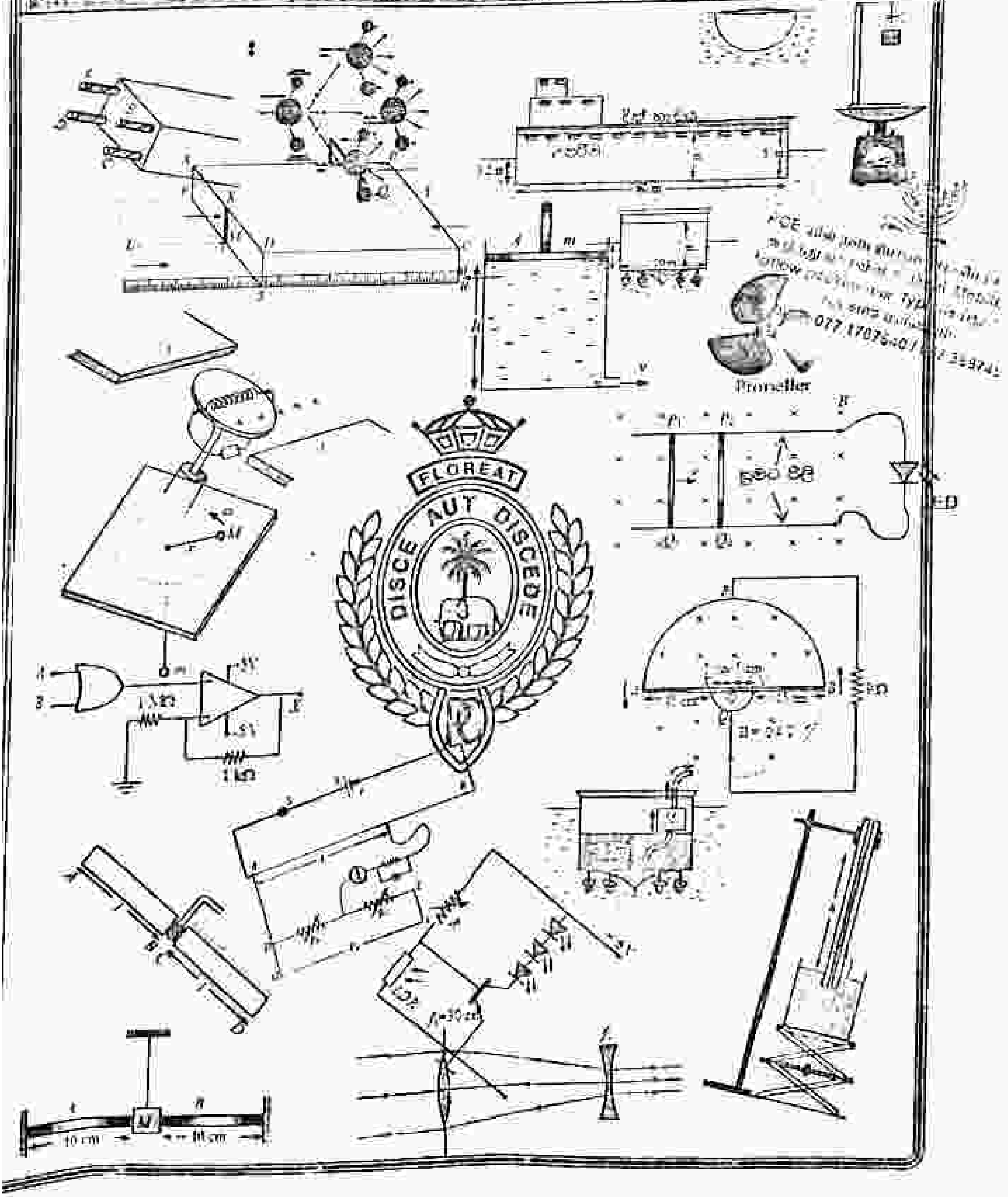
(W)

Royal College - Colombo 07
Grade 13
Final Term Test - 2017 (2018)
Physics

Marking Scheme



ROYAL COLLEGE – COLOMBO -07

Grade 13 - Final Term Test - July 2017

M C Q Answer Sheet

Subject and Subject No : PHYSICS 01   **Index Number** : ANSWERS

(01)	① ② ③ ● ⑤	(11)	① ② ③ ④ ●	(21)	① ② ③ ● ⑤	(31)	① ● ③ ④ ⑤	(41)	① ② ● ④ ⑤
(02)	① ● ③ ④ ⑤	(12)	● ② ③ ④ ⑤	(22)	① ② ③ ④ ●	(32)	① ② ③ ● ⑤	(42)	① ② ③ ● ⑤
(03)	① ② ③ ● ⑤	(13)	① ● ③ ④ ⑤	(23)	● ② ③ ④ ⑤	(33)	● ② ③ ④ ⑤	(43)	① ② ③ ④ ●
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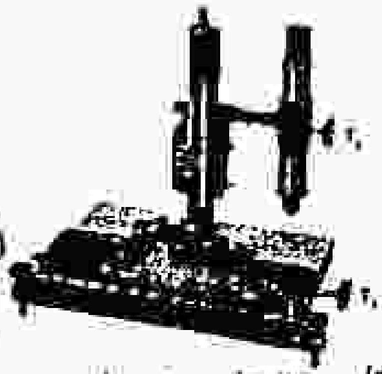
(05)	① ② ③ ● ⑤	(15)	① ② ● ④ ⑤	(25)	① ② ③ ● ⑤	(35)	① ② ③ ④ ●	(45)	● ② ③ ④ ⑤
(06)	① ② ● ④ ⑤	(16)	① ② ③ ④ ●	(26)	● ② ③ ④ ⑤	(36)	① ② ● ④ ⑤	(46)	① ② ● ④ ⑤
(07)	① ② ● ④ ⑤	(17)	① ② ③ ④ ●	(27)	① ② ③ ● ⑤	(37)	① ② ● ④ ⑤	(47)	① ② ● ④ ⑤
(08)	① ● ③ ④ ⑤	(18)	① ② ● ④ ⑤	(28)	① ● ③ ④ ⑤	(38)	① ② ③ ④ ●	(48)	① ② ③ ● ⑤
(09)	① ② ● ④ ⑤	(19)	① ② ● ④ ⑤	(29)	● ② ③ ④ ⑤	(39)	① ② ③ ● ⑤	(49)	① ② ③ ● ⑤
(10)	① ● ③ ④ ⑤	(20)	● ② ③ ④ ⑤	(30)	① ● ③ ④ ⑤	(40)	① ② ③ ● ⑤	(50)	● ② ③ ④ ⑤

No. of correct answers

Part A - Structured Essay

1) Consider the following particulars regarding a laboratory set - up to find the surface tension of a Liquid using a thin tube



a) Figure on the right shows the main scale and vernier scale of the traveling microscope What is the least count of the Instrument?

$\text{Least Count} = \frac{1/2}{50} = \frac{1}{100} = 0.01\ mm$ —(01)

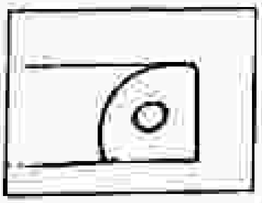
b) In the figure shown, what is the function of the screws T_1 and T_2.

i) $T_1 \rightarrow$ move the travelling microscope horizontally —(01)

ii) $T_2 \rightarrow$ Screw which is used to focus the object —(01)

c) The cross - section of a thin tube as observed using a traveling microscope is shown in the figure. Sketch how the entire cross – section will be seen in the given box.

consider the positions of vertical & horizontal margins (lines)



d) When finding the diameter, the venier scale at two positions are shown in the figures a and b, what is the diameter of the tube?

$d = d_a - d_b$

$= 67.58\ mm - 70.14\ mm$

$= 2.56\ mm$ —(01)

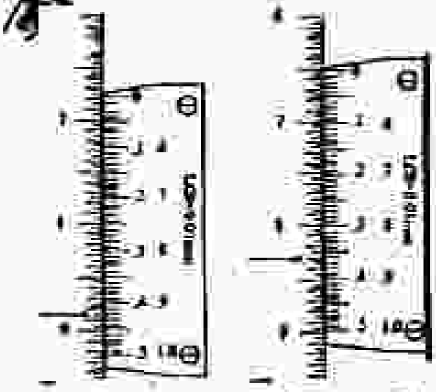
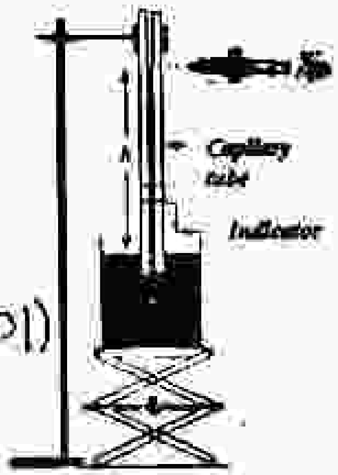


Figure (a) Figure (b)

e) It is required to find the surface tension of a liquid using the capillary rise. Write the necessary important experimental steps to be followed regarding the thin tube.

wash by dilute acid | dilute base | distilled water and dry by a wind of dry air —(01)

f) A wire indicator is fixed to the tube using a rubber band and one end is inserted into the water beaker on a stand and height of the rising water column is measured.



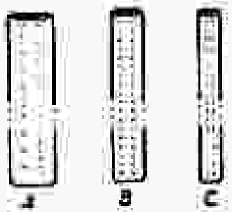
i) Before taking readings an important adjustment of the experimental setup is required. Explain how this is done.

Raise the water bath until the surface water get contact with the tip of the indicator —(01)

ii) Write an expression for the height of the water column in the thin tube in terms of surface tension (T) radius of the tube (r) angle of contact (θ). Name the quantities not mentioned above.

$h\rho g = \frac{2T\cos\theta}{r}$ ρ = density of the liquid —(01)

g) You have been given the tubes shown below, which tube will you choose for this experiment? Give your reasons



C is suitable, small radius. Therefore height of the water column is increased. Because of comparatively high radius, the percentage error of lengths are increased. —(01)

h) During the time taken to complete the experiment the following physical quantities have changed. Explain their effect on the surface – tension.

1) Atmospheric pressure changed

No any effect by atmospheric pressure.
∴ No any change.

2) Temperature changed

The surface tension is reduced with the temperature.

(01)

i) Soap can be used to make (soap) air bubbles but water cannot be used to make bubbles. Explain the reasons for this phenomenon

Soap bub le get stretched because the surface tension of the soap is comparatively less. The surface tension of water is greater ∴ it breaks. —(01)

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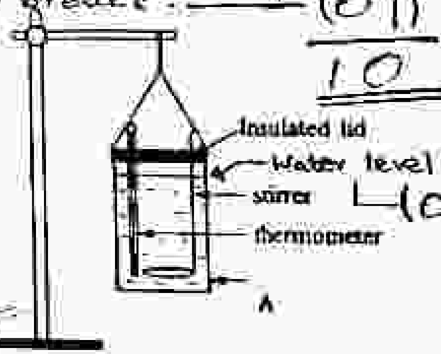
2) Figure shows a vessel with a heat insulated lid suspended by a heat insulated string. A student intends to find the specific heat capacity of coconut oil using this setup. He plans to add hot water first and hot coconut oil second and obtain readings at two separate instances.



(01)

i) What are the conditions required to satisfy Newton's Law of cooling?

1. Heat loss by forced convection
2. Room temperature should be constant

—(01)

ii) In order to make the experiment successful, what characteristic should the vessel A have in additio to nature of the surface?

Should need a good conductivity. —(01)

iii) Mark the level to which water should be added to the vessel, in the above figure.

iv) Why is it necessary to add water upto the above level?

To distribute the temperature throughout the calorimeter uniformly. —(01)

v) Why is it necessary to close the vessel with an insulated lid? ✓

To avoid heat loss from surface of water
To stop the loss of mass by the evaporation } — (01)

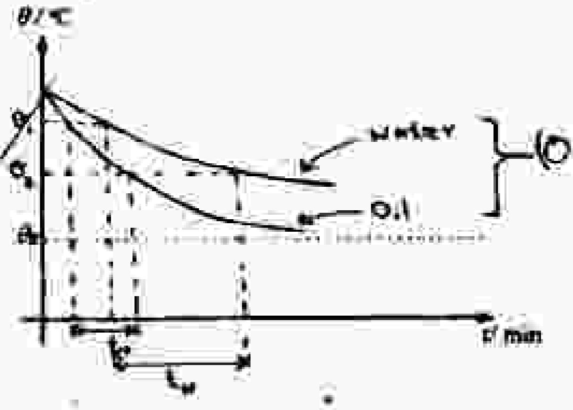
vi) What are the readings to be obtained by the student?

X_1 mass of empty calorimeter
X_2 mass of water + calorimeter.
X_3 mass of oil + calorimeter. } — (01)
Variation of temperature with time.

vii) What are the conditions which must be constant during both instances when taking readings?

1. Contact surface area of the calorimeter with the water
2. Nature of the surface of the calorimeter.
3. Excess temperature } (01)

viii) If the specific heat capacity of water is C_W and specific heat capacity of coconut oil is C_o ($C_W > C_o$) draw the cooling curves that the student is expected to obtain in the given axis systems. (θ_R is the room tempetature)



} (01)

$t_w, t_o, \theta_2, \theta_1$ } — (01)

ix) Mark the two values t_o and t_w which are required to calculate C_o using the above graph, in the given axis system

x) Write an equations including above X_1, X_2, X_3, t_o, t_w, C_W, and C_o

$$\left[(X_2-X_1)c_w + X_1C_{ca}\right]\frac{(\theta_1-\theta_2)}{t_w} = \left[(X_3-X_1)c_o + X_1C_{ca}\right]\frac{(\theta_1-\theta_2)}{t_o}$$

(01)

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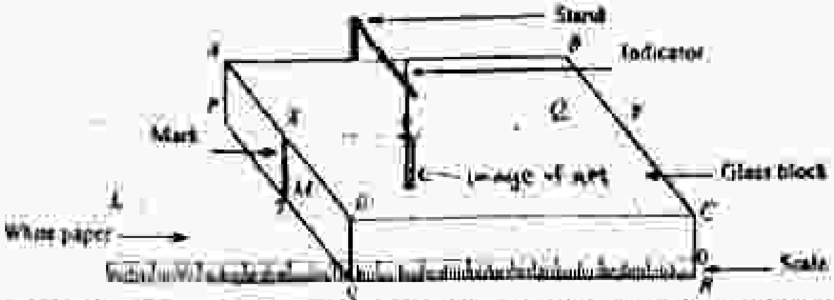
3) In a laboratory without a traveling microscope a student uses a practical arrangement to find the refractive index of a glass block as shown below.



First he places the glass cube on a white paper place on a drawing board and draws the outline. Next he marks a thick line M across the center line of the face APSD, now he plans to find the location of the image of M using the parallax method, by looking through face BQRC.

i) How will he identify that the image of M is coincided with the indicator.

When there is no relative motion between the Image of M and the indicator pin, if the eye moved to either sides of XY line ——— (01)

ii) At this moment draw the location of the indicator, and the image in the above drawing.

For labeling the diagram ——— (01)

iii) If all measurements are taken from QR, what are the measurements(x,y) he should take to find the refractive index of the glass.

x = the horizontal distance to M from QR ——— (01)

y = the horizontal distance to pin from QR ——— (01)

iv) Write an expression to find the refractive index *n* of the glass block using these two measurments.

$\frac{n}{x} = \frac{1}{y}$, $n = \frac{x}{y}$ ——— (01)

v) In iii) above if one measurement was 6 cm and the other was 4 cm find the value of *n*.

$n = 6/4 = 1.5$ ——— (01)

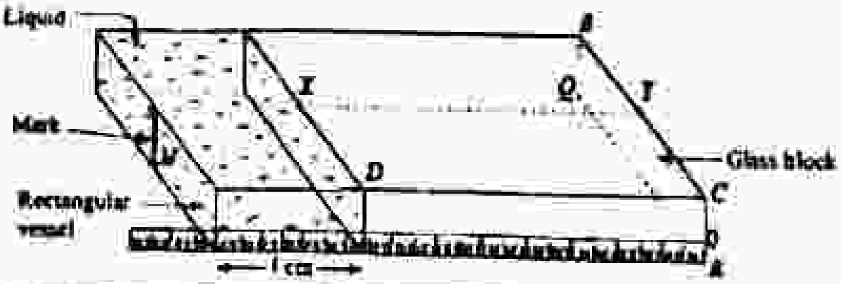
vi) If the thickness of the glass block is t and the apparent displacement of the image is d write the relationship between *n*, t, d.

$d = t(1 - 1/n)$ ——— (01)

vii) Now he removes the mark M and places an indicator pin vertically on line ST and obtains the location of the image using the above method. If the value was 6cm, what is the distance from QR at which he had placed the indicator pin?

8 cm ——— (01)

viii) In order to find the refractive index of a transparent liquid using the above method a rectangular vessel having very thin walls made of the same material as the glass block is used, as shown in the figure



The liquid is filled into the vessel and a mark is marked on the vessel wall, and the location of M's image is found using the above method. The displacement of the image from QR is 7cm.

a) Find the refractive index of the liquid

$$10 - 7 = 4\left(1 - \frac{1}{n}\right) + 6\left(1 - \frac{1}{3/2}\right)$$

$$n = 4/3$$ ——— (01)

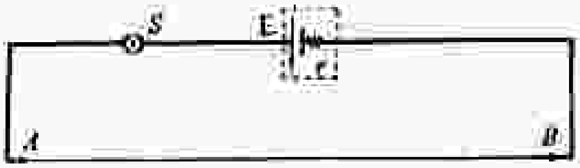
b) If two transparent liquids having refractive index n_1 and n_2 are filled into the vessel in two separate occasions and the apparent displacement of the images are d_1 and d_2 write an expression relating d_1, d_2, n_1 and n_2

$d_1 = 4\left(1 - \frac{1}{n_1}\right) + 6\left(1 - \frac{1}{3/2}\right)$; $d_2 = 4\left(1 - \frac{1}{n_2}\right) + 6\left(1 - \frac{1}{3/2}\right)$

$d_1 - d_2 = 4\left(\frac{1}{n_2} - \frac{1}{n_1}\right)$; $\frac{d_1 - d_2}{4} = \frac{1}{n_2} - \frac{1}{n_1}$ ——— (01)

10

4) Consider that the normal potentiometer wire needs to be adjusted to measure small potential differences and large potential differences. The following figure shows a normal circuit of a potentiometer. The length of the potentiometer wire AB is 1m and its electrical resistance is 4Ω. The lead acid accumulator, E connected to the circuit has an emf of 2V and an internal resistance r = 1Ω. S is a plug key.



a) i) Give an advantage of using a lead acid accumulator for E.

To keep a constant potential gradient for a long time ——— (01)

ii) A plug key is more suitable for S than a tap key, explain?

Resistance of the current is comparatively less, suitable to use for a long time, continuous current. ——— (01)

iii) What is the potential gradient across the wire AB.

16 mVcm⁻¹ ——— (01)

$I = \frac{2}{5} = 0.4\,A$

$V = IR = 1.6\,V$

iv) If a normal cell of emf $E_1 = 1.2\,V$ is used to find the potential gradient experimentally, calculate the balance length of the wire.

75cm ——— (01)

$E = kl$

$1.2 = 16 \times l$

$l = \frac{1200}{16} = 75\,cm$

b) i) Now it is required to change the above wire to measure the small emf values. What is the required resistance of the resistor to be connected to reduce the potential gradient to a value of 0.4 mVcm⁻¹. Is this resistance obtained by using a resistance box or a rheostat?

19.5 kΩ, by resistance box ——— (01)

ii) A student says that the above standard cell cannot be used to find the potential drop per unit length (K) give reasons for this?

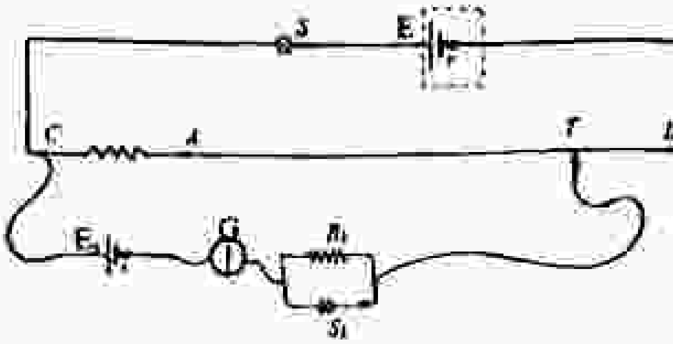
Potential difference across the wire < EMF of the standard cell ——— (01)

$V = kl$

$400 = 1 + R$

$R = 195\,\Omega$

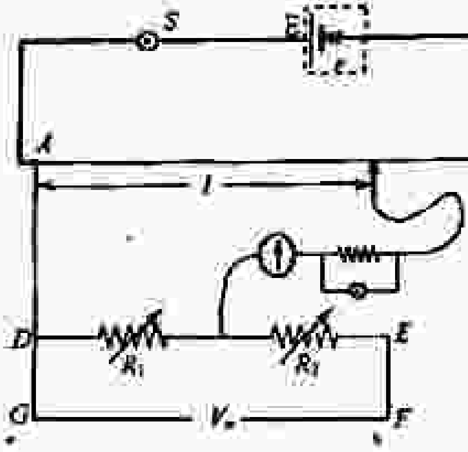
iii)



——— (01)

In order to over come the difficulty encountered in (ii) above a method of using the resistance calculated in (i) above to obtain a balance length for E_2 is applied between CA. Complete the circuit between galvanometer (a), sliding key (T), Resistance R_1 and switch S_1.

c) The circuit diagram below shows how the potentionmeter in figure (1) can be used to measure large potential differences.



i) The circuit DEFG shows a large voltage and potential divider V_0, R_1 and R_2 are two resistance boxes. The potential difference across resistance R_1 gives a balance length l. Consider the potential gradient of the wire to be K and write a a relationship between V_0, R_1, R_2, K, l.

$V_0 \frac{R_1}{(R_1+R_2)} = Kl$ ——— (01)

ii) Now while changing the value of R_1, l can be measured. Make R_1 the independent variable and l the dependent variable and re – arrange the terms in the form of a linear graph.

$l = \frac{V_0 R_2}{K}\left(\frac{1}{R_1}\right) + \frac{V_0}{K}$ ——— (01)

iii) If the value of K is known, consider the data to be obtained from the graph, to find the large voltage V_0 as M and write an expression for V_0.

$\frac{V_0 R_2}{K} = m$ or $m = \frac{V_0}{K}$ ——— (01)

$V_0 = \frac{mK}{R_2}$ $V_0 = mK$

$\underline{\underline{10}}$

(15)(a) i) ρ - density , h - vertical depth ———— (01)

ii) Upthrust $u = V\rho g$ ———— (01)

V - submerged volume
ρ - density of liquid
g - gravitational acceleration } ———— (01)

iii) Magnitude of upthrust $= \frac{1}{2} \times \frac{4}{3} \pi r^3 \rho g = \frac{2}{3} \pi r^3 \rho g$ ——(01)
direction of upthrust ↑ ———— (01)

(b) i) mass of the tanker (ship) without oil
$m = V\rho = 20 \times 60 \times 3.2 \times 1000 = \underline{38.4 \times 10^5\ kg}$ ——(01)

ii) $F = A v^2 \rho g$
$= 0.6 \times 4 \times 8^2 \times 1000 \times 10 = 153.6 \times 10^4 = \underline{1.536 \times 10^6\ N}$ ——(01)

iii) power supplied to ship by four propellar
$P = FV$
$= 1.536 \times 10^6 \times 18 \times \frac{5}{18} = \underline{7.68 \times 10^6\ W}$ ——(01)

(c) i) $\frac{1}{2} \rho v^2 = h\rho g$
$\frac{1}{2} \times v^2 = 3.2 \times 10$
$v^2 = 64$
$v = \underline{8\ ms^{-1}}$ —(01)

ii) $8\ ms^{-1}$
Because the level of water inside and outside of the ship remains same in 3.2 m. } —(01)

iii) The volume of water enter to the ship = rate of entering water × time

$(7 - 3.2) \times 20 \times 60 = 2 \times 8 \times t$

$t = \frac{3.8 \times 20 \times 60}{2 \times 8} = 3.8 \times 75$
$= 285\ s$
$= \underline{4.75\ min}$ ——(01)

iv) The time taken by the second ship to reach to the first ship } $= \frac{4000}{10} = 400\ s$ ———— (01)

Can't reach Because,
the time taken by the first ship to sink < time taken by the second ship to reach ——(01)

(d) $t \times 2 \times 8\ (1000 \times 10 - 800 \times 10) = (0.3 \times 20 \times 60 \times 1000 \times 10)$

$t = \frac{0.3 \times 20 \times 60 \times 1000 \times 10}{2 \times 8 \times 1000 \times (10 - 8)} = \frac{1800}{16} = \underline{112.5\ s}$ ——(01)

(e) The height of the oil column raised, when the ship get tilted is less. Therefore the centre of gravity of the system rise up with less value. It helps to keep the stability of the ship ———— (01)

15

(06) (a) i) For the difinition of Doppler effect ——— (01)

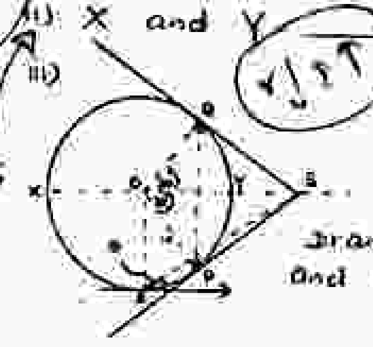
ii) $F_o = f_s\left(\frac{V+V_o}{V-V_s}\right)$

V = Velocity of sound inside the medium
V_o = Velocity of observer relative to the medium
V_s = Velocity of source relative to the medium
f_s = frequency of source
} (01)

(b) i) at Y position, Because of the closest position between source and the boy ——— (01)

ii) X and Y ——— (01)

iii)



Drawings tangent ——— (01)
and marking 'P' & 'Q' ——— (01)

iv) $T = \frac{2\pi r}{V}$
$= \frac{2\times 3\times 10}{5}$
$= \underline{\underline{12\,s}}$ ——— (01)

v) Angle subtended at 12 s = 360°
Angle subtended at 2 s $= \frac{360^\circ}{12}\times 2 = \underline{\underline{60^\circ}}$ ——— (01)

vi) $\cos 30^\circ = \frac{10}{OQ}$
$OQ = \frac{10}{\sqrt{3}/2} = \frac{20}{\sqrt{3}} = \underline{\underline{11.547\,m}}$ ——— (01)

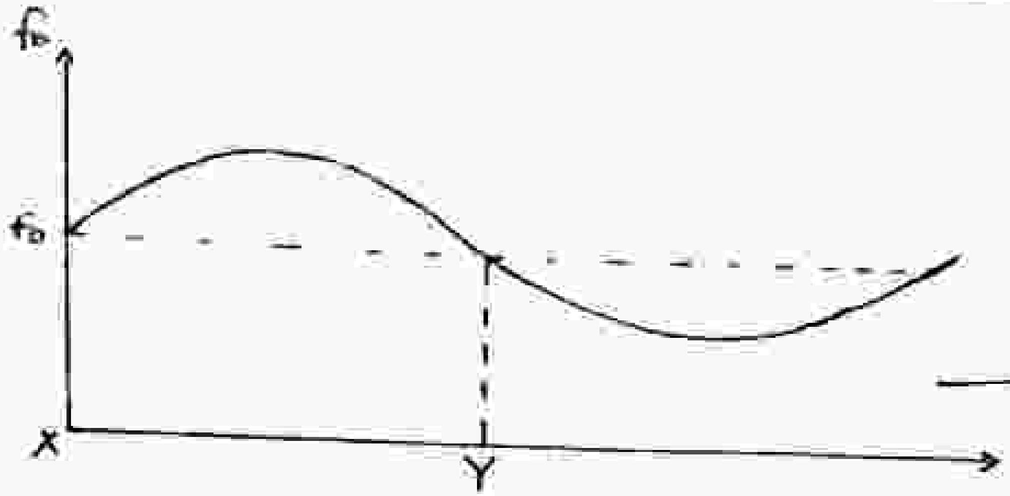
vii) $F_{maximum} = f_s\left(\frac{V+V_o}{V}\right)$
$= 1000\left(\frac{340+5}{340}\right) = \underline{\underline{1014.7\,H_z}}$ ——— (01)

$F_{minimum} = f_s\left(\frac{V-V_o}{V}\right)$
$= 1000\left(\frac{340-5}{340}\right) = \frac{335}{340}\times 1000 = \underline{\underline{985.29\,H_z}}$ (01)

viii) $f = f_s\left(\frac{V + V_o\cos\theta}{V}\right)$
$= 1000\left(\frac{340+5\times\frac{20}{\sqrt{3}}\times\frac{\sqrt{3}}{\sqrt{700}}}{340}\right)$
$= \frac{1000\,(343.78)}{(340)}$
$= \underline{\underline{1011.12\,H_z}}$ ——— (01)

$\sqrt{10^2+\frac{20^2}{3}}$
$\frac{3\times 100+400}{3}$
$=\sqrt{\frac{700}{3}}$
$=\frac{\sqrt{700}}{\sqrt{3}}$

ix)



——(01)

x) $I = \dfrac{P}{4\pi r^2}$

$= \dfrac{16 \times 3}{4 \times 3 \times 20^2}$

$= \dfrac{16}{4 \times 400}$

$= \underline{\underline{10^{-2}\ Wm^{-2}}}$ ——(01)

$I = \dfrac{P}{4\pi r^2}$

$\beta = 10 \log_{10}\left(\dfrac{I}{I_0}\right)$

$= 10 \log_{10}\left(\dfrac{10^{-2}}{10^{-12}}\right)$

$= 10 \log_{10} 10^{10}$

$= \underline{\underline{100\ dB}}$ ——(01)

$\underline{\underline{15}}$

07 (a) Under the tension concrete breaks at a low stress but under compression breaking stress is very large —(01) (01)

(b) $y = \tan\theta$

$$= \frac{8\times10^{8}}{4\times10^{-2}} = \underline{\underline{2\times10^{10}\ Pa}} \text{ ——— (01)}$$

(c) Steel works well in tension while concrete works well in compression. ——— (01)

(d) The steel strands do not slide through concrete. —(01)

(e) i) $L < l_0 < L_0$ ——— (01)

ii) $4T = F$ ——— (01)

iii) $$4 \times A_s \times y_s \frac{(l_0 - L)}{l_0} = A_c y_c \frac{(L_0 - L)}{L_0} \text{ ——— (01)}$$

$$y_s = 15\, y_c$$

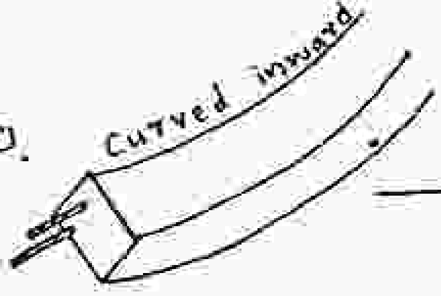
$$A_s = \frac{A_c}{160}$$

$$\therefore 4 \times \frac{A_c}{160} \times 15\, y_c \frac{(l_0 - L)}{l_0} = A_c y_c \frac{(L_0 - L)}{L_0} \text{ ——— (01)}$$

$$3(l_0 - L)L_0 = 8\, l_0 (L_0 - L)$$

$$L = \frac{5\, l_0 L_0}{8\, l_0 - 3 L_0} \text{ ——— (01)}$$

(f)



——— (02)

(g) Because when a load is put on it, the lower part of the beam is subjected to tension while the upper part is subjected to compression. ——— (01)

As steel works well in tension and ——— (01) concrete works well in compression steel is needed only towards the lower part of the beam. ——— (01)

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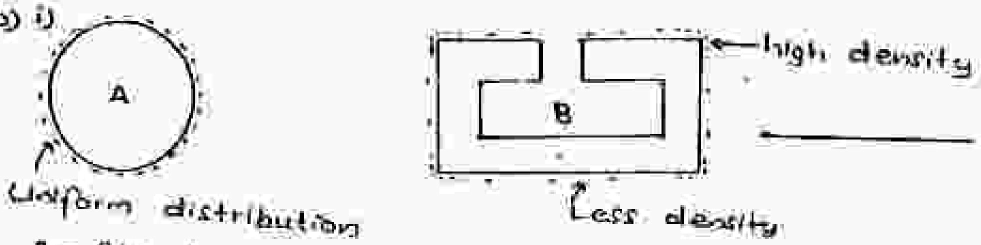
(08) (a)
- paint is not wasted
- A proper finishing
- Environment is not polluted

—— (01)

(b) i)



—— (02)

A – Charge distribution is uniform

B – More charges accumulate arround the edges and no charges inside

ii) Because of the electric field between the gun and the work piece.

or,

due to the electric forces acting on charge particles towards the workpiece —— (01)

iii) Charge density around the edges is high. Therefore more ink droplets are collected around them

As no charges exist inside no more paint is attracted —— (02)

(c) Because like charges repel each other —— (01)

(d) $E = \frac{Q}{4\pi\varepsilon_0 r^2}$

$3\times10^{4} = \frac{Q\times9\times10^{9}}{9\times10^{-12}}$

$Q = \underline{3\times10^{-19}C}$

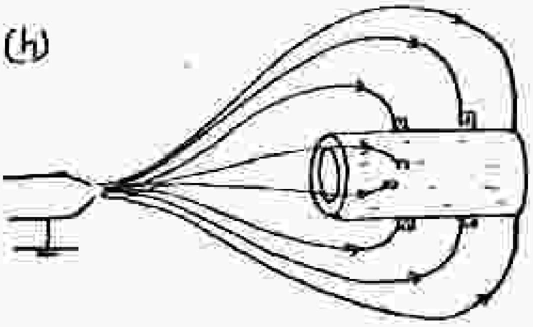
(02)

(e) $n = \frac{1.08\times10^{-6}}{\frac{4}{3}\times3\times3^{3}\times10^{-18}} = \underline{\underline{10^{10}}}$ —— (01)

(f) $I = 10^{10}\times3\times10^{-15} = \underline{\underline{3\times10^{-5}A}}$ —— (01)

(g) No Because the crosssectional area increase as the flow progress —— (01)

(h)



- lines must be ⊥ to the surface.
- no paths into the cylinder.

—— (02)

(i) The workpiece fails to hold charges on it —— (01)

$\underline{\underline{15}}$

(09) (A)(a)(i) The rate of change of flux link with a conductor is directly propotional to the induced e.m.f. ———— (01)

(ii) The induced current is formed so that it oppose the action cause to generate it. ———— (01)

(b) I)

(i) $E = BAf$

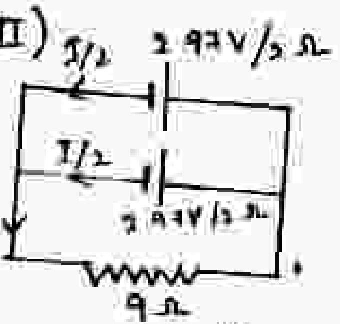
$= 0.4 \times 3 \times (2500 - 25) \times 10^{-4} \times 10$

$= 2.97\ V$ ———— (01)

(ii) From A to X $(\overrightarrow{AX})$ ———— (01)

II)

(i)



$2.97 = \frac{I}{2} \times 2 + 9 + I$

$I = 0.297\ A$ ———— (01)

(ii) $P = I^2R$

$= 0.297^2 \times 9$

$= 0.793\ W$ ———— (01)

III) $F = BIl$

$= 0.4 \times 0.297 \times 0.45$

$= 0.53\ N$ ———— (01)

$\tau = F \times r$

$= 0.53 \times 0.55$

$= 0.29\ Nm$ ———— (01)

(IV) (i) The induced e.m.f. is increased with the increase of angular velocity of the rod. Then the current get increased and the induced force is increased.

∴ The torque exert by the couple for the rotation is increased.

When the torque exert by the induced couple got equal to the torque exert by the supplied couple, the angular acceleration become zero. ——— (01)

(ii) $\tau = F \times r$ $\qquad F = BIl$

$0.55 = F \times 0.55$ $\qquad 1 = 0.4I \times 0.45$

$F = 1\,N$ ——(01) $\qquad I = 5.55\,A$ ——(01)

$E = \frac{5.55}{2} \times 2 + 9 \times 5.55$

$E = 5.55 + 49.95$ ——(01)

$E = 55.0\,V$

$E = BAf$

$55.5 = 0.4 \times (2500 - 25) \times 10^{-4} \times f$

$f = \frac{55.5}{0.4 \times 2475 \times 10^{-4}}$ ——(01)

$f = 560.6\,Hz$

V)

(i) $30 - E = 10 \times 2$

$E = 10V$ ——(01)

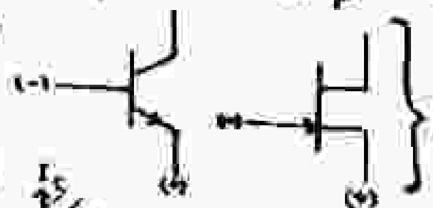
(ii) $\text{Efficiency} = \frac{10}{30} \times 100$

$= 33.33\,\%$ —(01)

15

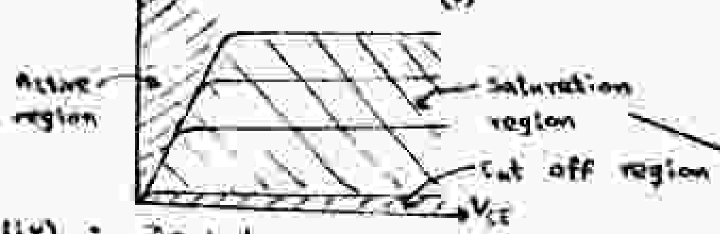
(09) (B) (a) (i) Bipolar – n, p both
Unipolar – n or p } both ———— (01)

(ii)



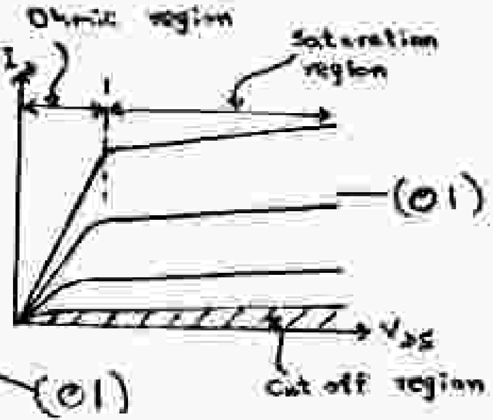
} (01)

(iii)



(01)

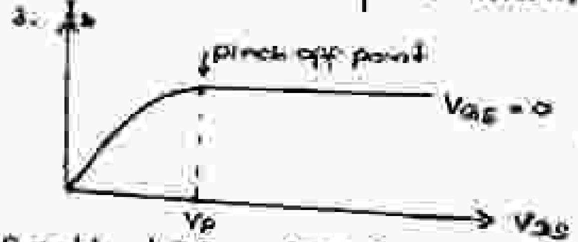
(iv) 1.



(01)

(iv) 2. Depletion region round the p-n junction is uniform
n channel uniform width ———— (01)

3.



———— (01)

(b) Bright LDR = 200 Ω
V_{LDR} << very small ($I_B = 0$, $I_C = 0$) LED off } —— (01)

Dark LDR = 500 kΩ V_{LDR} Large, I_B maximum, I_C maximum LED on —— (01)

(c) (i) $(V_{DS})_{min} = 4\,V$ ———— (01)

(ii) $I_{DS} = 4\,mA$ ———— (01)

(iii) $V_G = V_{DD} \dfrac{R_2}{R_1 + R_2}$

$5 = 15 \dfrac{R_2}{1 + R_2}$

$1 + R_2 = 3R_2$

$R_2 = \underline{\underline{0.5\,M\Omega}}$ —— (01)

$V_{DD} - V_D = I_D R_D$

$15 - 7 = 4 R_D$

$8 = 4 R_D$

$R_D = \underline{\underline{2\,k\Omega}}$ —— (01)

$V_{GS} = V_G - I_D R_S$

$-2 = 5 - 4 \times 10^{-3} R_S$

$R_S = 7/4\ k\Omega$

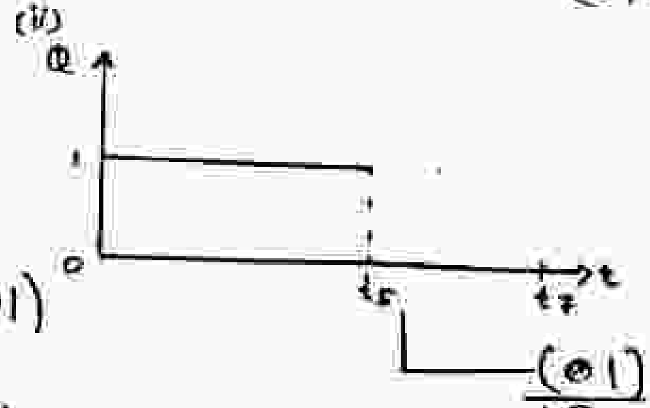
$R_S = \underline{\underline{1.75\,k\Omega}}$ —— (01)

(d) (i)

S	R	Q old	Q new
0	0	0	0
		1	1
1	0	0	1
		1	1
0	1	0	0
		1	0

—— (01)

(ii)



—— (01)

15

⑩ (a)

(i) $\Delta Q = \Delta U + \Delta W$ ———— (01)

ΔQ – the change of heat supplied
ΔU – the change of internal energy
ΔW – the work done by the system } (01)

(ii)

	ΔQ	ΔW	ΔU
a	+	+	0
b	0	+	–
c	+	+	+
d	+	0	+

———— (02)

(b)

(i) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{1\times10^{-4}}{300} = \frac{V_2}{900}$

$V_2 = 3\times10^{-4}\ m^3$ ———— (01)

$\Delta W = P.\Delta V$

$\Delta W = 150\times10^{3}(3\times10^{-4} - 1\times10^{-4})$

$\Delta W = 30\ J$ ———— (01)

$PV\ \frac{3nRT}{2}$

(ii) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{150\times10^{3}}{900} = \frac{P_2}{300}$

$P_2 = 50\times10^{3}\ Pa.$ ———— (01)

$E = \frac{3PV}{2}$

Internal energy of the system at 627°C

$E_1 = 3\times150\times10^{3}\times3\times10^{-4}$

$= 67.5\ J$ ———— (01)

Energy at 27°C

$E_2 = \frac{3\times50\times10^{3}\times3\times10^{-4}}{2}$

$E_2 = 22.5\ J$ ———— (01)

Heat released

$= 67.5 - 22.5$

$= 45\ J$ ———— (01)

(iii) The heat should supplied at constant pressure.

$\Delta Q = \Delta W + \Delta U$.

$\Delta Q = 30 + 45$

$\underline{\underline{\Delta Q = 75\ J}}$

The work has to be done at constant volume

$\Delta Q = \Delta U$

$\therefore \Delta U = \underline{\underline{75\ J}}$ ———— (01)

$\dfrac{\Delta Q_p}{\Delta Q_v} = \dfrac{C_p}{C_v}$

$\Delta Q_p = nC_p \Delta\theta$

$\Delta Q_v = nC_v \Delta\theta$

(iv) $75 = m\,C_p\,(627 - 27)$ — ①
$45 = m\,C_v\,(627 - 27)$ — ② } ———— (01)

①/② $\dfrac{C_p}{C_v} = \dfrac{75}{45} = \underline{\underline{1.66}}$ ———— (01)

(C) $a \rightarrow b$ When T is constant $\Delta U = 0$
$\Delta Q = \Delta W = +80\ J$

$b \rightarrow c$ When V is constant $\Delta W = 0$
$\Delta Q = -\Delta U_2 = -50\ J$ ⌊ (01)

(d) $\Delta Q = Q_{in} - Q_{out} = (2800 - 2100)$

Rate of flow of steam $= 700\ kJkg^{-1}$.

$= \dfrac{m}{t}$

$\Delta Q = 700\dfrac{m}{t}\ kW$

$\Delta W = 5 - 1000 = -995\ kW$

$\Delta Q + \Delta W = 0$

$700\dfrac{m}{t} - 995 = 0$

$\dfrac{m}{t} = 1.421\ kgs^{-1}$

Steam flow required $= \underline{\underline{1.421\ kgs^{-1}}}$ — (01)

(10) (B) ⓐ (i) $x = 138$
$y = 36$ } ——— (01)

(ii) pre mass $= 1.008665\ \text{amu} + 235.0439\ \text{amu}$
$= 236.052565\ \text{amu}$
$= 236.052565 \times 1.66 \times 10^{-27}\ \text{kg}$
$= 391.8472579 \times 10^{-27}\ \text{kg}$ ——— (01)

post mass $= (137.9050 + 94.9 + 3.025945)\ \text{amu}$
$= 235.830995$
$= 391.4794517 \times 10^{-27}\ \text{kg}$ ——— (01)

$\therefore$
$= 236.052565\ \text{amu} - 235.830995\ \text{amu}$
$= 0.22157\ \text{amu}$
$= 0.22157 \times 1.66 \times 10^{-27}\ \text{kg}$
$\Delta m = \underline{\underline{3.678062 \times 10^{-28}\ \text{kg}}}$ ——— (01)

(iii)
$E = mc^2$
$E = 3.678062 \times 10^{-28} \times (3 \times 10^8)^2$
$E = \underline{3.3102558 \times 10^{-11}\ \text{J}}$
$E = \underline{2.0689 \times 10^{8}\ \text{eV}}$
$E = \underline{206.89\ \text{MeV}}$ } ——— (01)

(iv) Number of neucleus required to get $3.3102558 \times 10^{-11}$ J energy] $= 01$

Number of neucleus required to get 120×10^9 J energy at one second] $= \dfrac{1}{3.3102558 \times 10^{-11}} \times 120 \times 10^{9}$
$= 3.625097 \times 10^{21}$ neucleus ——— (01)

Mass required to get 120×10^9 J energy at one second } $= \dfrac{N}{L} \times M$
$= \dfrac{3.625097 \times 10^{21}}{6.023 \times 10^{23}} \times 235 \times 10^{-3}\ \text{kg}$
$= 6.01876 \times 10^{-3} \times 235 \times 10^{-3}\ \text{kg}$
$= 1.41464 \times 10^{-3}\ \text{kg}$
$= 1.41464\ \text{g}$ ——— (01)

ⓑ (i)

α	β	γ
positively charged	negatively charged	No charge
Deflection occurs in electric & magnetic field	Deflection occurs slightly in E & M fields	No deflection
Velocity is less than light velocity (c)	0 & C	C

(01)

(ii) Geiger Counter ———————— (01)

(iii) $^{95}_{36}Kr \longrightarrow {}^{95}_{37}X + {}^{0}_{-1}\beta^{-}$ + energy —— (01)

(C) (i) The time taken to get half the number of parent neuclei in a given Sample is called half life time. —————— (01)

(ii)

No of radioactive Kr neucleii (N) $= \frac{m}{M} \times L$

$= \frac{60 \times 10^{-6}}{95} \times 6.022 \times 10^{23}$

$N = 3.8 \times 10^{17}$ neucleii —— (01)

(iii) Radio activity $R = \lambda N$

$= \frac{0.693}{T_{1/2}} \times N$

$= 9.857 \times 10^{13}$ Bq — (01)

(iv) Medicine – To destroy cencer calls.
Identify the blocking places in the circulatory system.

Engineering – To investigate the constant thickness of metal plates.
To identify the probleme in the casting process of the underground tubes.

Agriculture – As insectidides, To introduce new floral types.
To identify the effect of fertilizer in parts.

(01)

(v) use safety wear, Do not touch radioactive materials Do not look at them directly, Insert them inside thick Pb blocks. (01)