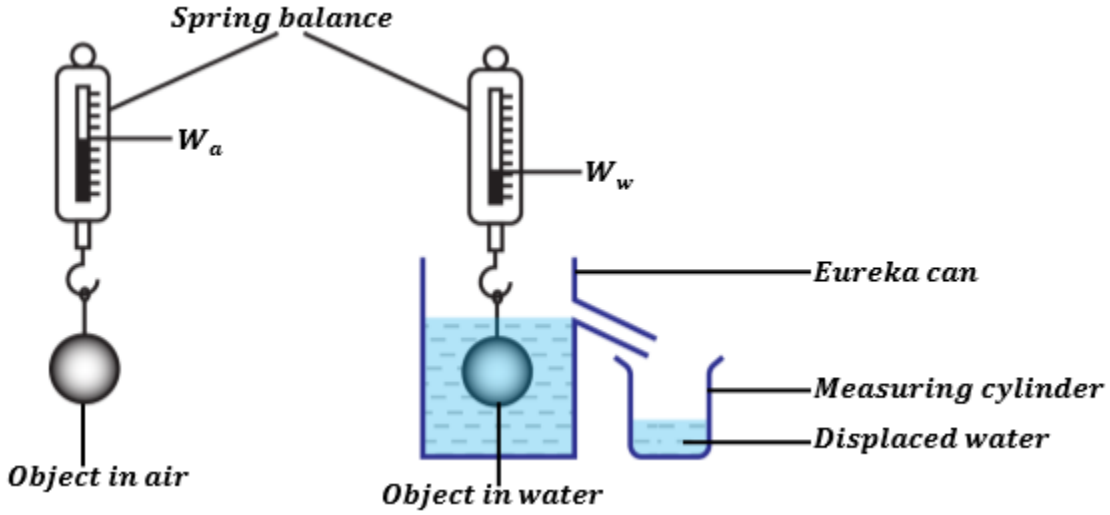
= 600 – 200

= 400N

(iii) Submarines
Ships
Hot air balloons
Hydrometer to measure relative density of liquids

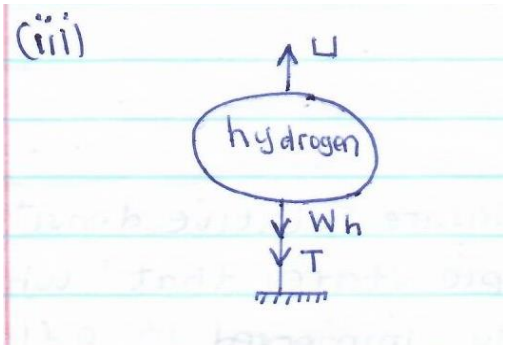
4a (i) Archimedes' principle states that when a body is wholly or partially immersed in a fluid, it experiences an upthrust equal to the weight of fluid displaced.

(ii)



- An object is weighed in air using a spring balance
- The height, w_a, is recorded.
- An overflow can is filled with water to the level of the spout.
- The weight of an empty beaker, w_b in air is measured and recorded.
- The beaker is placed below the level of the spout.
- The object is then completely immersed in water.
- The weight of the object in water *Ww* is recorded.
- Upthrust is determined from $U = Wa - Ww$
- The weight of a beaker with displaced water is measured and recorded as W_{b+d}
- Weight of displaced water is determined from $W_d = W_{b+d} - W_b$.
- It is found that $\boldsymbol{U=W_d}$ thus verifying Archimedes' principle.

(iii)



Upthrust = Tension in a string + Weight of hydrogen gas

$$U = T + W_h$$

$$M_a g = T + M_h g$$

$$\rho_a V_a g = T + \rho_h V_h g$$

$$1.2 \times 100 \times 10 = 0.18 \times 1000 \times 10 + T$$

$$T = 1020N$$

4b (i) A joule is the work done when a force of 1N moves through a distance of 1m.

(ii) The rate of doing work (Power) = Area under the curve

Power = (100 x 5) + ½ X 5(100 +200)

= 1250W

(ii) ●The hydrometer is placed in a liquid whose relative density is to be measured.

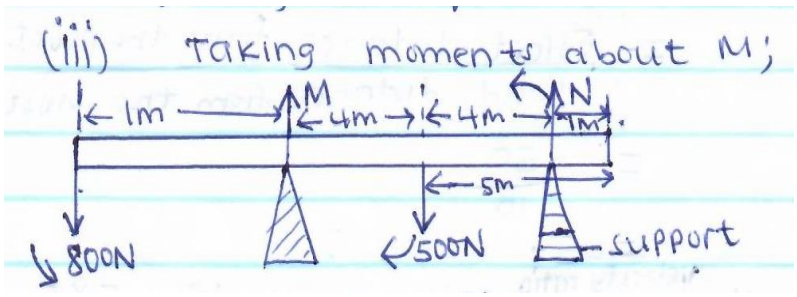
●When the hydrometer floats vertically, the value of relative density is read directly from the scale on the stem where the liquid surface ends.

5a

(i) Stable equilibrium is when a body is slightly displaced, it moves back to its original position on release while neutral equilibrium is when a body is slightly displaced, the body remains on the displaced position and the position of centre of gravity above the ground remains the same on release.

(ii)The position of centre of gravity above the ground for a half filled jerrycan of water is lower than that of an empty jerrycan. This makes it more istable than an empty jerrycan whose position of centre of gravity is higher above the ground.

(iii)



For a system in equilibrium;

Sum of clockwise moments about m = Sum of anticlockwise moments about M

$500 \times 4 = 8 \times N + 1 \times 800$

$8N = 1200$

$N = 150N$

Taking moments about N

$M \times 8 = 800 \times 9 + 500 \times 4$

$8M = 7200 + 2000$

$M = 1150N$

b (i) Efficiency is the ratio of work output to work input expressed as a percentage.

Mechanical advantage is the ratio of load to effort

(ii) Velocity ratio of hydraulic press= $\frac{\text{Area of a large piston supporting load}}{\text{Area of a small piston supporting effort}}$

Velocity ratio of hydraulic press= $\frac{100}{20}$

Velocity ratio of hydraulic press= 5

Velocity ratio of the lever arm = $\frac{Effort\ distance\ from\ the\ pivot}{Load\ distance\ from\ the\ pivot}$

$= \frac{50}{10} = 5$

Overall velocity of the machine = 5X5

= 25

$$\text{Efficiency} = \frac{\text{M.A}}{\text{V.R}} x100\%$$

$$98\% = \frac{\text{M.A}}{25} x100\%$$

$$\text{M.A} = 24.5$$

$$\text{M.A} = \frac{L}{E}$$

$$24.5 = \frac{20000}{E}$$

$$E = 816.33N$$

c (i) The Mass M_c of an empty container is measured using a beam balance and recorded

- The liquid is poured into the container and the mass of a container with a liquid M_{C+L} is measured using a beam balance and recorded.
- Mass of a liquid alone is determined from $M_L = M_{C+L} - M_C$.
- The liquid in the container is poured into a measuring cylinder and its volume, V, is read and recorded.
- The density of the liquid is determined from; $\boldsymbol{\rho = \frac{M_L}{V}}$

(ii)

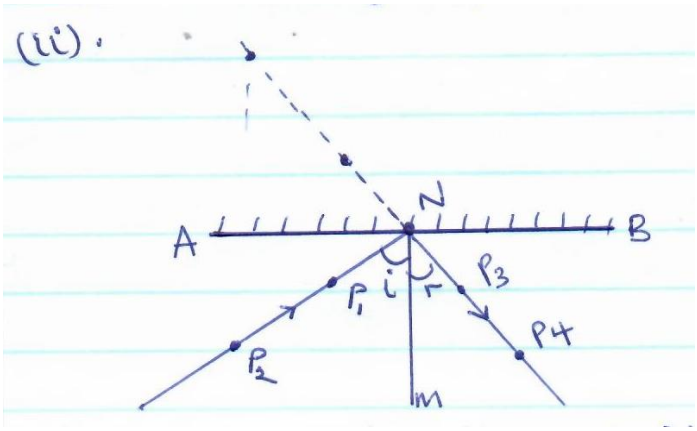
- Determine the purity of the substances
- Identify materials
- To know why objects sink or float.

LIGHT

6 a (i)

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

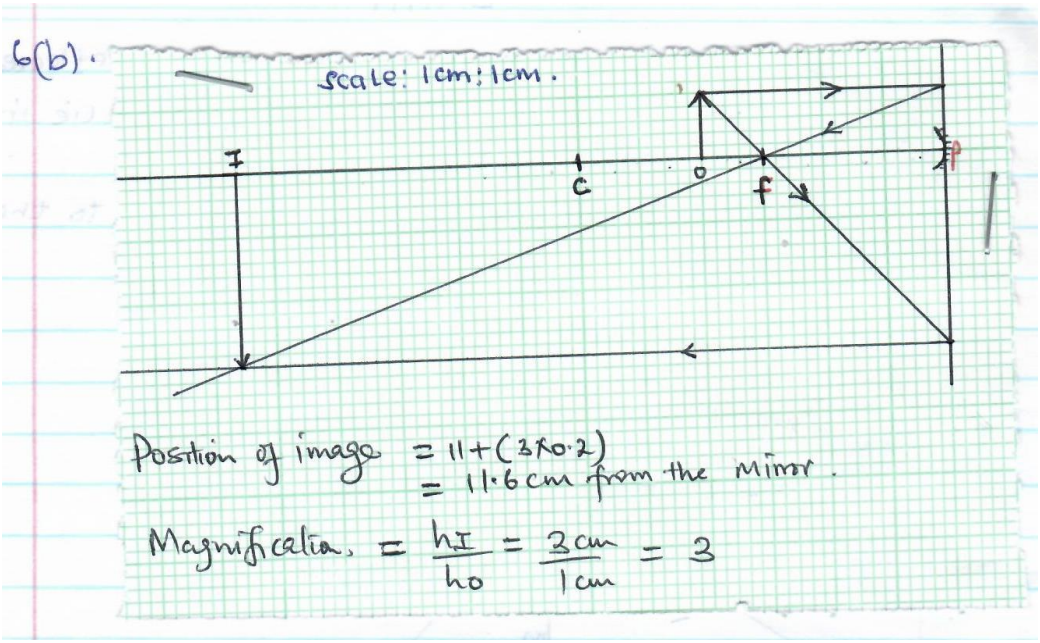
(ii)



- The white sheet of paper is fixed on a soft card board.
- A straight line AB is drawn on the white sheet of paper
- A perpendicular line MN is drawn at N to AB.
- The angle of incidence say 20^0 is measured from the normal and marked
- Pins P1 and P2 are fixed along the line marking angle i

- A plane mirror is placed on line AB with reflecting surface facing the observer
- Looking through the mirror from the right hand side, pins P3 and P4 are fixed such that they appear to be in line with images of P1 and P2
- The pins and the mirror are removed
- A line is drawn through the marks of P3 and P4 to meet AB at N
- The angle of refraction, r is measured and noted
- It is found that i = r and the incident ray, the normal and the reflected ray are all in the same plane, hence verifying the laws of reflection

(b)



c (i) Total internal reflection is a phenomenon which occurs when all light energy is reflected back into a denser medium when the angle of incidence is greater than the critical angle

(ii)

- It is applied in optical fibres to transmit signals
- It is used in prism periscopes to view objects over an obstacle
- It is used in prism binoculars to view distant objects
- It is applied in bicycle hind reflectors for alert

(d) $\sin C = \frac{1}{n}$

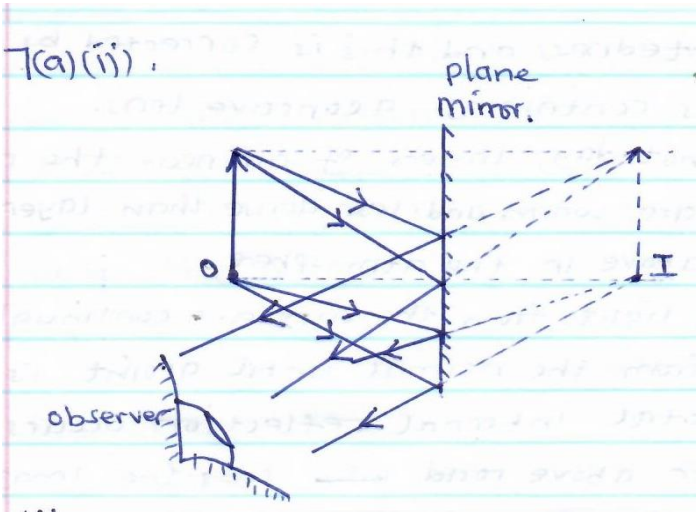
$C = \sin^{-1}(1/1.65)$

$C = 37.3°$

7(a)

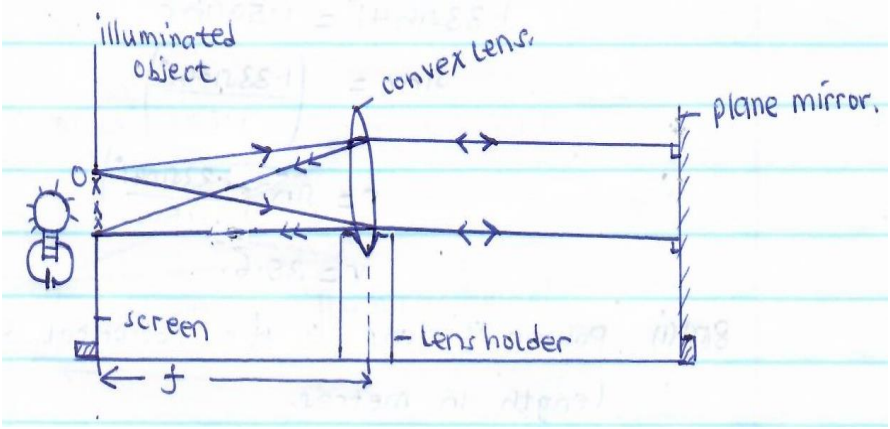
(i) A virtual image is one formed by apparent intersection of light rays and is not formed on the screen

(ii).



(iii)

When a source of light is placed at the principal focus of a parabolic mirror, the parabolic mirror produces a parallel beam of light whose intensity does not practically diminish as the distance increases.



- An illuminated object is placed in front of a converging lens behind which a plane mirror is placed.
- The position of a convex lens is adjusted until a sharp image of the object is formed on the screen besides the object.
- The distance ,**f**, is measured and recorded
- **f** is the focal length of a convex lens.

c (i)

Accommodation is the ability of the eye to change its focal length so as to focus images of far and near objects on the retina.

(ii). Short sightedness and this is corrected by wearing spectacles containing a concave lens.

d.(i). During a hot day, layers of the air near the road surface are warm and less dense than layers of air higher above in the atmosphere.

Rays of light from the sun are continually refracted away from the normal until a point is reached when total internal reflection occurs. The observer above road sees the image of the sky as a pool of water hence mirage.

(ii) **i= 90-49**

=41^0

From $nsin\ i = a\ constant$

$$n_w \sin i = n_g \sin r$$

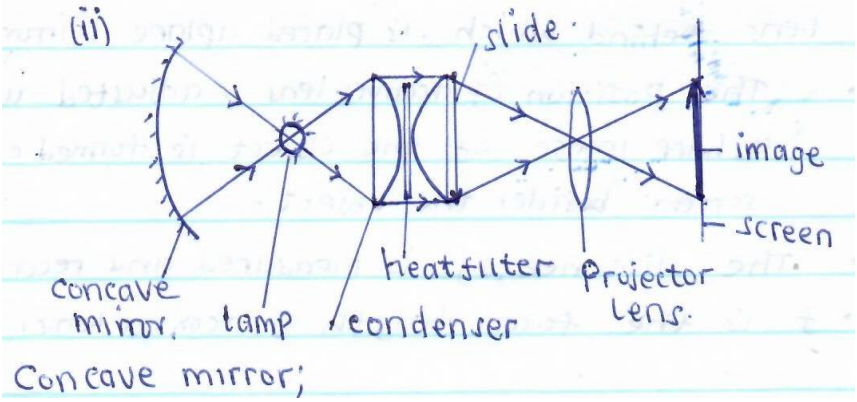
$$1.33 \sin 41 = 1.50 \sin r$$

$$r = 35.6^0$$

8(a)(i) Power of the lens is the reciprocal of its focal length in metres.

The S.I unit of the power of a lens is dioptres (D).

(ii)



Concave mirror: Reflects back light onto a condenser lens.

Lamp: Provides light which illuminates the slide

Condenser lens: Collects and concentrates light onto the slide

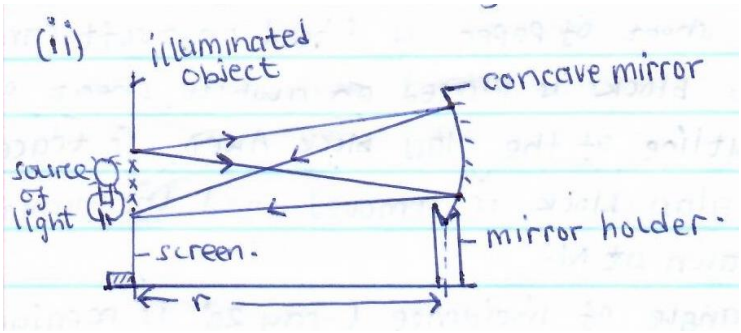
Projector lens: Focuses the image of the slide onto the screen.

The screen: This is where a real, upright magnified image of the slide is formed.

b (i) **Primary colours** are colours that cannot be obtained by mixing any other colours

Secondary colours are colours are colours that are obtained by mixing two primary colours

(ii)



The apparatus are arranged as shown.

- The position of the mirror is adjusted until a sharp image of the illuminated object is formed on the screen, besides the object.
- The distance, r, from the mirror to the screen is measured and noted and is the radius of curvature of the mirror.
- The focal length of the mirror is determined from **f =** $\frac{r}{2}$

(c). **P =** $1/f(m)$**;**

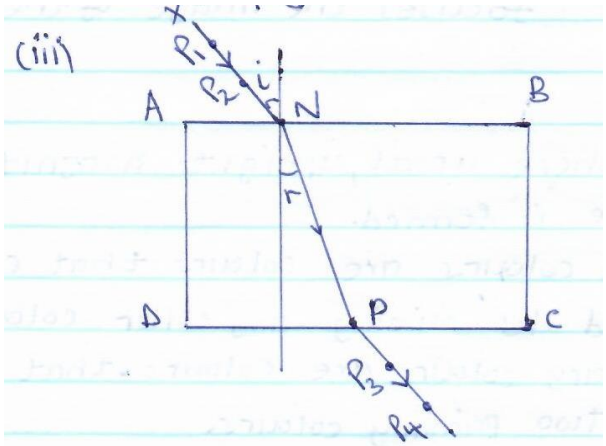
P = $\frac{1}{0.05}$

=20D

9 a (i)Refractive index is the ratio of speed of light in the vacuum to the speed of light in a given medium

(ii) **n =** $\frac{C}{V}$

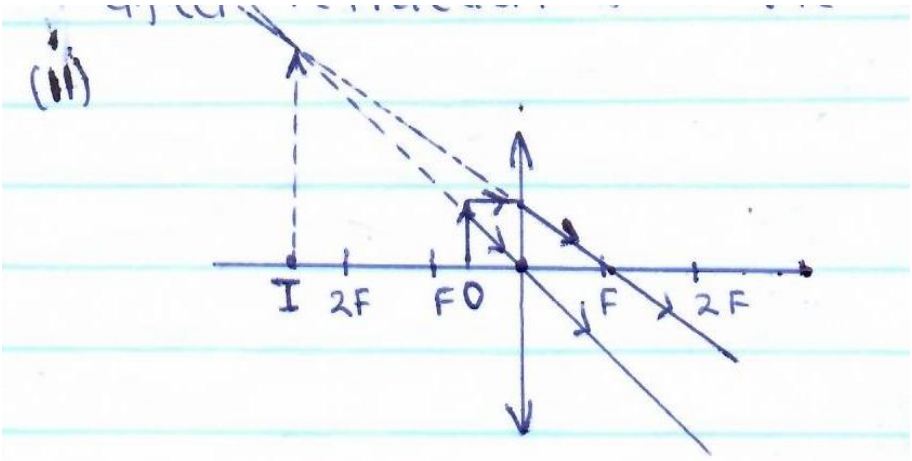
= $3x10^8/2x10^8$ **= 1.5**



- A white sheet of paper is fixed on a soft card board
- A glass block is placed on a white sheet of paper.
- The outline of the glass block ABCD is traced.
- The glass block is removed and the normal to AB is drawn at N
- The angle of incidence **i** say 20^0 is measured from the normal at N and line XN drawn.
- Pins P1 and P2 are fixed along XN.
- The glass block is placed on its outline looking through the glass block from side DC, Pins P3 and P4 are fixed such that they appear to be in a straight with images of P1 and P2.
- The pins and the glass are removed
- A line is drawn through marks of P3 and P4 to meet DC at P a line is drawn joining N to P
- The angle of refraction, r is measured and recorded.
  - The experiment is repeated for increasing values of angle, i and corresponding values of r are obtained.
  - Results are tabulated including values of sin i and sin r.
  - A graph of sin i against sin r is plotted.
  - The slope, s is determined and is the refractive index of the glass material.

(b)(i) Focal length is the distance between the optical center and the principal focus of the lens. Principal focus is a point on the principal axis to which all rays originally parallel and close to principal axis converge or appear to come from after refraction from the lens.

ii)



The image formed is;

- Virtual
- Upright
- Magnified

iii) P = $\frac{1}{f}$

= $\frac{1}{-0.2}$

= - 5 D.

d) The green object appears green since green colour is refracted and red colour is absorbed.

MODERN PHYSICS

10a(i)Isotopes are atoms of the same element having the same atomic number but different atomic mass.

(ii) It has 6 protons.

It has 8 neutrons.

b (i) Alpha particle is a helium nucleus while a gamma radiation is an electromagnetic radiation of short wave length emitted by radioactive substances.

- Alpha particle is positively charged while gamma rays carry no charge.
- Alpha particle when emitted, the mass number of the parent nucleus reduces by 4 and the atomic number by 2 while the gamma rays cause no change in both the mass number and the atomic number.

ii) Radioactive material should be kept in lead containers when not in use.

- They should be held with forceps or pair of tongs and not with bare hands.
- Avoid eating, drinking or smoking where radioactive materials are in use.
- Any cut on the body should be covered before dealing with radioactive substances.
- You should wear gloves and lead coats when using radioactive materials.

c(i)

$$^{60}_{27}Co \qquad\qquad ^{60}_{27}M + \ ^{0}_{-1}e + energy$$

Mass number of M is 60.

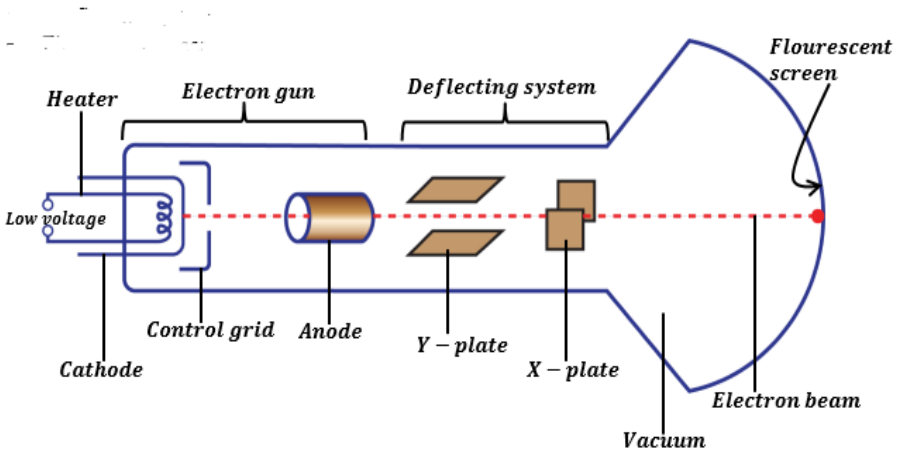
Atomic number of M is 28.

c (ii)

- Cause leukemia (blood cancer)
- Cause sterility (inability to produce)

- Cause blindness
- Cause mutation
- Cause skin burn (redness and sores on the skin).

d(i)



The cathode ray oscilloscope consists of three main parts : electron gun, deflecting system and the fluorescent system.

Electron gun: It consists of:

- Heater which heats the cathode.
- Cathode which emits electrons due to thermionic emission.
- Control grid which regulates the brightness of the spot on the screen by controlling the number of electrons reaching the screen.
- Anodes A_1 and A_2 which accelerate and focus electrons onto the fluorescent screen.

Deflecting system: it consists of the

- X- Plates which are vertical and deflect the electron beam horizontally.
- Y- Plates that are horizontal and deflect the electron beam vertically.

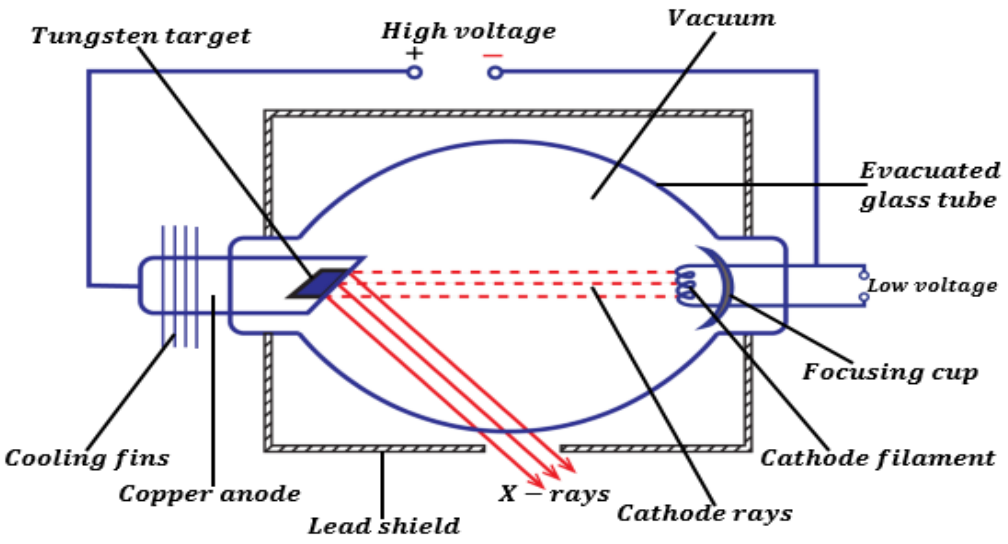
Fluorescent screen which provides a background on which the patterns of the wave forms to be studied are formed.

ii) X which is the bright spot at the Centre is obtained when the time base is off and no signal on the y plates.

Y which is sinusoidal wave is obtained when the time base is switched on and y plates connected to a signal

11. (a)(i) X-rays are electromagnetic radiations of very sort wave length produced when fast moving electrons strike a metal target.

(ii)



The cathode is heated by a low voltage supply to produce electrons thermionically.

The electrons produced are focused by the focusing cap and accelerated by a very high p.d (E.H.T) connected across the tube..

When electron's strike the target, they are decelerated rapidly and x-rays are produced .The largest percentage of the kinetic energy of electrons goes into production of heat and the rest into x-rays. The heat is conducted away by the copper anode which is cooled by cooling fins.

(iii)

- X-rays are used to detect bone fractures in the body.
- X-rays are used to treat cancer
- X-rays are used to detect cancer
- X-rays are used to sterilize medical equipment
- X-rays are used for DNA test (that was the first method)
- X-rays are used to detect ulcers
- X-rays are used to detect and to treat brain tumors

(b)(i) Nuclear fusion is the process where two light nuclei combine to form a heavier nucleus with release of energy while nuclear fission is the process where a heavy nucleus splits into two lighter nuclei with release of energy.

(ii) During nuclear fission, a heavy nucleus breaks up into two lighter nuclei which are more stable, the total mass of the lighter nuclei is less than the mass of a heavy nucleus. The difference in mass is accounted for the energy released.
(iii) The uranium atoms in the nuclear reactor are bombarded with energy neutrons. This drives Uranium atoms into excited state (they become more unstable) and then breaks into lighter nuclei: with the release of a lot of energy (heat energy).This heat boils water in the boiler, producing too much steam at high pressure. The steam drives the turbines of the generator, hence generating electricity.

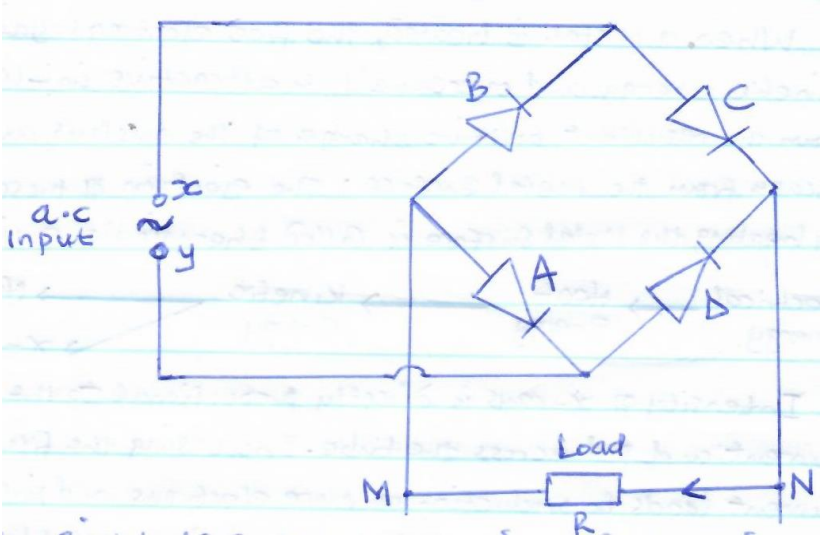
c. Let the initial activity be A_0

12(a). Photoelectric emission is the ejection of electrons from metal surfaces when electromagnetic radiation of high enough frequency falls on them.

b) (i) Photoelectric emission occurs only when the frequency of incident electromagnetic radiation exceeds the threshold frequency for a metal.

The metal surface should be clean.

(ii)This can be done using a bridge rectifier. Four diodes A, B, C and D connected to a.c input and load R are used as shown below;



In the first half cycle, when x is made positive relative to y, diodes A and C conduct while B and D don't conduct. In the second half cycle, when y is made positive relative to x, diodes B and D conduct and A and C do not conduct.

In each half cycle, the current through the load is in the same direction, that's from N to M hence full-wave rectification.

(c) (i) The fluorescent screen glows when struck by electrons and acts as a display for the wave forms.

(ii).

- C.R.O is used to measure both a.c and d.c voltages
- It is used for measuring and comparing frequencies.
- It is used for measuring phase differences.
- It is used as a clock to measure very small time intervals

(d) (i)

$$^{226}_{88}X \qquad\qquad ^{222}_{86}Y + {}^{4}_{2}He$$

(ii) The mass number would not change but atomic number would increase by 1.

13. (a)(i). Thermionic emission is the ejection of electrons from the metal surface when it is heated.

(ii). Cathode rays are streams of fast moving electrons.

(b). When a metal is heated, the free electrons gain more kinetic energy and overcome the attractive inward force from the resultant positive charge of nucleus and then escape from the metal surface. The ejection of these electrons by the metal surface is called thermionic emission.

(c)$electrical\ energy \qquad heat\ energy \qquad kinetic\ energy \qquad heat\ and\ x-rays$

(d)(i). Intensity of x-rays is directly proportional to the filament current and p.d across the tube. Increasing the filament current leads to production of more electrons and increasing the p.d across the tube, more energy is available for x-ray production.

The penetrating power of x-rays increases with the p.d across the tube. This p.d accelerates electrons and hence gives energy.

(ii). The photographic plate is placed behind the suspected part of the body and x-rays are directed towards that part. The broken part of the bone will appear dark on the photographic plate and unbroken part of the bone absorbs these x-rays and the plate is not affected.

(e). Balancing charges; **92+0 = 56 + y + (3x0)**

y = 36

Balancing mass numbers; **235+1 = x + 92 + (3x1)**

x = 141

(f)

- A C.R.O measures both a.c and d.c voltages.
- It is not affected by overloading
- Electron beam behaves as a pointer of negligible inertia responding instantaneously and having a perfect “dead beat” action.
- It has almost infinite resistance to d.c and very high opposition to a.c, so the circuit to which connection is made is little affected.

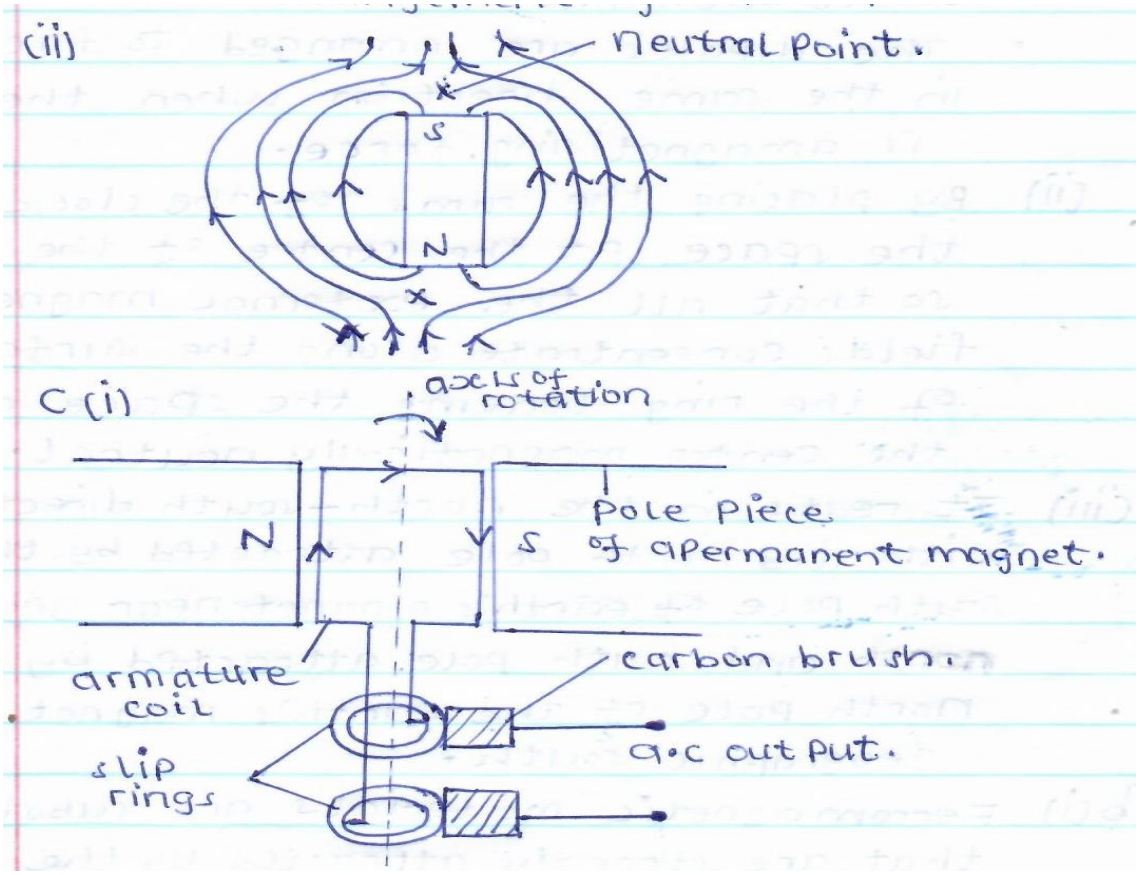
MAGNETISM

14a i) Magnetic saturation is a state when all magnetic dipoles in the magnetic material are aligned in the same direction and the material cannot be magnetized any further..

ii) Magnetic shielding is the creation of a magnetically neutral space in the neighborhood of a magnetic field irrespective of the strength of the field.

(b) (i)

- A solenoid is connected to alternating current supply.
- A magnet is placed in a solenoid while resting in east- west direction.
- The current is turned on and off.
- The magnet is removed and it is found to have lost magnetism of the dipoles.



- By converting sli[p rings into half-slip rings which lose contact with carbon brushes when the armature coil reaches the upper most position. This maintains current in the external circuit in the same direction.

d (i) P.d across the galvanometer

$$= I_g x R_g$$

$$= 0.002x40 = 0.08V$$

(ii) By connecting a high resistance resistor (multiplier) in series with the galvanometer.

C (ii) Transmitting a.c at high voltage implies small current which minimizes power loss in form of heat.

15(a)(i)All magnetic materials are made of tiny magnets called dipoles.

- These dipoles are found in small groups called domains.
- The dipole arranged to face in the same directions when there is a magnetizing force.

(ii) By placing the arms of the clock in the space at the Centre of the ring so that all the external magnetic fields concentrate along the surface of the ring leaving the space at the center magnetically neutral.

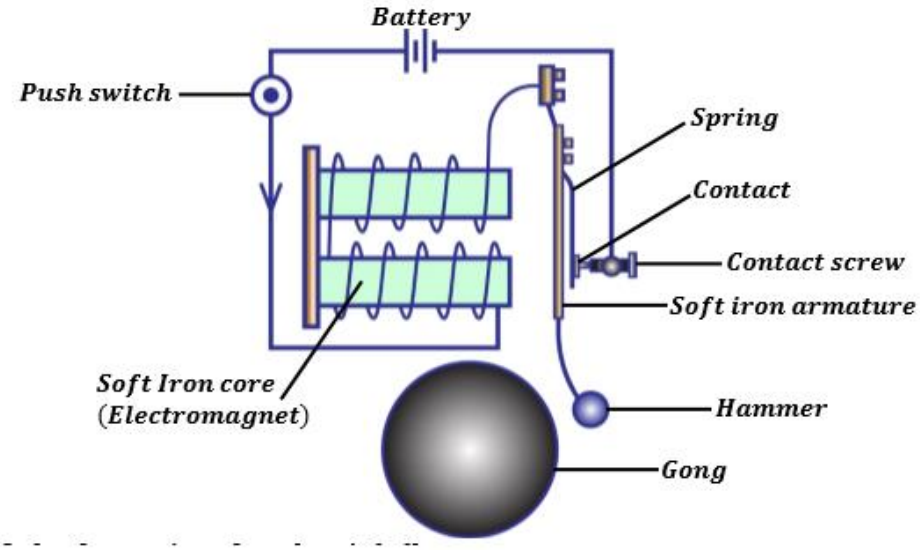
(iii) It rests in the north-south direction with its north pole attracted by the south pole of the earth's magnet near the geographic north and the South Pole attracted to the north pole of the earth's magnet near the geographic south.

(b) (i) Ferromagnetic materials are substances that are strongly attracted by the magnet.

(ii)Diamagnetic materials are substances that are weakly repelled by the magnet.

(iii) Neutral point is a region in magnetic field where the resultant magnetic force is zero

(c)



- When switch is closed, current flows through the coil wound round the soft iron. The soft iron becomes magnetized and attracts the soft iron armature.
- The hammer hits the gong and sound is produced.
- The circuit is broken at the contact screw and no current flows.
- The soft iron is demagnetize and no longer attracts the armature.

- The springy metal attracts the armature and contact is regained. This completes the circuit and the cycle is repeated.
- The hammer continuously hits the gong as long as the switch is closed.

d (i) P.d across the galvanometer = P.d across the resistor (shunt)

$$I_g R_g = I_s R_s$$

$$I_s = I - I_g$$

$$\text{Therefore, } 0.025 \times 4 = (15 - 0.025) R_s$$

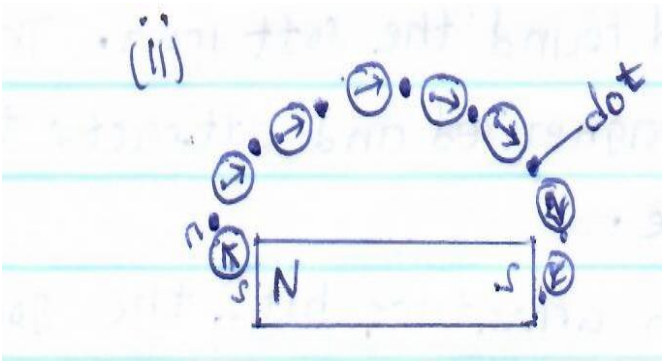
$$R_s = 0.0067\ \Omega$$

d(ii)

- Winding a secondary coil on top of a primary coil to minimize energy loss due to flux leakage
- Laminating the soft iron core to minimize energy loss due to eddy currents.
- Using a more soft iron core material to minimize energy loss due to hysteresis.
- Using thick copper wires to minimize energy loss due to joule heating.

16(a)(i) It states that l like poles repel and unlike poles attract each other;

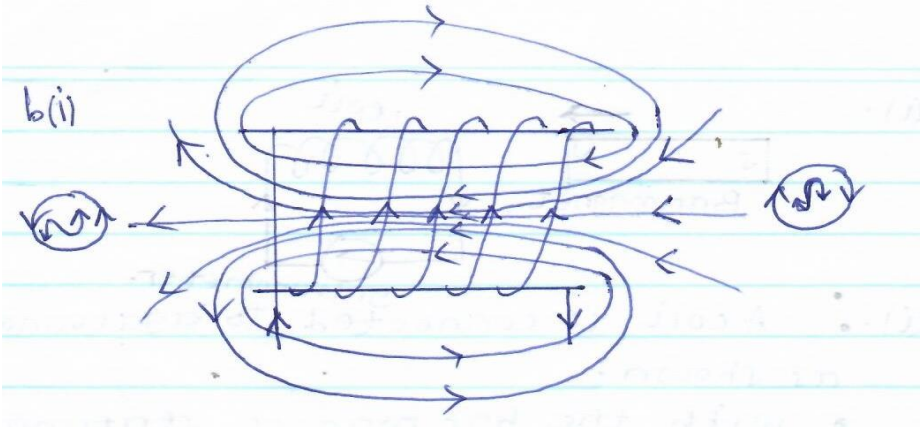
(ii)



- A bar magnet is placed on a piece of paper
- The outline of the bar magnet is marked and its poles indicated on the paper.
- The direction of the north pole of a plotting compass is marked with a pencil dot

- The plotting compass is then placed at the position of the dot to mark the new direction of the North Pole.
- The process is continued until South Pole of the bar magnet is reached.
- The dots are joined using a smooth curve which represents the magnetic field line

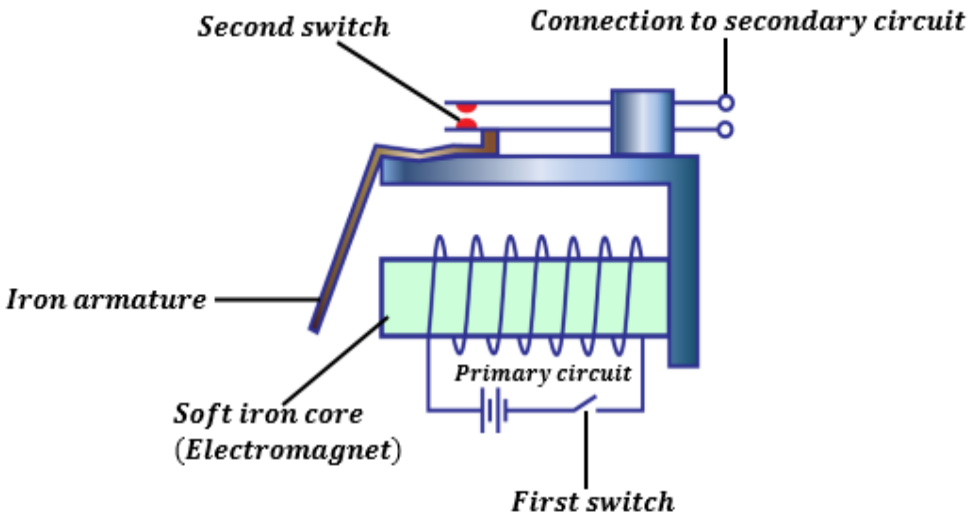
b(i)



(ii)

- The size of current flowing through the coil
- The number of turns of coils

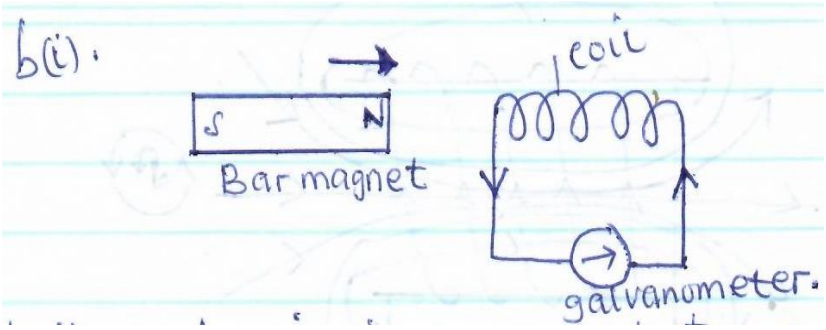
(c)



- The primary circuit supplies current to the soft iron (electromagnet).
- The soft iron gets magnetized and it then attracts the iron armature.
- As the armature is attracted, the contacts of the second switch are closed and current flows to the secondary circuit.
- When current in the primary circuit is switched off, the electromagnet loses its magnetism. This makes the iron armature to return back to its original position thus making the contacts of the second switch to become open again

17 (a).
Faraday's law states that the magnitude of induced emf is directly proportional to the rate of change of magnetic flux linked with the circuit or coil.
Lenz's law states that the direction of induced emf in a coil is such as to oppose the change causing it

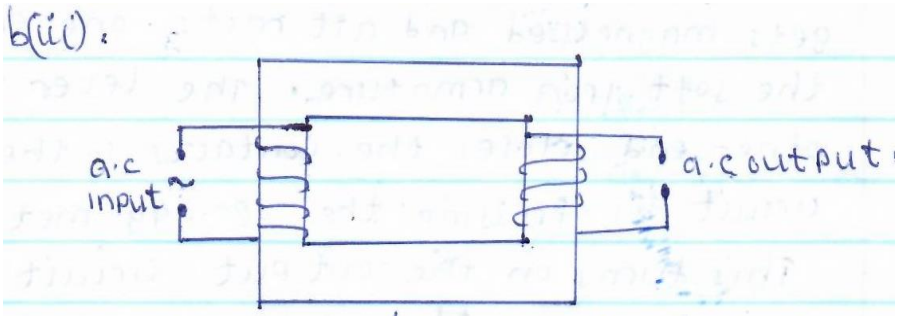
b(i)



- A coil is connected to galvanometer as shown
- With the bar magnet stationary , the pointer does not deflect
- When the bar magnet is moved towards one end of the coil., The pointer is seen to deflect in one direction of the coil

- When the bar magnet is moved away from the coil, the pointer is seen to deflect in on the opposite direction .this demonstrates electromagnetic induction

b(ii) Mutual induction is the generation of emf in coil due to change in current in a nearby coil.



- A transformer consists of a laminated core of magnetically soft material.
- A primary coil is wound on the soft iron core and connected to the input alternating emf
- The secondary coil is wound on the soft core that produces the emf to be taken to the load.
- When alternating current passes through the primary coil, a changing magnetic field is set up through the soft iron core.
- The magnetic field lines then cut through the secondary coil and changing emf is induced in the secondary coil to be taken up by the load.

(iv). A broken magnet has fewer dipoles and magnetic domains which determine the strength of a magnet, hence weak

c(i) Flemings left hand rule states that when the first finger, second finger and thumb of the left-hand are placed mutually at right angles, the first finger points in the direction of magnetic field, the second finger points in the direction of current and thumb points in the direction of force.

d(i)

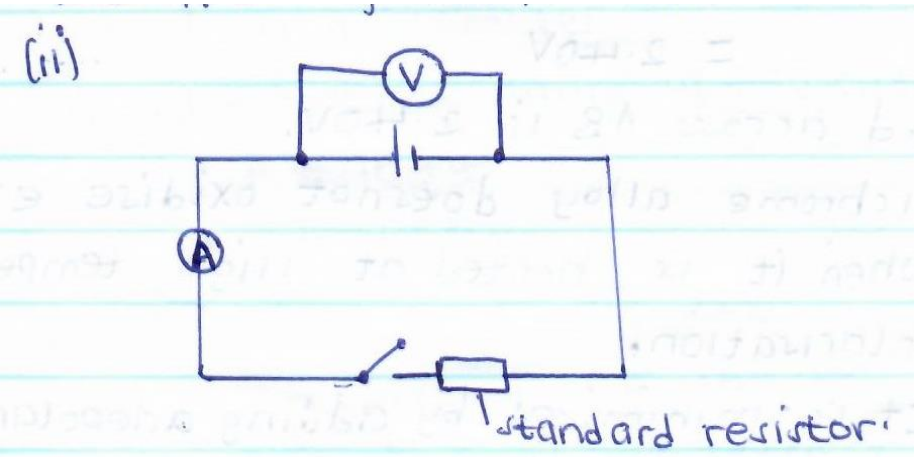
- To magnetise the soft iron core
- It is attracted towards the electromagnet
- The reading of the spring balance increases.

CURRENT ELECTRICITY

18 a i) **Terminal p.d** is the work done to move one coulomb of charge across terminals of a cell in a closed circuit.

Lost volts is the work done to move one coulomb of charge within a cell against internal resistance of a cell.

Internal resistance is the opposition to the flow of current with in a cell.



- With the switch open, the voltmeter reading, E is read and recorded
- The switch is closed, and the new voltmeter reading, V is noted.
- The ammeter reading, I is also noted
- The internal resistance of a cell is determined from $r=\left(\frac{E-V}{I}\right)$

b) i) **ohm's law** states that the current flowing through a conductor is directly proportional to the potential difference across its ends provided temperature and other physical conditions are kept constant.

ii) 3Ω and 6 Ω resistor are in parallel

Let their effective resistance be R_p

$R_p=\left(\frac{3\ x\ 6}{3\ +6}\right)$

=2 Ω

R_p and 8 Ω are in series; let their effective be R

R= 2+8

=10 Ω

E= I(R+r); r=0 (negligible) "ohms law may also be used"

12= I (10)

I =1.20A

P.d across parallel connection;

$V_p= IR_p$

=1.20 x 2

=2.40V

P.d across AB is 2.40V

c) Nichrome alloy does not oxidize even when it is heated at high temperatures

d) Polarization

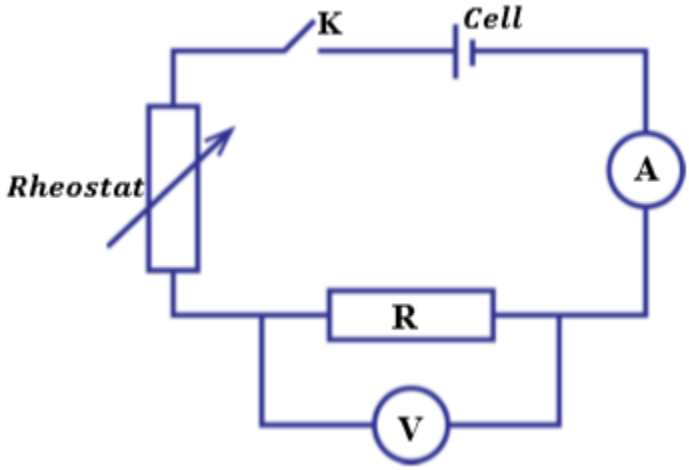
- It is minimized by adding a depolarizer in the electrolyte

Local action.

- It is minimized by using pure zinc to avoid impurities in the cathode which keeps on dissolving into the electrolyte.

19 a (i) **E.M.F** is the potential difference across the terminals of a cell in open Circuit.

(ii)



- The circuit is arranged as shown.
- Switch K is closed and using a suitable setting of the rheostat, the ammeter reading I and voltmeter reading V are noted.
- The rheostat is adjusted to obtain other several values of I and V
- Results are recorded in a suitable table
- A graph of V against I is plotted which gives a straight line through the origin which verifies Ohm's law.

b(i) X is an ammeter
Y is a voltmeter

(ii) Effective resistance of the circuit

R = 10 + 4

= 14 Ω

Effective E.M.F;

E = 2 x 8

= 16V

Effective internal resistance

R = 0.5 x 8

= 4.0 Ω

E = I (R + r)

16 = I (14 + 4)

I =0.89 A

The reading of x is 0.89 A

P.d across the 4 Ω resistor

V = I R

= 0.89 x 4

= 3.56 V

The reading of Y is 3. 56 V

c)

- Draw the same voltage from the source.
- A fault in one does not affect others
- They can be controlled by one switch

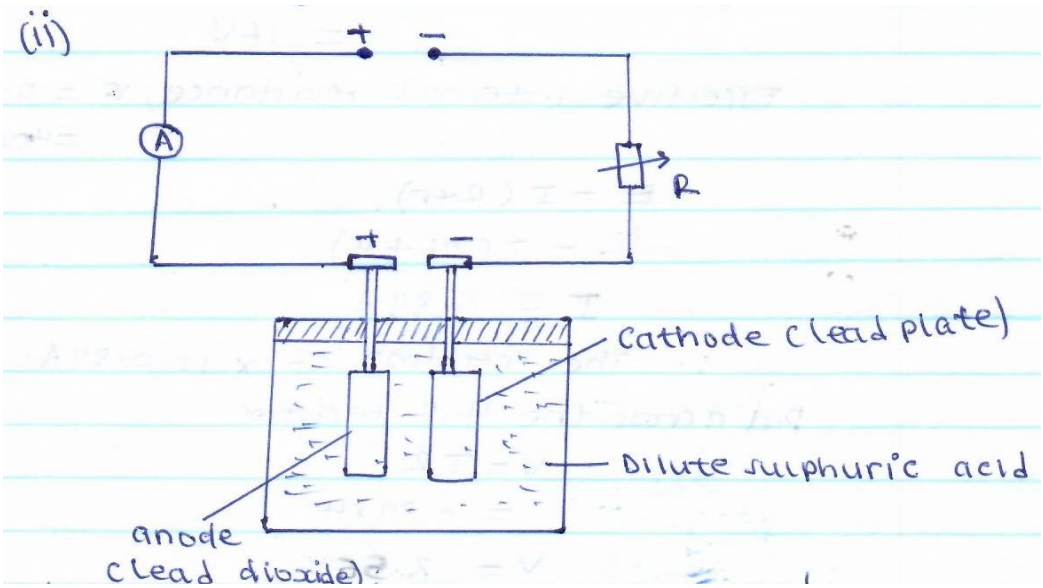
d)

- They do not produce too much heat
- The energy consumption is low.

20 a (i)

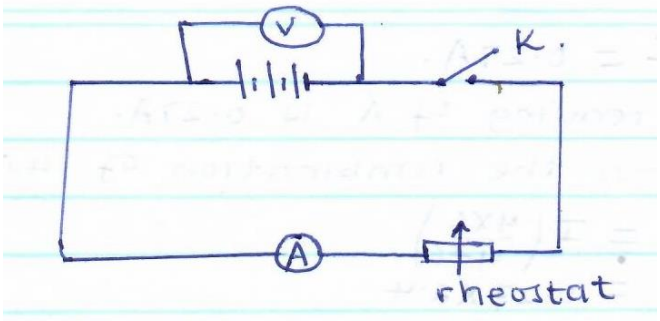
- Lead acid accumulators should be charged regularly using recommended values of current.
- The terminals should be kept dry and clean
- Avoid short circuiting the terminals by joining them together
- It should be placed on an insulator not directly on the floor
- The relative density of the electrolyte should be maintained above 1.25 by refilling with distilled water.

(ii)



- The tops of an accumulator are removed.
- The positive terminal of an accumulator is connected to the positive terminal of the d.c supply and the negative terminal of the accumulator is connected to negative terminal of the d.c supply whose EMF is greater than that of an accumulator
- The rheostat is adjusted for recommended charging value of current to flow.
- When it is fully charged, the gas bubbles are produced by the positive terminal.

(b)



- The circuit is arranged as shown above.
- Switch k is closed the rheostat is adjusted for a suitable value of current I.
- The ammeter reading I and voltmeter reading V are noted.
- The rheostat is then adjusted to obtain other several values of I and V

- The results are recorded in a suitable table
- A graph of V against I is plotted.
- The intercept, E on V-axis is read and recorded which is the value of emf of the battery.

c) Effective emf of the circuit = Emf of a single cell.

E = 1.50 V

Effective internal resistance;

$$r = \left(\frac{0.5 \; x \; 0.5}{0.5 + 0.5}\right)$$

r = 0.25 Ω

Effective external resistance

$$R = \left(\frac{4 \; x \; 6}{4+6} + 3\right)$$

R = 5.4 Ω

E = I (R + r)

1.50 = I(5.4 + 0.25)

I = 0.27 A

The reading of A is 0.27 A

P.d across the combination of 4 Ω and 6 Ω

$$V_p = I\left(\frac{4 \; x \; 6}{4 \; x \; 6}\right)$$

V_p = 0.27 x 2.4

V_p = 0.65 V

Current through the 6 Ω resistor

$V_p = I_1R_1$

0.65 = I_1 x 6

I_1 = 0.11 A

The reading of A_1 is 0.11A

d) (i)

This means that an electric appliance consumes 1800J of electrical energy every second when connected to 200V supply

(ii)

P = 1800w

$=\frac{1800}{100}$

= 1.8 kW

T= $2\frac{1}{2}$ hrs

= 2.25 hrs

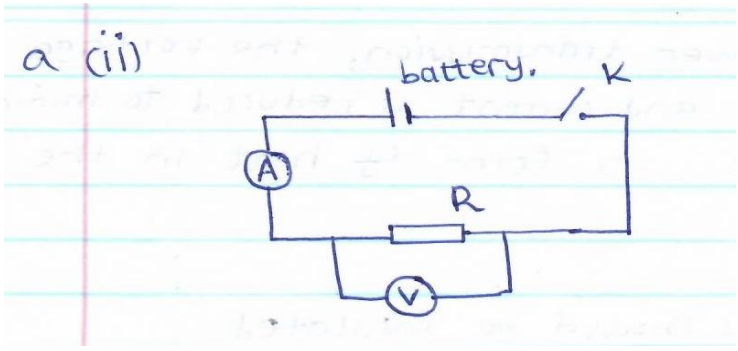
Total cost = P (kW) x t (hrs) x unit cost

= 1.8 x 2.25 x 850

= ug shs. 3442.5

21 a (i) **Electrical conductor** is a material which allows electricity to flow through it while an **insulator** is a material which does not allow electricity to flow through it

.ii)



- The circuit is arranged as shown above
- The voltmeter is connected across the conductor R
- Switch K is closed.
- The ammeter reading, I and voltmeter V reading are noted.
- The resistance of a conductor is obtained from R = $\frac{V}{I}$

iii)

- Dilute sulphuric acid
- Thermionic diode
- Filament lamp
- Neon gas
- Semi- conductor diode

b)

$E = I(R + r)$; $V_1 = I_1R_1$; $I_1 = \frac{2}{5}$

$E = 0.4 (5 + r)$ …… (i)

$V_2 = I_2R_2$

$2.4 = 8\ I_2$

$I_2 = 0.3$ A

$E = O.30 (8 + r)$……ii)

(i) = (ii)

$0.4(5 + r) = 0.3 (8 + r)$

$2 + 0.4r = 2.4 + 0.3r$

$0.1r = 0.4$

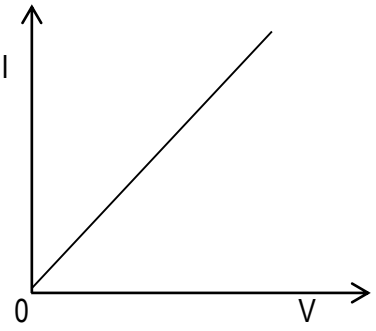
$r = 4\Omega$

C i) during power transmission, the voltage is stepped up and the current is reduced to minimize power loss in the form of heat in the cables.

ii)

- The wires should be insulated.
- The circuit breaker should be connected to the live wire.
- The switch should be connected to the live wire.
- All live wires should be kept away from water and fire.
- All wire should be kept out of reach of children.

d)



WAVES

22(a)

(i) Mechanical waves are waves formed by periodic disturbance of material medium while electromagnetic waves are waves formed by oscillating electric and magnetic fields.

(ii) Gamma rays, x-rays, ultra-violet radiation, visible light, infrared radiation and radio waves (microwaves).

(iii) $\lambda = 150m$, $v = 3x10^8\ ms^{-1}$, $f = ?$

Using,

$V = f\lambda$

$F = v/\lambda$

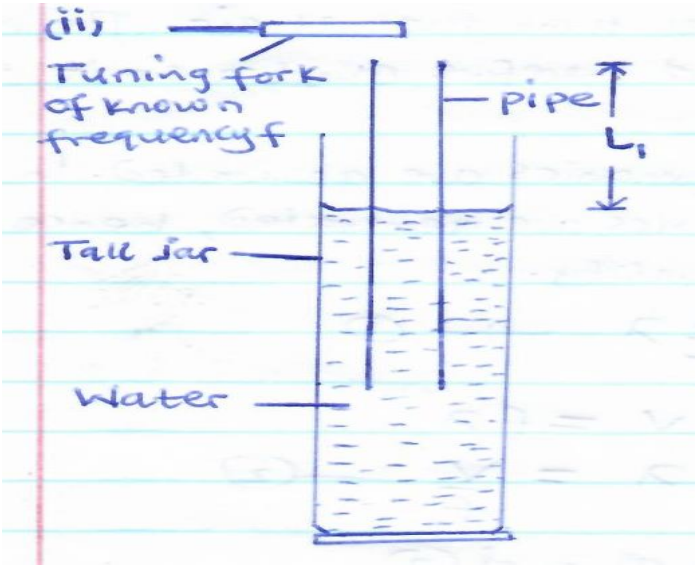
$= (3x10^8)/150$

$= 2.0x10^6\ Hz$

(b)

(i) This statement means that sound travels a distance of 330m in one second in air.

(ii)



- Water is poured in the tall jar

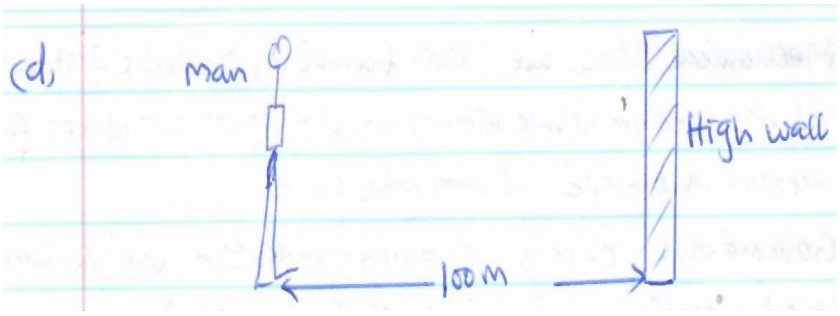
- An open pipe is inserted into the tall jar to form a closed pipe
- A vibrating tuning fork of known frequency
- The pipe is raised until the first loud sound is heard and length, L_1 of air column is measured and recorded.
- The pipe is raised further until the second loud sound is heard and the length, L_2 of air column is measured and recorded.
- The speed of sound is calculated from; $V = 2f(L_2 - L_1)$

(c)

This is due to;

- Absorption sound energy in the body. Some sound energy is converted into thermal energy in the body.
- Loss of energy (attenuation) due to reflection of sound at the tissue level.

(d)



$V = \frac{2d}{t}$

$V = \frac{2X100}{0.6}$

$V = 333.333ms^{-1}$

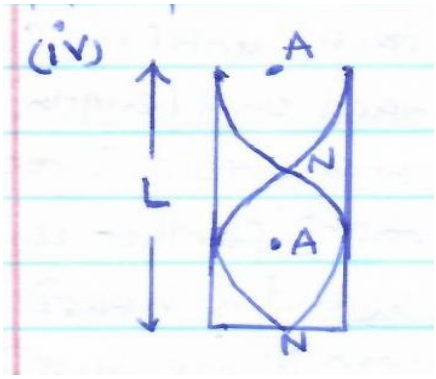
23(a)

(i) Sound is a longitudinal wave produced by vibrating bodies that stimulate the sensation of hearing.

(ii) Solids have higher densities than that of air. The molecules of solids are closer together and therefore can transmit the vibrations (energy) faster.

(iii) In closed pipe, only odd harmonics are generated. In open pipe both odd and even harmonics are generated; hence open pipes produce sound of better quality.

(iv)



L = $\frac{3\lambda}{4}$ 1

From V= fλ

λ = $\frac{V}{f}$ 2

combining 1 and 2

L = $\frac{3V}{4f}$

L= $\frac{3X320}{4X260}$

L = 0.9231m

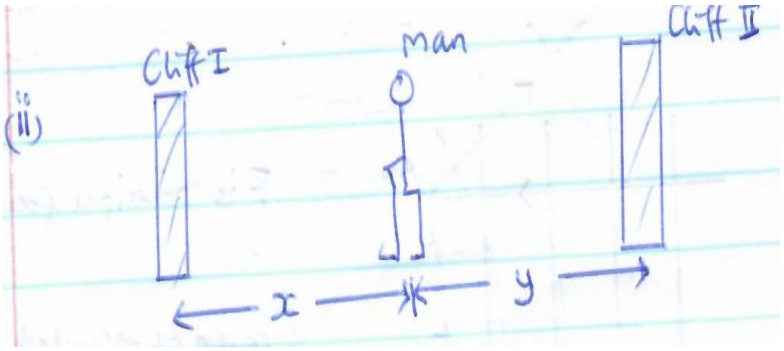
(b)

(i) **Period** of a wave is the time taken for the particle of the medium to make one complete oscillation while frequency of a wave is the number of complete oscillations made in one second.

Frequency of a wave is inversely proportional to the period of a wave; That's

f = $\frac{1}{T}$

(ii)



If a man is standing mid-way, x = y

V = $\frac{2x}{t}$

X = $\frac{Vt}{2}$ = $\frac{330X3}{2}$ =495m

Total distance between the cliffs = x + y

=495 + 495

=990m

(C)

Two experiments; one to make sound and the other to carry out the timing, station themselves a known distance, d from a high wall.

One experimenter claps together two small wooden blocks and adjusts the rate of clapping until each clap is made simultaneously with the arrival of the echo from the previous clap.

The second experimenter uses a stop clock/stopwatch and measures the time for n-clap intervals.

Sound travels a distance =2d

Time taken to cover distance 2d = t/n

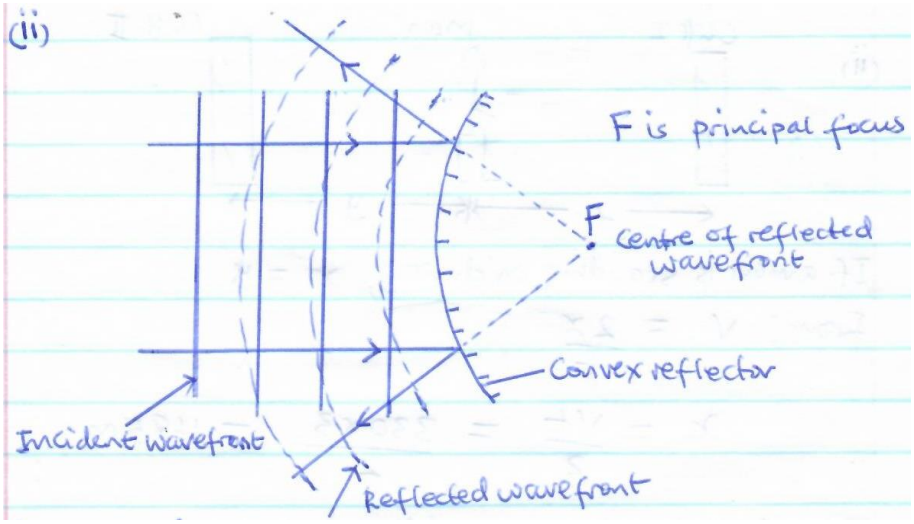
Velocity of sound, V=2d/ (t/n)

V= 2nd/t

24(a)

(i) Longitudinal waves is the wave in which particles of the medium vibrate parallel to the direction of propagation of the wave while transverse wave is the wave in which particles of the medium vibrate perpendicular to the direction of propagation of the wave.

(ii)



(b)

(i) **Industrial uses** of ultrasonic sounds are;

- Testing the quality of the linings and pads used in vehicles and aircrafts.
- Cleaning Jewelry (jewelry and other similar articles are cleaned thoroughly if they are immersed in a tank of cleaning solution through which ultrasonic waves are passed)
- Dirt is readily removed from crevices by high frequency vibrations which are setup.

Medical uses of ultrasonic sounds are;

- Scanning a portion of a body is done using ultra sonic beam.
- Cleaning of surgical instruments can be done using ultrasonic sound waves.

(ii)

Echo sounder is an electrical device which is fitted at the bottom of the ship. It sends out regular sound pulses which are reflected back from the seabed. The reflected sound is received by a hydrophone which is a microphone designed to work in water. The time interval between emission of a signal and its arrival back to the ship I s computed by a special circuit and gives indication of the depth as the ship proceeds on its way.

(C)

(i)

- Length of the string
- Tension in the string
- Mass per unit length

(ii)

$L = \frac{1}{2}\lambda$

$\lambda = 2 \times 0.47$

$\lambda = 0.94m$

Using $V = f\lambda$

$V = 50 \times 0.94$

$V = 47ms^{-1}$

25(a)

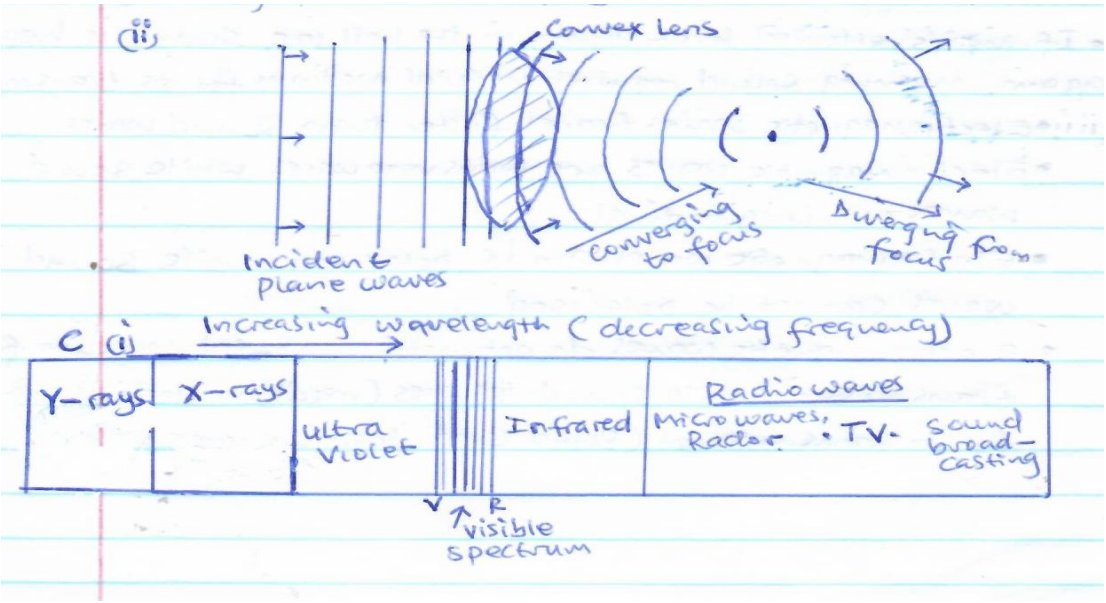
(i) **Amplitude** of a wave is the maximum displacement of a particle of the medium from its rest position.

(ii) **Antinode** is the point of maximum displacement of a particle of the medium from rest position on a stationery wave.

(b)

(i) **Interference** of waves is the superposition of two or more identical waves, travelling in the same direction resulting into a wave of greater or lower amplitude.

(ii)

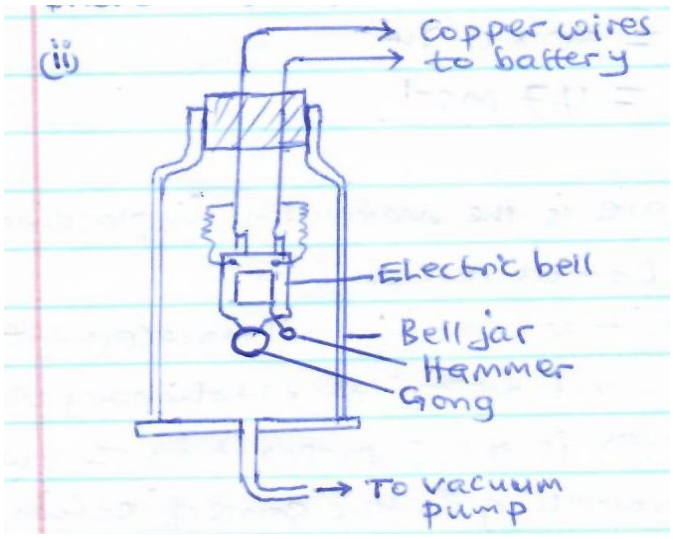


C(ii) **A band** is any particular range of wavelengths of electromagnetic waves.

(d)

(i) It is due to refraction of sound waves. On clear days, the lower layer of the atmosphere is hotter than the layers above. Since sound travels faster in hotter medium, its speed is greater near the surface and as a result, the waves are bent away from the surface. On a clear night, the lower layer of the atmosphere is colder than the air above. Sound travels faster at the higher layers than at the lower layers and thus, the waves are bent towards the earth's surface. The intensity of sound increases and seems to travel a greater distance.

(ii)



- When an electric bell is switched on, the hammer is seen striking the gong and sound is heard.
- When air is gradually pumped out using a vacuum pump, it is observed that sound steadily gets weaker and when all the air is removed from the bell jar, the ringing can no longer be heard although the harmer can still be seen striking the gong.
- If air is allowed back again in the bell jar, the sound is heard again, meaning sound requires material medium for its transmission.

(iii)

- Electromagnetic waves travel faster than sound waves.
- Electromagnetic waves are transverse waves while sound waves are longitudinal.
- Electromagnetic waves can be polarized while sound waves cannot be polarized
- Electromagnetic waves do not need material medium for transmission while sound requires (needs) material medium for transmission (sound can’t pass through a vacuum)

26(a)

(i) Wave length is the distance between two successive particles of the medium which are in phase.

(ii) $f = \frac{n}{t} = \frac{2.5}{10} = 0.25Hz$

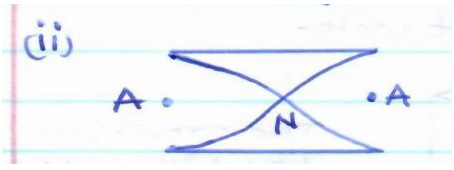
but $V = f\lambda$

$\lambda = \frac{v}{f} = \frac{20}{0.25} = 80cm$

(b)

- Stationary waves do not transfer energy from place to another while progressive waves transfer energy from one place to another.
- For a stationary wave, the distance between successive particles in phase is (½) λ while for a progressive wave, the distance between successive waves in phase is λ.
- A stationary wave is a wave in which the position of the maxima and minima do not travel, but remain in one place while progressive wave is the wave that travels continuously in the medium in the same direction without a change in amplitude.
- A stationary wave has a series of alternating nodes and antinodes while a progressive wave has a series of alternating crests and troughs or compression and rarefactions.

b(ii)



$L = \frac{1}{2}\lambda$

$\lambda = 2L$

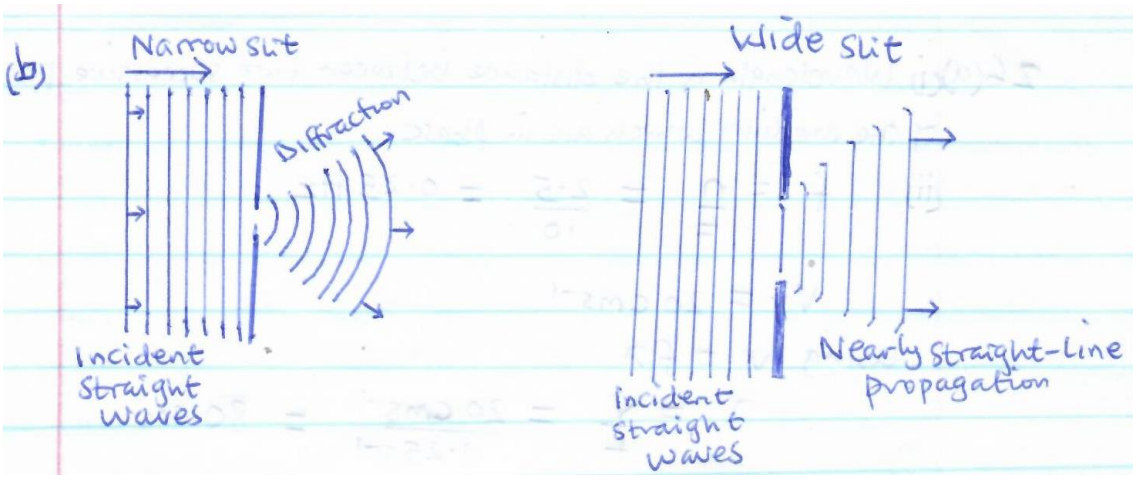
but $V = f_0\lambda$

$f_o = \frac{V}{\lambda}$

$f_o = \frac{v}{2L}$

$f_o = \frac{340}{2X0.2}$

f_o = 850Hz



(C)

(i) **Beats** are the periodic rise and fall in the intensity of sound when two notes of nearly equal frequency and similar amplitude are sounded together.

(ii)

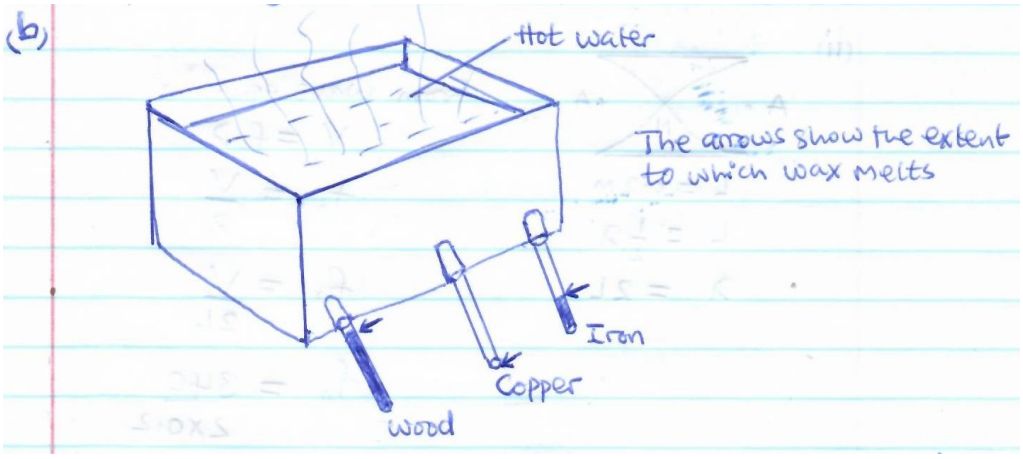
- Used for matching the frequencies of different musical instruments by artists.
- Setting a radio station to a particular frequency.

HEAT

27(a)

Conduction is the flow of heat from a region of heat from a region of high temperature to a region of low temperature through a material without bulk movement of the material itself while **convection** is the flow of heat from a region of high temperature to a region of low temperature by bulk movement of the medium itself.

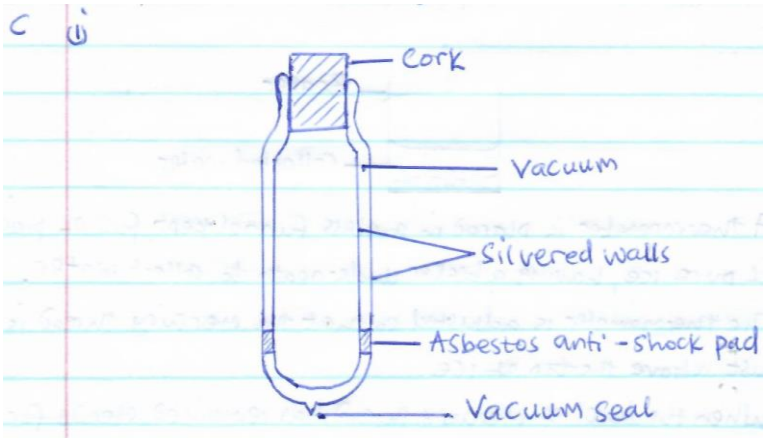
(b)



- Rods of copper, iron and wood of equal dimensions are dipped into molten wax and withdrawn to allow a coating of wax to solidify on them.
- The rods are passed through corks inserted in holes in the side of a metal trough.
- Boiling water is poured into the trough so that the ends of the rods are heated to the same temperature.
- After few minutes, it is observed that wax has melted to different distance along the rods. It is completely done on the copper, followed by Iron and it is almost unmelted on wood. This shows that copper has a higher rate of conduction than iron, and iron has a higher one than that of wood.

(C)

(i)



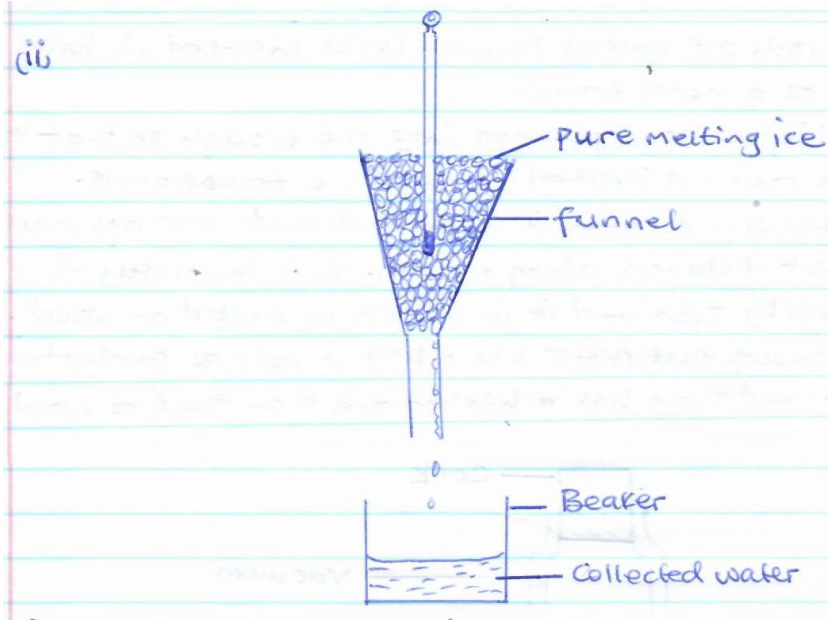
(ii) To keep the snacks hot since heat lost by the snacks through radiation is reduced to minimum due to the silvering. The silvered surfaces tend to reflect back the heat radiation produced by the snacks hence keeping them warm for longer period.

(d)

(i) $T = \theta + 273$

$= -220 + 273$

$= 53K$



- A thermometer is placed in a glass funnel kept full of pieces of pure ice, having a beaker underneath to collect water.
- The thermometer is adjusted so that the mercury thread is just above the top of ice.
- When the level of mercury thread has remained steady for some time, its position is marked and this is the lower fixed point.

28 (a)

- Water is a poor conductor of heat.
- Water sticks on the walls of glass.
- Water is colourless therefore cannot easily be seen.
- Water has irregular expansion.
- Water freezes at 0°c, so it cannot measure lower temperatures.

(b) Radiation as applied to heat is the mode of heat transfer by electromagnetic waves.

(c) (i)The level of ether in the limb connected to flask A falls while that in the limb connected to B rises.
(ii)Flask A absorbs more heat from the flame than flask B. this makes ether vapour in A to expand and exert greater pressure on ether forcing it to fall in limb connected to A and rise in the limb connected to B.

(d)(i) A bimetallic strip is the combination of two metal strips of the same dimensions but of different expansivities riveted together to form a bar.

(ii)

- Thermostat for regulating temperature.
- Car flasher unit
- Bimetallic thermometer

(iii) Coefficient of linear expansion = $\frac{change\ in\ length}{original\ length\ X\ temperature\ change}$

$$\alpha = \frac{L - L0}{l0\Delta\theta}$$

$$L = L_0 (1 + \alpha\Delta\theta)$$

For brass; $L_b = 0.1 \left[1 + 1.9 \times 10 (820 - 20)\right]$

$= 0.10152$ m

For iron; $L_I = 0.1 \left[1 + 1.2 \times 10 (770 - 20)\right]$

$L_I = 0.1009$ m

Difference in their length = $L_b - L_I$

$= 0.10152 - 0.1009$

$= 0.00062$ m

(e) (i) To absorb heat from the water in the radiator and easily emit it to the surrounding since black is a good absorber and good emitter of heat radiation.

(ii) Water has a high value of specific heat capacity, therefore it absorbs significant amount of heat energy before it heats up.

End.