Marking Scheme KCSE 2016

PHYSICS
PAPER 1

No. 1.State what mechanics as a branch of physics deals with. (1 mark)

- *Study of motion of bodies under the influence of forces or motion and forces*

No. 2.Figure 1 shows the change in volume of water in a measuring cylinder when an irregular solid is immersed in it.

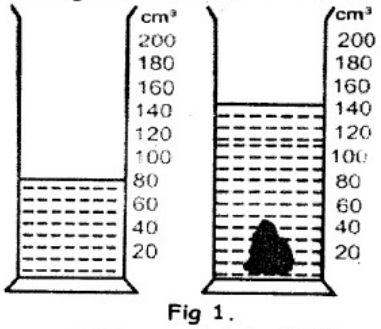


Fig 1.

Given that the mass of the solid is 567 g, determine the density of the solid in gcm^{-3} (Give your answer correct to 2 decimal places) (3 marks)

Volume = 68cm^3

Mass = 567g

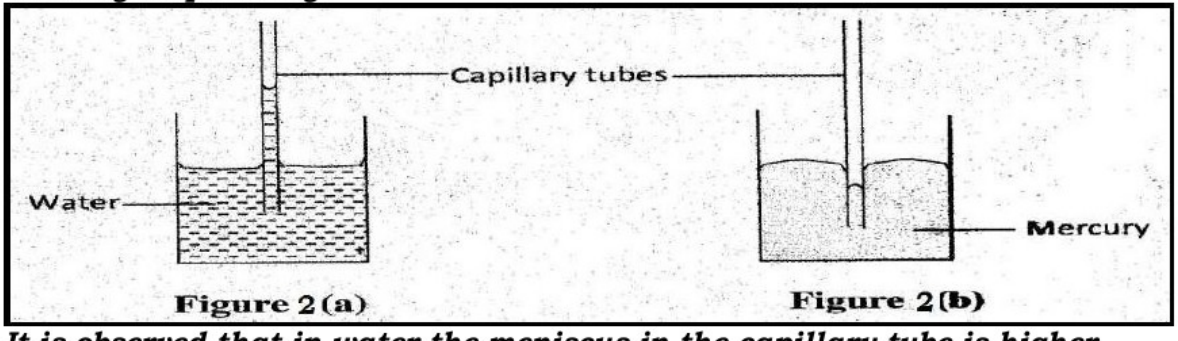
Density = $\frac{m}{V} = \frac{567}{68}$

= 8.34 g/cm^3

No. 3.When a drop of oleic acid of known volume is dropped on the surface of water in a large trough, it spreads out to form a large circular patch. State one assumption made when the size of the molecule of oleic acid is estimated by determining the area of the patch. (1 mark)

- Drop spreads out until the patch is one molecule thick

No. 4].Figure 2(a) and 2(b) shows capillary tubes inserted in water and mercury respectively.



It is observed that in water the meniscus in the capillary tube is higher than the meniscus in the beaker, while in the mercury the meniscus in the capillary tube is lower than the meniscus in the beaker. Explain this observation (2mks)

- *In (a), the adhesive force between water and capillary tube is stronger than the cohesive force between the water molecules while in (b) the cohesive forces between mercury and the tube is higher than the adhesive force between mercury and the tube.*

No. 5.Fig. 3 shows a hot water bath with metal rods inserted through one of its sides. Some wax is fixed at the end of each rod. Use this information to answer question 12.

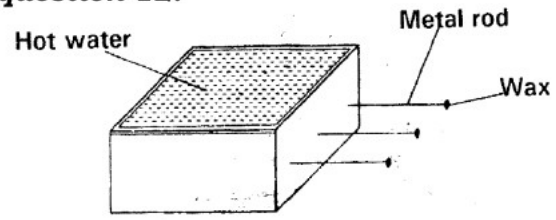


Figure 3

What property of metals could be tested using this set-up? (1mk)

- *Thermal conductivity*

No.6.Figure 2 shows a uniform light bar resting horizontally on corks floating on water in two beakers A and B.

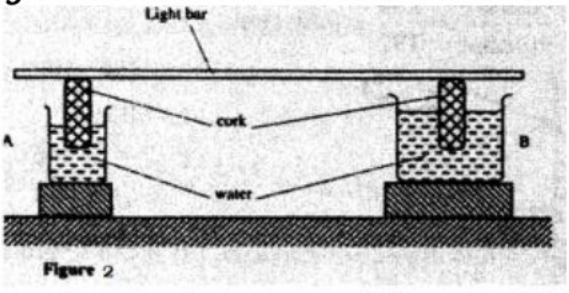


Figure 2

Explain why the bar tilts towards side A when equal amount of heat is supplied to each beaker (2 marks)

- *Since the quantity of water A is smaller, the heat supplied produces a greater change of temperature in A. This causes a greater expansion of water in A, causing the cork to sink further*

No. 7.Figure 5 shows an aluminium tube tightly stuck in a steel tube.

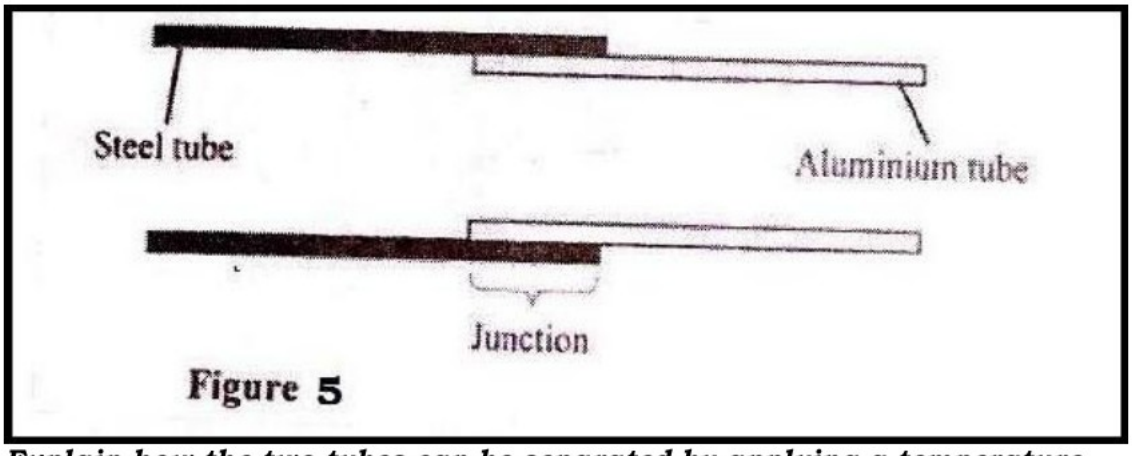


Figure 5

Explain how the two tubes can be separated by applying a temperature change at the same junction given that aluminum expands more than steel for the same temperature rise. (2 marks)

- *By cooling*
- *Aluminium contracts more than steel for the same temperature range*

No.8.(a)An aeroplane is moving horizontally through still air at a uniform speed. It is observed that when the speed of the plane is increased, its height above the ground increases. State the reason for this observation. (1 mark)

- *Increase in the speed of the plane decreases the pressure of air above it while the pressure below it remains high. This leads to a resultant upward force*

(b)Figure 6 shows parts A, B and C of a glass tube.

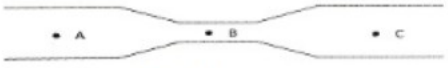


Figure 6

State with a reason the part of the tube in which the pressure will be lowest when air is blown through the tube from A towards C. (2 marks)

- Point B
- The velocity is high at this point hence pressure decreases

No. 9.The three springs shown in figure 5 are identical and have negligible weight. The extension produced on the system of springs is 20 cm.

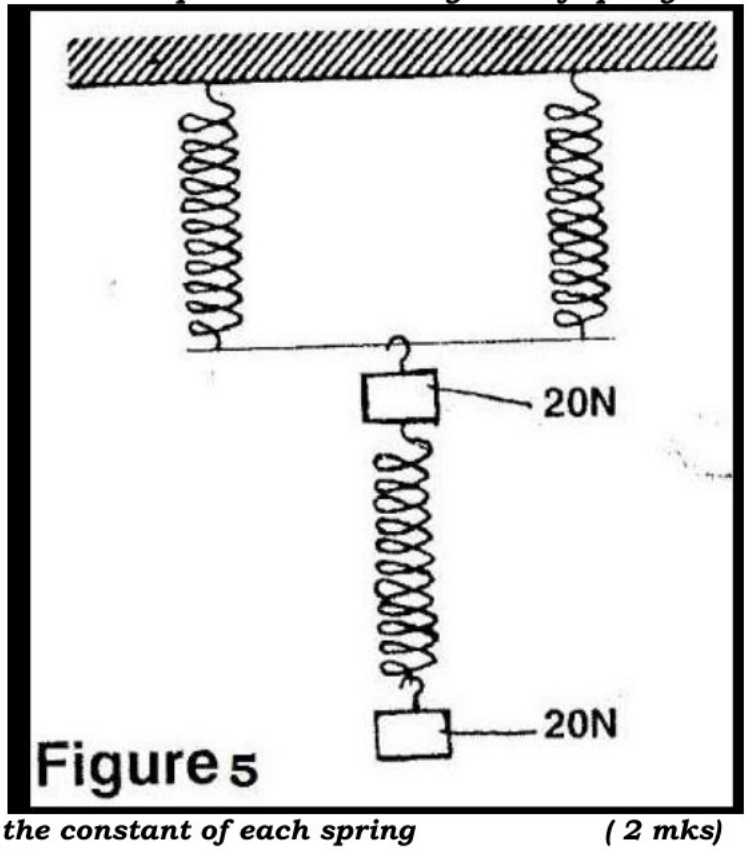


Figure 5

Determine the constant of each spring (2 mks)

Parallel

F= 2 ke

40= 2 x ke

$E_1 = {}^{40}/_{2k} = {}^{20}/_{k}$

Single $= f = ke_2$

$20 = ke_2$

$E_2 = 20/k$

$E_T = e_1 + e_2$

$20 = 20/k + 20/k$

20 k = 40
K= $^{40}/_{20}$ = 2N/cm
OR Extension of each spring = 10
K = 20N/ 10 cm
- 2N/ cm

Or

Extension of each spring =10,k= $\frac{20N}{10cm} = 2N/cm$

No.10. Figure 8 shows two cylinders of different cross-sectional areas connected with a tube. The cylinders contain an incompressible fluid and are fitted with pistons of cross-sectional areas 4 cm² and 24 cm².

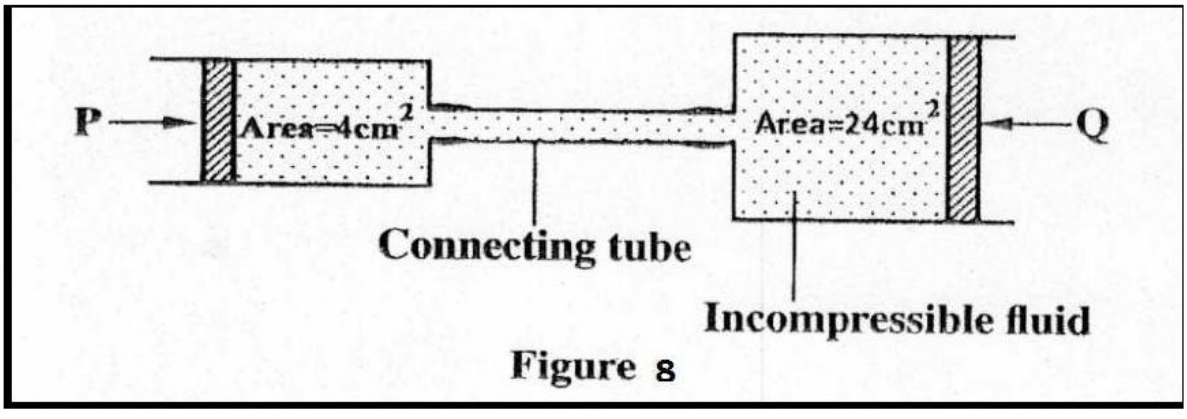
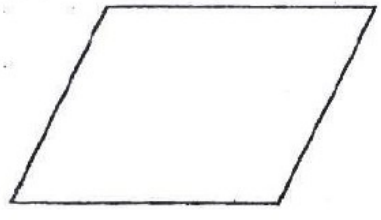


Figure 8

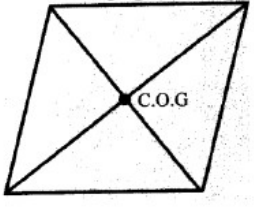
Opposing forces P and Q are applied to the pistons such that the pistons do not move. If the pressure on the smaller piston is 5 N cm2, Determine force Q. (2 marks)

- Pressure at P = Pressure at Q
- But force = P x A
- At Q, force = 24 cm^2 x 5 Ncm^{-2} = 120N

No. 11.Figure 9 shows a uniform cardboard in the shape of parallelogram



Locate the centre of gravity of the cardboard (1 mks)



No. 12.State why it is easier to separate water into drops than to separate a solid into smaller pieces(1 mark)

- *There are weaker intermolecular forces in liquids than in solids*

No.13.The graph in figure 10 shows the velocity of a car in the first 8 seconds as it accelerates from rest along a straight line.

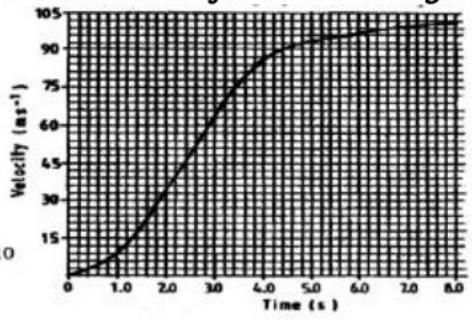


Figure 10

Determine the distance traveled 3.0 seconds after the start

- *Distance = area under curve between 0 and 3. 0 second;*
- *= 120 x 3 x 0.2 = 72M: Trapezium Rule (3 trapezia)*
- *Mid – ordinate = 70.5*

No.14.a) Explain why it is advisable to use a pressure cooker for cooking at high altitudes (2 mks)

- *At high altitudes pressure is low so boiling point is low*
- *A pressure cooker increases pressure inside it which raises the boiling point hence faster cooking*

b) Water of mass 3.0kg initially at 20^0C is heated in an electric kettle rated 3.0KW. The water is heated until it boils at 100^0C. (Take specific heat capacity of water 4200jkg1K-1. Heat capacity of the kettle = 450JK^{-1}, Specific latent heat of vaporization of water = 2.3mjkg-1)

Determine

(i) The heat absorbed by the water. (1 mk)

$Q = Mc\Delta\theta$ or $Mc\theta$ or $Mc\Delta T$
= 3 x 4200 x 80 = 1008000J

ii)Heat absorbed by the electric kettle (2 mks)

$Q = c\theta$ / $c\Delta\theta$ / $c\Delta T$ = 450 x 80
= 36000J

iii) The time taken for the water to boil (2 mks)

$PL = Mc\Delta\theta$ / $c\Delta\theta$
3000t = 1008000 + 36000
3000t = 1044000
t = 348 seconds

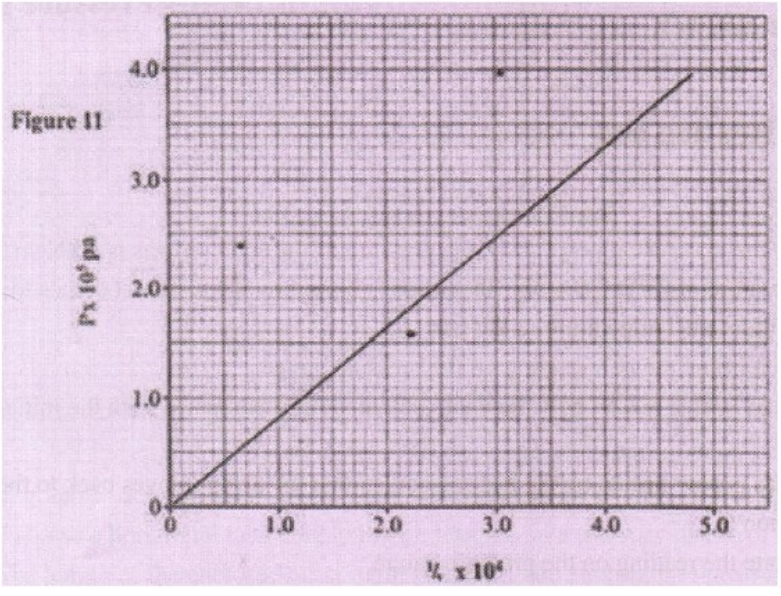
iv) How much longer it will take to boil away all the water.(2 mk)

$Mlv = Pt$ **OR** *$Mlv = Pt$*
$3 \times 2.3 \times 10^6 = 3000t$ *$3 \times 2.3 \times 10\text{-}3 = 3000t$*
$t = 2300s$ *$t = 2.3 \times 10^{-6}s$*
(38.3 minutes)

No.15.(a) State what is meant by an ideal gas (1 mark)

- *A gas that obeys the gas laws perfectly*

(b) The pressure acting on a gas in a container was changed steadily while the temperature of the gas maintained constant. The value of volume V of the gas was measured for various values of pressure. The graph in figure 11 shows the relation between the pressure, p and the reciprocal of volume $\frac{1}{v}$



(i) Suggest how the temperature of the gas could be kept constant

- *By changing pressure very slowly or by allowing gas to go to original temperature after each change*

(ii) Given that the relation between the pressure P_1 and the volume, V_1 of the gas is given by PV = k, where k is a constant, use the graph to determine the value of k.

k is slope of graph

$K = \frac{(2.9 - 0) \times 10^5}{(3.5 - 0) \times 10^6}$

$K = 0.083\ Nm$

(iii) What physical quantity does k represent? (4 mark)

- *Work done on the gas*

(iv)State one precaution you would take when performing such an experiment(1 mark)

- *Use dry gas*
- *Make very small changes in pressure*

(c) A gas occupies a volume of 4000 litres at a temperature of 370C and normal atmospheric pressure. Determine the new volume of the gas if it is heated at constant pressure to a temperature of 67^{0}C (normal atmospheric pressure P= 1.01 x 105 pa)

Since pressure is constant

$V_1 = V_2$

$T_1 = T_2$

$T_1 = 273 + 37 = 310k$

$T_2 = 273 + 67 = 340k$

$$\frac{4000}{310} = \frac{V_2}{340}$$

$V_2 = 4387$ litres

No.16.(a)Define the term velocity ratio of a machine. (1mk)

- *It is the ratio of distance moved by effort to distance moved by load*

(b) Fig. 12 shows part of a hydraulic press. The plunger is the position where effort is applied while the Ram piston is the position where load is applied. The plunger has cross-section area, a m^2 while the Ram piston has cross-section area, A m^2.

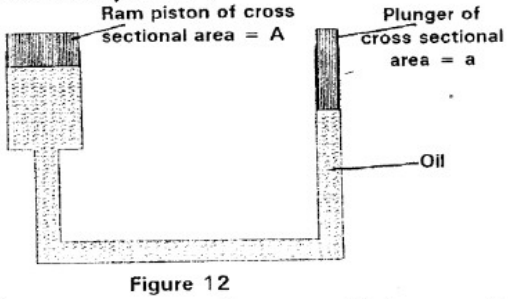


Figure 12

When the plunger moves down a distance d the Ram piston moves up a distance D.

Derive an impression for the velocity ratio (V.R) in terms of A and a(4 marks)

P x A x d = P x a x d or vol of oil at plunger = at RAM

$A \times D = a \times d$ $\qquad$ $a \times d = A \times D$

$$\frac{d}{D} = \frac{A}{a} \qquad \frac{d}{D} = \frac{A}{a}$$

$$VR = \frac{A}{a} \qquad VR = \frac{A}{a}$$

c) A machine of velocity ratio 45, overcomes a load of 4.5 x 10^{3}N when an effort of 135N is applied. Determine:

(i)The mechanical advantage of the machine; ***(2mks)***

$$MA = \frac{load}{Effort}$$

$$= \frac{4.5 \times 10^3}{135} = 33.3\ (33\ ^1/_3)$$

(ii) Efficiency of the machine; ***(2mks)***

$$Efficiency = \frac{MA}{VR} \times 100\% \quad OR\ efficiency = \frac{MA}{VR} = 33.3$$

$$= \frac{33.3}{45} \times 100\%$$

$= 74\%$

(iii) The percentage of the work that goes to waste. (1mk)

% work wasted = 100% - 74%

= 26%

No.17.(a) When a bus goes round a bend on a flat road, it experiences a centripetal force.
State what provides the centripetal force. (1 mark)

- *Frictional force*

(b) State the purpose of banking roads at bends. (1 mark)

- *Increases the centripetal force acting on the bus*
- *Provide more centripetal force*
- *Prevent skidding force, overturning or rolling*
- *Enable high speed or critical yield*

(c)A student whirls a stone of mass 0.2 kg tied to a string of length 0.4 m in a vertical plane at a constant speed of 2 revolutions per second. (Take acceleration due to gravity g as 10 ms^{-2})

(i) State two forces acting on the stone when it is at the highest point.(2 marks)

- *The weight/ force of gravity*
- *The tension on the string*

(ii) Determine the:
(I)Angular velocity of the stone (3 marks)

$w = 2\pi f = 2 \times 3.142 \times 2$

$= 12.568\ rad/s$

(II)Tension in the string when the stone is at the highest point; (3 marks)

$T = mw^2r - mg$

$= 0.2 \times 12.568^2 \times 0.4 - 0.2 \times 10$

$= 12.6364 - 2$

$= 10.636N$

No.18.(a) State Newton's first law of motion (1 mark)

- *A body at rest or motion at uniform velocity tends to stay in that state unless acted on by an unbalanced force/ compelled by some external force to act otherwise.*

(b)A wooden block resting on a horizontal bench is given an initial velocity, u, so that it slides on the bench surface for a distance d, before coming to a stop. The values of d were measured and recorded for various values of initial velocity. Figure 10 shows the graph of u^2 against d.

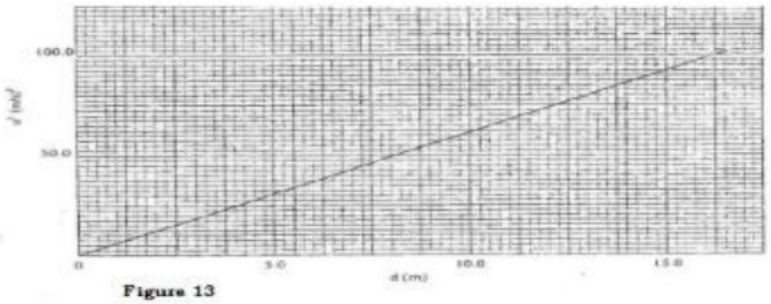


Figure 13

(i)Determine the slope, S of the graph (3 marks)

$S = \frac{\Delta u}{\Delta d}$ or

$\frac{98.75 - 0}{16 - 0}$ $(m/s)^2$

$= 6.17 ms^{-2}$

(ii)Given that $u^2 = 20kd$, where k is a constant for the bench surface, determine the value of k from the graph (2 marks)

$20k = s = 6.09$ depend on (i)

$K = \frac{6.172}{20} = 0.3086$

(iii)State how the value of k would be affected by a change in the roughness of the bench surface (1 mark)

- *Increase in roughness increases k and vice versa*
- *Uniform speed in a straight line – uniform velocity*

(c) A car of mass 800 kg starts from rest and accelerates at 1.2 ms-2. Determine its momentum after it has moved 400 m from the starting point (4 marks)

Applying equation

$V^2 - u^2 = 2as$

$V^2 - 0 = 2 \times 1.2 \times 400$

Momentum $p = mv$

$P = \sqrt{800 \times 2 \times 1.2 \times 400}$

$= 24787.07 = 24790 Kgms^{-1}$

PHYSICS PAPER 2

No. 1.Figure 1 shows a ray of light incident on a mirror at an angle of 45°. Another mirror is placed at an angle of 45° to the first one as shown.

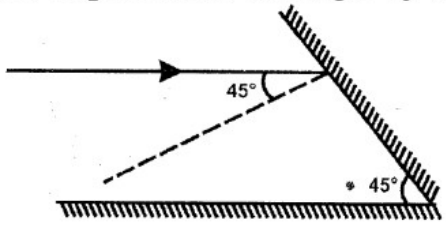


Figure 1

Sketch the path of the ray until it emerges. ***(2 marks)***

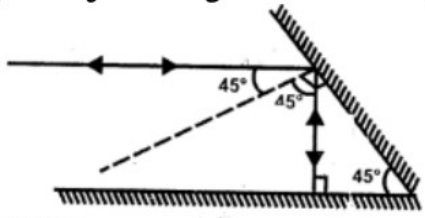
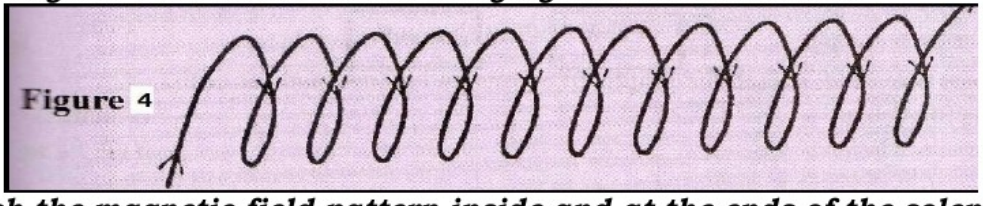


Figure 1

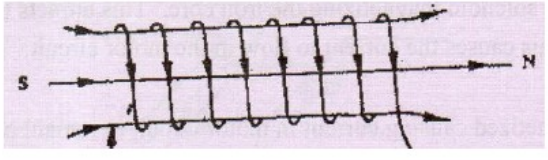
No. 2.An un-magnetized steel rod is clamped facing North-South direction and then hammered repeatedly for some time. When tested, it is found to be magnetized. Explain this observation. (2mks)

- *The mechanical disturbance due to hammering aligns the domain with the earth's magnetic field causing magnetization*

No. 3.Figure 4 shows a solenoid carrying an electric current.



Sketch the magnetic field pattern inside and at the ends of the solenoid (1 mrk)



No. 4.Figure 5, shows how the displacement of a point varies with time as a wave passes it.

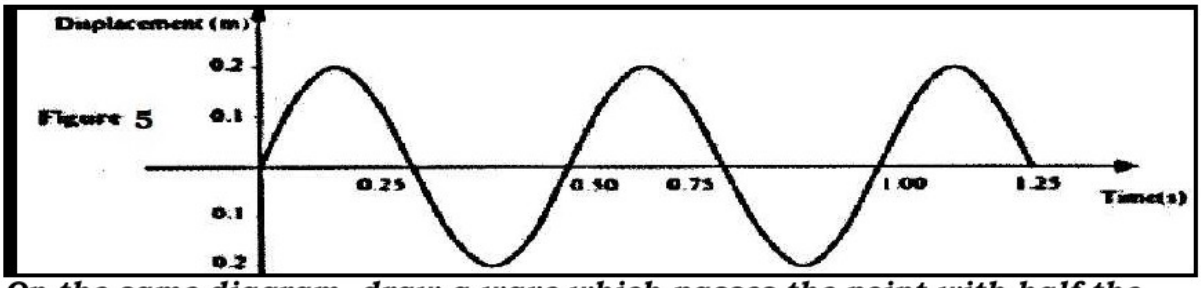
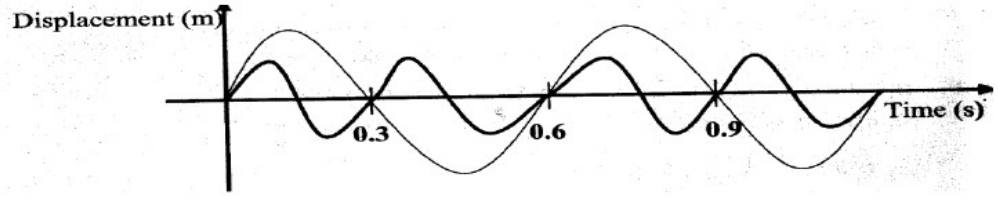


Figure 5

On the same diagram, draw a wave which passes the point with half the amplitude and twice the frequency of the one shown.



No. 5. State the reason why a convex mirror is preferred over a plane mirror for use as a driving mirror. (1 mark)

- *It has a wide field of view / wide angle of view / wider range of view*

No.6.Figure 4 shows straight waves incident on a diverging lens placed in a ripple tank to reduce its depth.

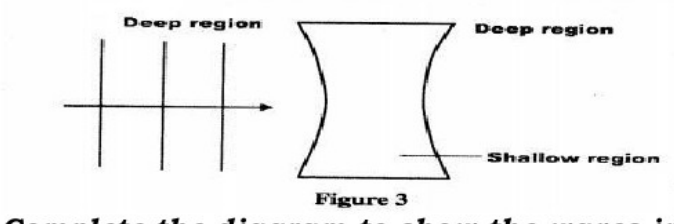


Figure 3

Complete the diagram to show the waves in both the shallow region and beyond the lens. (2 marks)

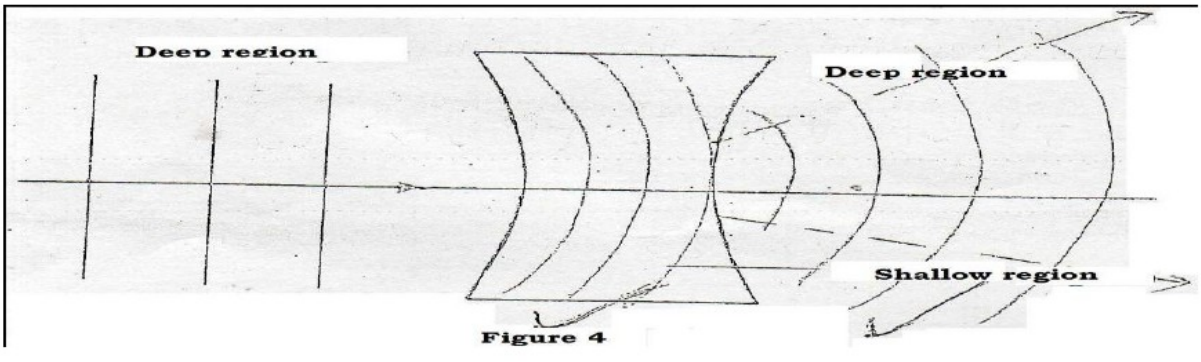


Figure 4

- *Decreased in shallow region*
- *Diverging after refraction to the deep region must be complete*

No. 7.Figure 5 shows the cross-section of a dry cell. Use the information on the figure to answer questions below

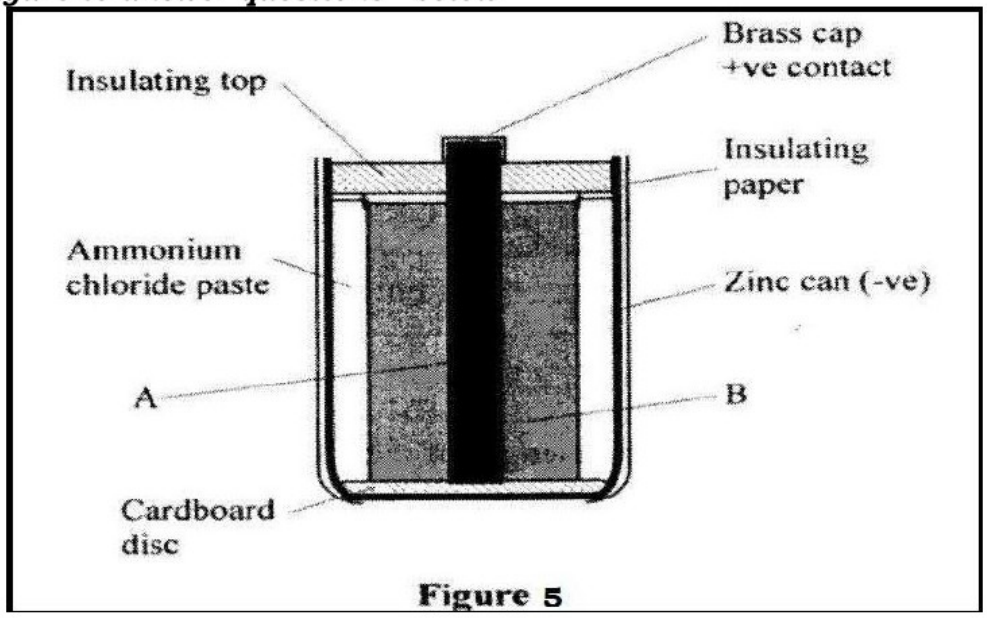


Figure 5

(a) Name the parts labeled A and B. (2 marks)

- *A – Carbon rod or graphite rod*
- *B – Mixture of Manganese (IV) oxide with carbon powder*

(b) State the use of manganese (IV) oxide in the cell. (1 mark)

- *Manganese (IV) oxide is a depolarizer or oxidizing agent. It is used to oxidize hydrogen to water*

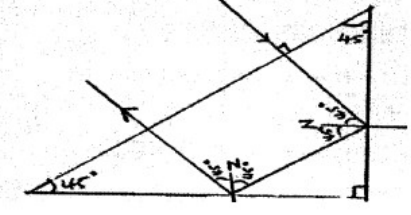
No.8. The following is part of radioactive decay series

$$^{234}_{83}Bi \xrightarrow{\beta} {}^{a}_{84}X \longrightarrow {}^{230}_{b}Y$$

Determine the values of a and b (2 marks)

- a = 234
- b= 82

No.9.Draw a ray diagram to show how a ray of light may be totally internally reflected two times in an isosceles right - angled glass prism. (Assume that the critical angle of glass is 42^0(2 marks)



No.10. Figure 6 shows a narrow beam of X-rays passing between two metal plates in air. The plates are connected in series with a switch, a cell and a milliameter.

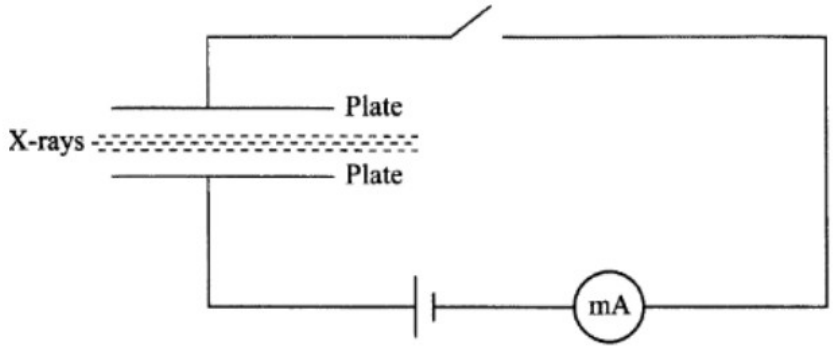


Figure 6

It is observed that when the switch is closed a current flows in the milliameter. Explain this observation. (2 marks)

- *X-rays cause ionization of air molecules between the plates. The ions move to plates of opposite charge.*

No.11.A heater of resistance R_1 is rated P watts, V volts while another of resistance R_2 is rated 2P watts, $V/2$ volts. Determine R_1 / R_2 3 marks)

$$R1 = \frac{V^2}{P} \qquad R_2 = \frac{V^2}{8P}$$

$$\frac{R_1}{R_2} = \frac{V^2 \times 8P}{P \quad V^2}$$

$$= 8$$

No.12.When germanium crystal is doped with arsenic, it becomes an N-type semiconductor. Explain how this change occurs. (2mks)
(Number of electrons in the outermost shell for germanium =4, arsenic =5)

- *Arsenic shares four electrons with germanium leaving a free electron for conduction.*

No.13.A boy standing in front of a cliff blows a whistle and hears the echo after 0.5s. He then moves 17 metres further away from the cliff and blows the whistle again. He now hears the echo after 0.6s. Determine the speed of the sound.

$$^{2d}/_{05} = {}^{2d}/_{0.6} + 34$$

$D = 17/0.2 = 85\ m$

$$Speed = \frac{2 \times 86}{0.5}$$

$= 340 m/s$

$OR\ V = {}^{d}/_{t}$

$$= \frac{17 \times 2}{0.1}$$

$= 340\ m/s$

No.1 4.Figure 6 shows a simple electric bell circuit

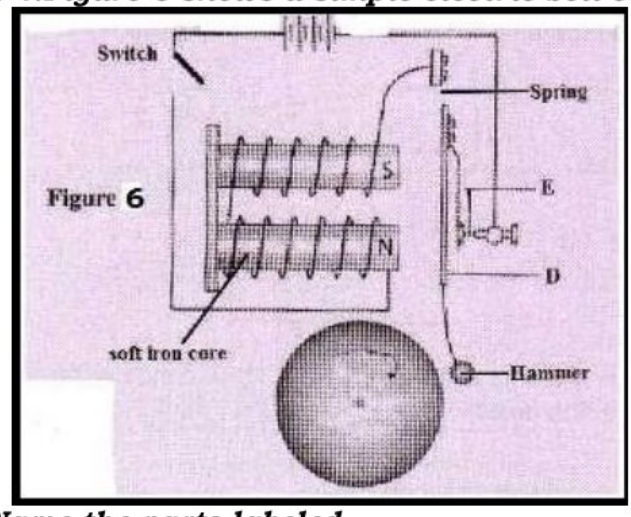


Figure 6

(i)Name the parts labeled

(I) D

- Soft iron armature

(II) E

- Contact screw

(ii)When the switch is closed, the hammer hits the gong repeatedly. Explain why:

(I) the hammer hits the gong. (2 marks)

- Soft iron core is magnetized
- It attracts the armature

(II) the hammer hits the gong repeatedly. (3 marks)

- Contact is broken
- The core then loses magnetism
- Armature spring back making contact again

(b) An electric bulb is rated 60 W, 240 V. Determine:

(i) the current that flows through it when it is connected to a 240 V supply.(3 marks)

- $I = P/V = 60/240 = 0.25A$

(ii) the resistance of the bulb. (3 marks)

- $R = P/I^2 = 60/0.25^2 = 960\Omega$ or $R = V/I = 240/0.25 = 960\Omega$

No.15. Figure 15, shows two coils A and B placed close to each other. A is connected to a steady D.C. supply and a switch, B is connected to a sensitive galvanometer.

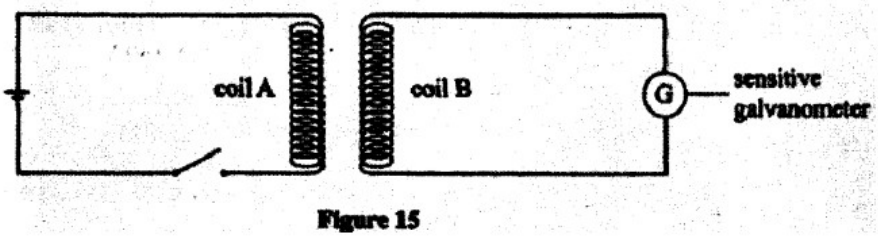


Figure 15

i)The switch is now closed, state the observation made on the galvanometer. (2marks)

- *The galvanometer will be deflected to one side and then back to zero.*

ii)Explain what would be observed if the switch is then opened. (2marks)

- *A greater deflection will be obtained in the opposite direction as the current takes less time to die off than to build up*

b) The primary coil of a transformer has 1000 turns and the secondary coil has 200 turns.

The primary coil is connected to a 240V ac. Mains supply.

i) Explain how an e.m.f is induced in the secondary coil. (2marks)

- *The changing current in the primary coil induces a current in the secondary coil due to changing magnetic field of the primary current*

ii)Determine the secondary voltage. (3marks)

$\frac{Ns}{Np} = \frac{Vs}{Vp}$ *hence* $Vs = \frac{240 \times 200}{1000}$

$= 48V$

iii) Determine the efficiency of the transformer given that the current in the primary coil is 0.20A and in the secondary coil it is 0.80A. 3marks)

$\text{Efficiency} = \frac{\text{power output}}{\text{Power input}} \times 100$

$\frac{4.8 \times 0.8}{240 \times 0.2} \times 100$

$= 80\%$

No.16. Figure 8, shows a cicuit that may be used to charge a capacitor.

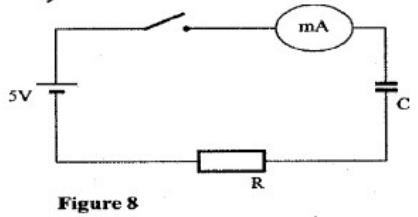


Figure 8

(i) state the observation on the milliameter when the circuit is switched on:

- *Current falls off to zero.Falling to zero deflects to maximum then zero.*

(ii) explain the observation in (i) above.

- *Current flows when the capacitor is charging. When fully charged no current flows and potential difference (p.d.) is equal to charging voltage*

b)The circuit in figure 8 is left on for some time. State the value of p.d. across:

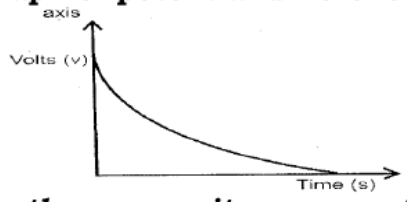
(i) the resistor R;

- $V_R = 0$ volts

(ii) the capacitor C;

- V_c = 5 Volts

(c) sketch the graph of potential difference (V) across R against time.



(d) Figure 9 shows three capacitors connected to a 10V battery

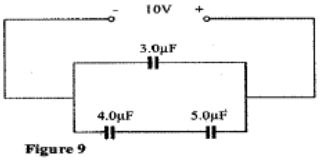


Figure 9

Calculate:

(i) the combined capacitance of the three capacitors;

- Parallel capacitance ,$C_p = \frac{1}{c} = \frac{1}{4} + \frac{1}{5} = \frac{9}{20} \Rightarrow Cp = \frac{20}{9} = 2.22\mu F$

(ii) the charge on the 5.0 juF capacitor.

- Charge on series section Q = CV
- = 2.22× 10 = 22.2 μc

No.17.a When a radiation was released into a diffusion cloud chamber, short thick tracks were observed. State with a reason, the type of radiation that was detected. (2 marks)

- *Alpha radiation. This radiation has a short range with intense ionization hence thick tracks*

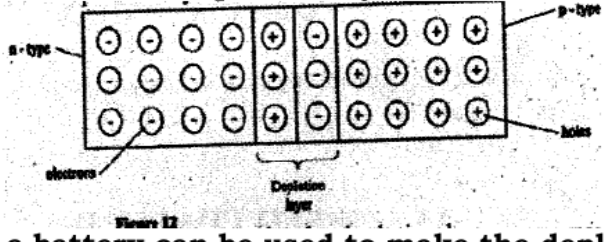
(b)The half-life of an element X is 3.83 days. A sample of this element is found to have an activity rate of 1.6 x 103 disintegrations per second at a particular time. Determine its activity rate after 19.15 days. (2 marks)

- Number of half lifes = 19.15/3.83 = 5
- N = $N(½)^{T/t}$ = 6 x 10^3 $(½)^5$ = 50 days/sec

(c) State what is meant by an extrinsic semiconductor. (1 mark)

- *It is a semiconductor in which impurities have been added to change conductivity*

(d)Figure 11, shows a depletion layer in an unbiased p-n junction



State how a battery can be used to make the depletion layer narrower. (1 mk)

- *By connecting it in a forward biased mode*

(e)Figure 12, shows an incomplete circuit of a full wave rectifier.

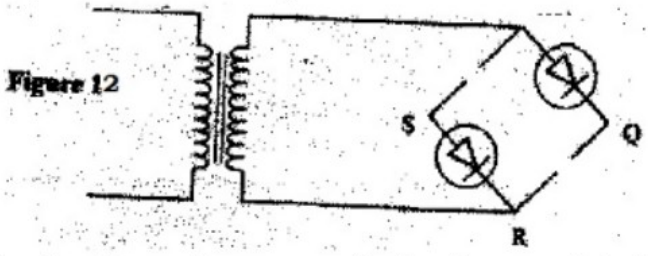


Figure 12

(i) Draw in the figure two more diodes to complete the circuit. (2 marks)

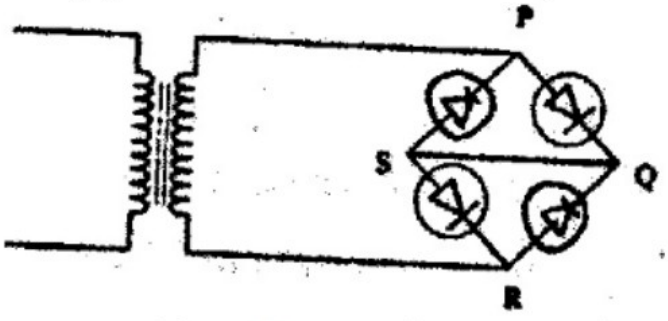


Figure 12

(ii) Show on the figure the points across which the output of the rectifier should be obtained. (1 mark)

- Across QS

No.18.(a)State one factor that affects the speed of sound in a solid.(1mk)

- *Temperature*
- *Density*

b)An observer stands half-way between two vertical cliffs that are L metres apart.He strikes a gong and measures the time interval, t, between the echoes heard from the two cliffs. He moves a further 10m and again strikes the gong and measures the time interval between the echoes. The process is repeated several times. The graph in Figure 13 shows the relation between the time interval, t and the distance, x from the centre.

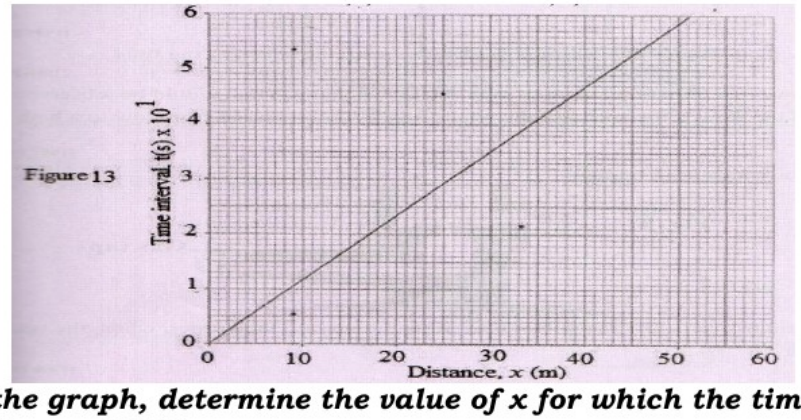


Figure 13

(i)From the graph, determine the value of x for which the time interval was 0.55. (1mk)

- 47 metres

(ii)Given that $t = \frac{4}{v}x$ where v is the speed of sound in air, determine the value of v from the graph. ***(3mks)***

From t = 4/Vx, 4/v = gradient hence v = 4/gradient

Gradient = $\frac{(4.7 - 2) \times 10^{-1}}{40 - 17}$

= 0.01174

V = 4/0.01174 = 340.715 m/s²

(iii)If the maximum time measured by the observer was t=4.7s, determine the distance L between the cliffs. ***(3mks)***

- Distance = speed x time
- 2D = distance to and from the cliff
- 2D = 340.715 x 4.7
- D = 800.68 metres

(c)A search boat uses a signal of frequency 6.0 x 104 Hz to detect a sunken ship directly below. Two reflected signals are received; one after 0.1 seconds from sunken boat and the other after 0.14 seconds from the sea bed. If the sea bed is 98 m below the boat, determine:-

(i)The speed of the signal in water. ***(3mks)***

You may use the value of v from (ii) above.

- Distance moved by sound from sea bed = 98 x 2 m
- V = $\frac{98 \times 2}{0.14}$
- = 1400 m/s

(ii)The depth of the sunken ship below the boat ***(2 mks)***

- Distance = v x t
- = 1400 x 0.10/2
- = 70 m