අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2017 අගෝස්තු
**General Certificate of Education (Adv.Level) Examination, August 2017**

# PHYSICS

## PART I

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 01. (2) | 02. (3) | 03. (4) | 04. (4) | 05. (5) | 26. (4) | 27. (3) | 28. (5) | 29. (4) | 30. (3) |
| 06. (4) | 07. (5) | 08. (1) | 09. (3) | 10. (5) | 31. (4) | 32. (2) | 33. (2) | 34. (1) | 35. (2) |
| 11. (4) | 12. (3) | 13. (1) | 14. (3) | 15. (1) | 36. (3) | 37. (4) | 38. (1) | 39. (2) | 40. (1) |
| 16. (4) | 17. (1) | 18. (3) | 19. (2) | 20. (1) | 41. (2) | 42. (3) | 43. (5) | 44. (1) | 45. (5) |
| 21. (4) | 22. (2) | 23. (2) | 24. (2) | 25. (3) | 46. (3) | 47. (3) | 48. (2) | 49. (1) | 50. (1) |

(Marks $2 \times 50 = 100$)

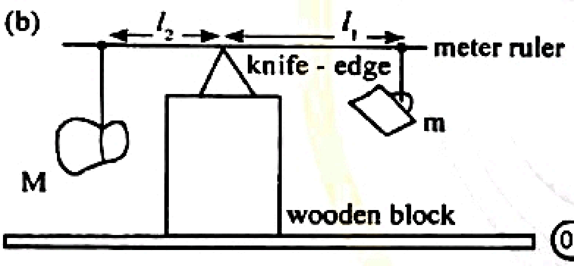
## PART II

## PART A

01. (a) To avoid the mass / weight / moments of the meter ruler in the calculations OR

To locate / mark the centre of gravity / center of mass of the meter ruler. (01)

(b)




(02)

(c) $l_2 = \dfrac{m}{M} l_1$ (01)

(d) On the centre of gravity / centre of mass of the meter ruler OR on the same point mentioned in (a) above OR

Balance point of the meter ruler alone. (01)

(e) (i) Small length measurements creates higher fractional / percentage error OR

To reduce the fractional / percentage error of the length measurements. (01)

(ii) Selecting only (16,13) and (39,31) points (01)

$$\text{Gradient} = \frac{Y_2 - Y_1}{X_2 - X_1} = \left(\frac{31 - 13}{39 - 16}\right) = \frac{18}{23}$$

$= 0.78$ (01)

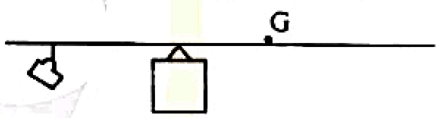
(0.78 - 0.80)

(iii) Mass $M = \dfrac{50 \times 10^{-3}}{0.78}$

$= 6.41 \times 10^{-2}$ kg

$= [(6.25 - 6.41) \times 10^{-2}$ kg$]$ (01)

(f)




(01)

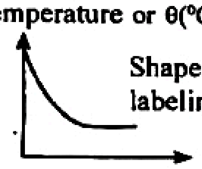
02. (a) (i) 1. Temperature of water with time OR

Temperature of water at regular time intervals (half a min one min)

2. Room temperature (temperature of laboratory) (01)

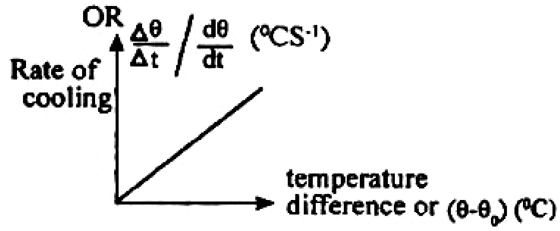
(ii) Stirring the water (01)

(iii) temperature or θ(°C)




Shape of the graph and labeling axies (01)

OR




labeling and appropriate units of both axes (01)

Straight line as shown in this graph (01)

(b) (i) To obtain the same surface nature / emissivity in both part of the experiments. (01)

(ii) To obtain the same rate of loss of heat for water and liquid / in both parts of the experiments at a given excess temperature / temperature range (01)

(iii) $H_m = (ms + m_l s_l)\,\theta_m$ (01)

(iv) $90 = (0.15 \times 400 + 0.25 \times s_l)(0.125)$ (01)

$$\frac{90}{0.125} = 60 + 0.25\, s_l$$

$$s_l = \frac{1}{0.25}\left(\frac{90}{0.125} - 60\right)$$

$$s_l = 2640\ \mathrm{Jkg^{-1}k^{-1}}$$

$(2640 - 2642\ \mathrm{Jkg^{-1}k^{-1}})$ (01)

03. (a) Longitudinal Vibrations (waves no mark) (01)

(b) $V = \sqrt{T/m}$ (01)

(c) A

Energy transfer is efficient OR

Air coloumn in side the sonometer box will vibrate with maximum amplitude will resonate OR surface of the Somometer will vibrate with maximum amplitude ( due to resonance) (01)

(d) Paper rider (01)

(e) Place the paper rider on the middle the wire AB place the stem of the vibrated tuning fork on top of the sonometer Surface. Adjust the bridge B until the paper rider jump off very quickly / in Stantly / to a maximum height. (01)

(f) $V = f\lambda$ & $l = \lambda/2$ both (01)

$$V = \sqrt{T/m}$$

$$\sqrt{T/m} = f\,2l$$

$$T/m = f^2 4l^2$$

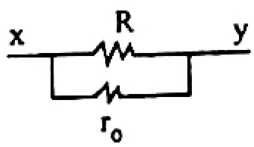
$$m = \frac{T}{4f^2\, l^2}$$ (01)

(g) Increasing the weight of the load OR adding more masses (01)

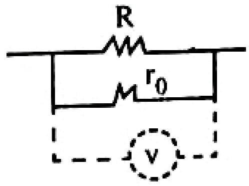
(h) $$m = \frac{3.2 \times 10}{4 \times (0.25)^2 \times 320^2}$$

$$m = 1.25 \times 10^{-3}\ \mathrm{kgm^{-1}}$$ (01)

04. (a) (i)




OR




(01)

(ii) $$\frac{1}{R_{xy}} = \frac{1}{R} + \frac{1}{r_0}$$

$$R_{xy} = \frac{Rr_0}{R + r_0}$$ (01)

(b) Yes

Under this situation current through the voltmeter is Zero though it indicates a reading (01)

As ideal voltmeters carry no currents the voltmeter acts as in ideal voltmeter (01)

OR

The current supposed to be flowing through the voltmeter is new going through $r_0$ marking the current though voltmeter equel to zero (01)

As ideal voltmeters carry no currents the voltmeter acts as in ideal voltmeter (01)

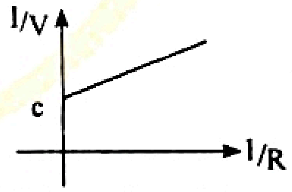
(c) $V = IR$

$$I = V/R_{xy}$$

$$I = V\left(1/R + 1/r_0\right)$$ (01)

(d) $$\frac{I}{V} = \frac{1}{R} + \frac{1}{r_0}$$ (01)

(e)




$$\frac{I}{V} = \frac{1}{R} + \frac{1}{r_0}$$

$$y = mx + c$$

*Straight line with positive gradient and intercept* (01)

(f) *intercept* $= 1/r_0$ OR

$$r_0 = \frac{1}{\text{Intercept}}$$ OR

$$C = 1/r_0$$ (01)

(g) Resistance Box (01)

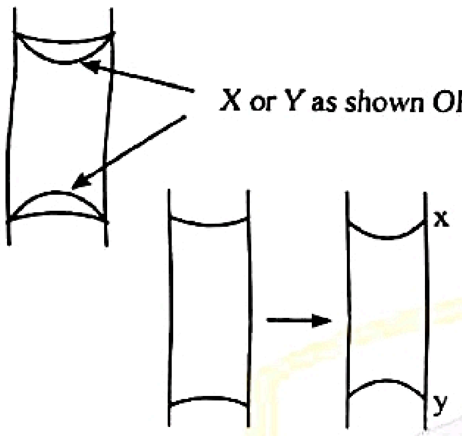
(h) $V_1 < V_3 < V_2 < E_0$ OR $V_1, V_3, V_2, E_0$ (01)

(g) $h = \frac{2 \times 7.2 \times 10^{-2}}{10^3 \times 10}\left(\frac{1}{0.8 \times 10^{-3}} - \frac{1}{1.0 \times 10^{-3}}\right)$ (01)

$= 14.4 \times 10^{-3}\left(\frac{1 - 0.8}{0.8}\right)$

$h = 3.6 \times 10^{-3}$ m (01)

(h)




(I) The radii of the mensci will decrease until it becomes equal to the radius of the void between the grains

Contact angle will decrease to zero

The resultant reaction force will decreace to zero (02)

(J) Removal of soil from the base of a slope

Addition of pesticides / herbicides/ fertilizers into the soil

Road constrictions in mountion regions without proper study (01)

08. (a) (i) $F = \frac{mv^2}{r}$

Grovitational force on B = Centripetal force on B

$\frac{GMm_B}{R_B^2} = \frac{m_B V_B^2}{R_B}$ (01)

$V_B = \sqrt{\frac{GM}{R_B}}$ (01)

(ii) Orbital period $T_B = \frac{2\pi R_B}{V_B}$ (01)

(iii) $T_B^2 = \frac{4\pi^2 R_B^2}{V_B^2}$ $\quad V_B = \sqrt{\frac{GM}{R_B}}$

$M = \frac{4\pi^2 R_B^3}{GT_B^2}$ (01)

(iv) $M = \frac{4 \times 10 \times (0.3 \times 1.5 \times 10^{11})^3}{6.7 \times 10^{-11} (50 \times 24 \times 60 \times 60)^2}$

($\pi^2 = 10$ OR $3.14^2$)

$= \frac{4 \times 10 \times (0.3 \times 1.5)^3}{6.7 \times (5 \times 24 \times 36)^2} \times 10^{38}$

$= 2.92 \times 10^{30}$ kg

[(2.90 - 2.92)$\times 10^{30}$ kg (01)

[$\pi = 3.14$ Answer (2.87- 2.90) $\times 10^{30}$ kg]

(b) (i) From part (iii) above $M = \frac{4\pi^2 R_B^3}{GT_B^2}$

Similary $M = \frac{4\pi^2 R_A^3}{GT_A^2}$ (01)

$\frac{R_A^3}{T_A^2} = \frac{R_B^3}{T_B^2}$ (OR any correct form) (01)

(ii) From b (i) above $R_A = \left(\frac{T_A}{T_B}\right)^{2/3} R_B$

$R_A = \left(\frac{300}{50}\right)^{2/3} (0.3 \times 1.5 \times 10^{11})$ (01)

(For correcet substitation

$R_A = 1.49 \times 10^{11}$ m [(1.48 - 1.50) $\times 10^{11}$m

(01)

Other method

$R_A = \left(\frac{300}{50}\right)^{2/3}$ (0.3) AU (01)

$R_A = 0.99$ AU (0.99 - 1.00) AU (01)

(c) (i) Gravitational attraction on mass m at th surface of the planet A as

$mg_A = \frac{GM_A m}{r_A^2}$ (01)

Acceleration due to gravity on palnet A a

$g_A = \frac{Gm_A}{r_A^2}$

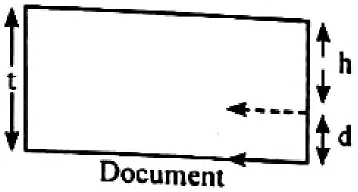
$m_A = 23m_E$ and $r_A = (4.6\, r_E)$

$\therefore g_A = \frac{G23m_E}{(4.6\, r_E)^2} = \frac{23}{(4.6)^2} \times \frac{GM_E}{r_E^2} = \frac{1.09\, GM_E}{r_E^2}$ (01)

from $m = \frac{D}{F} + 1 = \frac{25}{10} + 1 = \frac{35}{10}$

$= 3.5$ (01)

(iv)




Refractive index $n = \frac{\text{real depth}}{\text{apperent depth}} = \frac{t}{h}$

$h = \frac{t}{n}$

$= \frac{2\text{ cm}}{1.6}$

$h = 1.25\text{ cm}$ (01)

Other method

$d = t(1 - 1/n)$

$= 2(1 - 1/1.6)$

$= 0.75\text{ cm}$

$h = t - d$

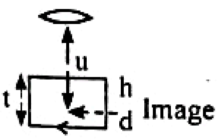
$= 2.00 - 0.75$

$h = 1.25\text{ cm}$ (01)

(v) (1) D or 25 cm or least distance of distinct vision of the person (01)

(2) $u - h + t = 7.14 - 1.25 + 2.00$

$= 7.89\text{ cm}$ (01)

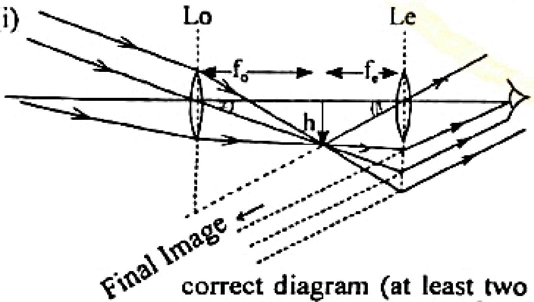



Other method $= u + d$

$= 7.14 + 0.75\text{ cm}$

$= 7.89\text{ cm}$ (01)

(b) (i)




correct diagram (at least two rays with arrow heads) (01)

To mark the objective, eye piece $f_e$ and $f_o$ correctly (01)

*(ii) Angular magnification*

$M = \beta/\alpha$

$= \frac{h/f_e}{h/f_o}$

$M = \frac{f_o}{f_e}$ (01)

(iii) Angular magnification of the Astronomical telescope

$M = \frac{f_o}{f_e} = \frac{100}{10}$, $M = 10$ (01)

(iv) To obtain a brighter image / finer details of the distant object OR

To collect more light / photons from the distant object (01)

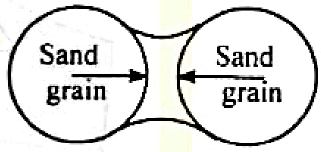
07. (a) Gravity, friction and Surface tension (01)

(b) clay,silt and sand (01)

(c) Angle of the slope is higher than the $\alpha$ / repose angle / steepest stable slope that the particular substance can form (01)

(d) The enhancement of the stability due to the capillary/ forces / surface tension forces / adhesive forces between the grains (01)

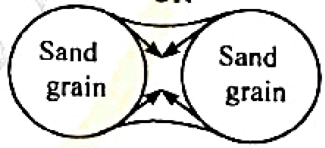
(e)




leftward arrow on the right side grain exactly as shown in figure (01)

Rightward arrow on the left side grain exactly as shown in figure (01)

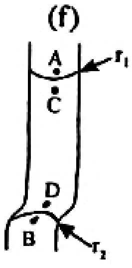
OR




Upper two arrows on the left side and right side grains - exactly as shown in figure. (01)

Lower two arrows on the left side and right side grains exactly as shown in figure. (01)

(f)




$P_A - P_C = \frac{2T}{r_1}$ —(X)

$P_B - P_D = \frac{2T}{r_2}$ —(Y)

(X) or (Y) (01)

$P_D = P_C + h\rho g$ (01)

$(X) - (Y) \longrightarrow P_D - P_C = \frac{2T}{r_1} - \frac{2T}{r_2}$

$h = \frac{2T}{dg}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ (01)

(g) $h = \frac{2 \times 7.2 \times 10^{-2}}{10^3 \times 10}\left(\frac{1}{0.8 \times 10^{-3}} - \frac{1}{1.0 \times 10^{-3}}\right)$ (01)

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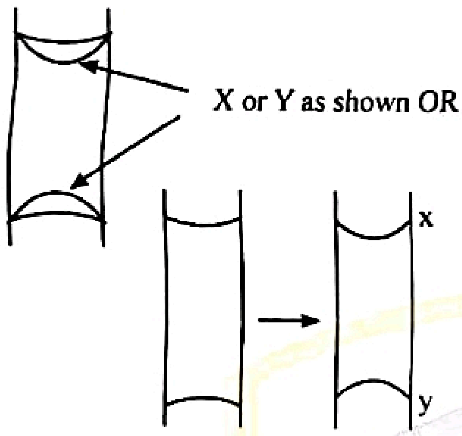
$h = 3.6 \times 10^{-3}$ m (01)

(h)

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$R_A = 1.49 \times 10^{11}$ m [$(1.48 - 1.50) \times 10^{11}$m (01)

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(ii) $g_A = \frac{23}{(4.6)^2} g_E = 1.09\, g_E$

$[(1.08 - 1.10)g_E]$ (01)

(iii) Weight of the module is

$= 100 g_A = 100 \times 1.09 \times 10 N$

$= 1.09 \times 10^3 N$ (01)

$[(1.08 - 1.10) \times 10^3 N$

(iv) Average density of planet A is

$$d_A = \frac{m}{V} = \frac{m_A}{\left(\frac{4\pi}{3}\right) r_A^3} = \frac{(23 m_E)}{\left(\frac{4\pi}{3}\right)(4.6\, r_E)^3} = \frac{23}{4.6^3}\left(\frac{m_E}{\frac{4\pi}{3} r_E^3}\right)$$

$= \frac{23}{4.6^3} d_E = 0.24 d_E \quad [(0.23 - 024) d_E]$

(01)

09\. (A) (a) Back e.m.f is produced due to the rate of change of magnetic field / flux through the coil. (01)

(i) Faraday's Law
(ii) Lenz's law — both (01)

(b) $E = V - Ir$ (01)

(c) $V = 80$ v, $r = 1.5\,\Omega$, $I = 4.0$ A

(i) $E = 80 - 4 \times 1.5$

$= 74$ V (01)

(ii) Power given to motor

$= VI = 80 \times 4$ (01)

$= 320$ W (01)

(iii) Power dissipated in the coil

$I^2 r = 16 \times 1.5$ (01)

$= 24$ W

Mechenical power output

$= VI - I^2 r = 320 - 24$ (01)

$= 296$ W (01)

Alternative method
mechenical power output $= EI$ (01)
$= 74 \times 4$ (01)
$= 296$ W (01)

Efficiency of the motor

$= \frac{296}{320} = 0.925 \ (0.92 - 093)$ (01)

OR

$= 92.5\% \ (92\% - 93\%)$ (01)

(d) Resistance at 30°C $= r_{30} = 1.5\,\Omega$

Resistance at θ °C $= r_\theta = \frac{V-E}{I_o} \; \frac{80-74}{3.6} = \frac{6}{3.6} = 1.67\,\Omega$

(01)

$r_{30} = r_o(1 + 0.004 \times 30)$
$r_\theta = r_o(1 + 0.004 \times \theta)$ } Any correct equ. (01)

$1.5 \times \frac{3.6}{6} = \frac{1 + 0.12}{1 + 0.004\theta}$

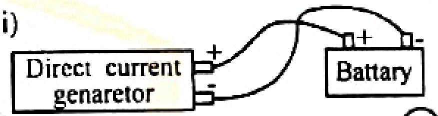
$\theta = \frac{0.22}{0.9 \times 0.004}$

$\theta = 61.11$ °C (61.0 - 62.0 °C)

(01)

(e) (i) Rotate the coil of the motor with a machenical force (01)

(ii)




(01)

(B) (a) $I_E = I_B + I_C$ (01)

(b) (i) $V_C = 5$ V $\beta = 100$ $V_{BE} = 0.7$

$I_C = \frac{10 - 5}{10 \times 10^3} = \frac{5}{10^4}$ (01)

$I_C = \beta I_B$

$I_B = \frac{I_C}{\beta} = \frac{5 \times 10^{-4}}{100}$ (01)

$I_B = 5 \times 10^{-6}$ A OR 5μA (01)

(ii) $R_1 = 12\,K\Omega$

$\frac{10 R_2}{R_1 + R_2} = 0.7$ OR

$\frac{R_1}{R_1 + R_2} \times 10 = 9.3$ (01)

$R_2 = \frac{0.7 \times 12 \times 10^3}{9.3}$ OR

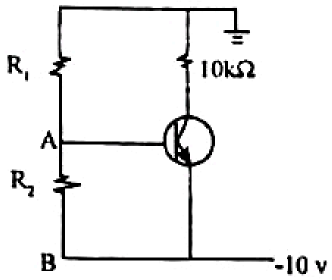
$R_2 = \frac{120 \times 10^3 - 12 \times 10^3}{9.3}$

$R_2 = 903.2\,\Omega$

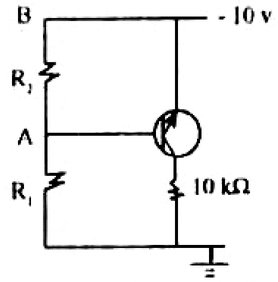
$R_2 = 903.2\,\Omega$

$[(903.0 - 903.5)\,\Omega]$ (01)

(iii)

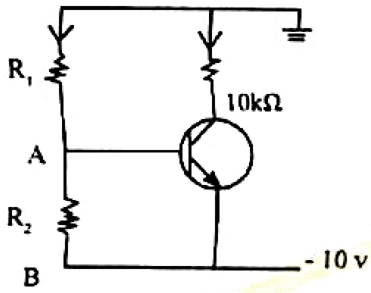



OR

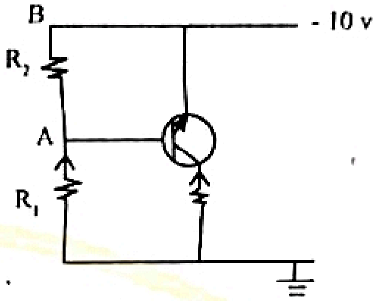



For the correct diagram (01)

For the correct labeling of $R_1$, $R_2$, A & B (01)



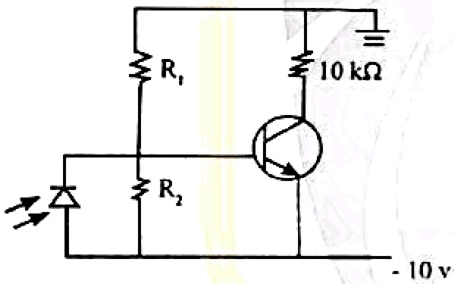

OR



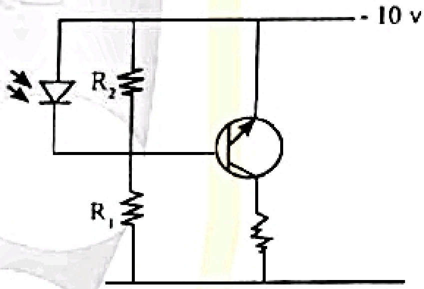

Arrow Indicative the direction of $I_c$ (01)

Arrow Indicating the direction of current through $R_1$ & $R_2$ (01)

(C) (i)




OR




(01)

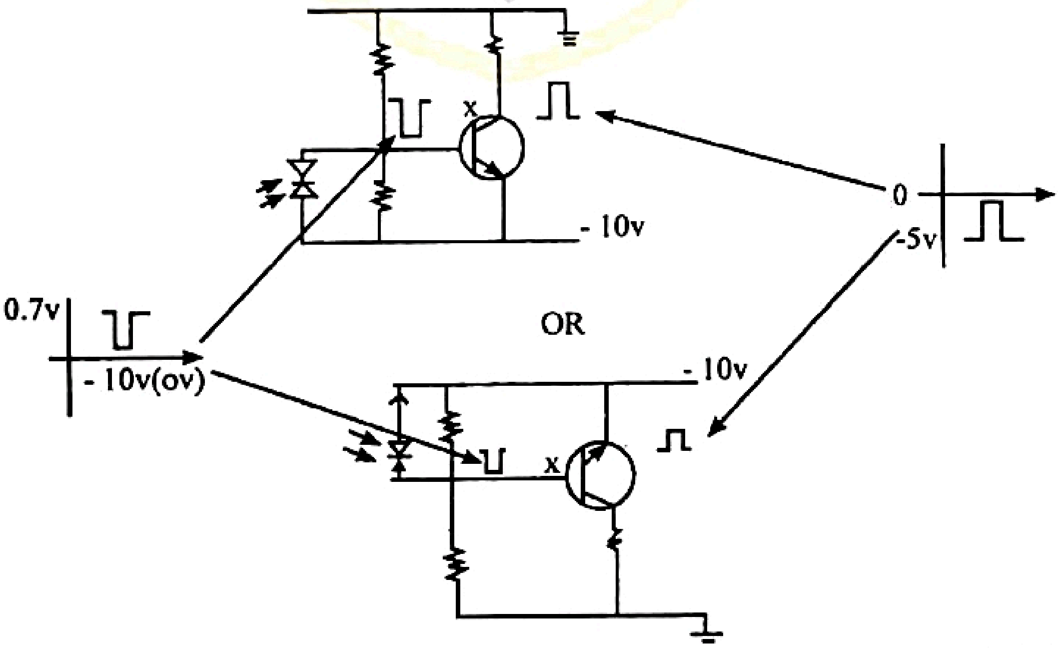
(ii) No

As the photodiode is connected reverse biased its resistance is very large compare to $R_2$ (>>>$R_2$).

Photodiode is in parallel with the B - E Junction.

Therefor it doesnot change the effective resistance across B – E Junction.

(iii)



(1) Direction of the current Arrow drawn in the direction opposite to the direction of current in a normal forward biased diode. (01)

(2) Rectangular voltage pulse appearing at the base relative to the emitter as shown (01)

Rectangular voltage pulse at the collector relative to the earth as shown (01)

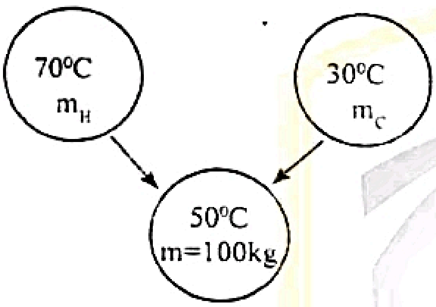
10. (A) (a) Let the amount of let water at 70°C $= m_H$ kg

Amount of cold water at 30°C $= m_C$ kg

Amount of water at 50°C $= m = 100$kg

Amount of heat lost by hot water at 70°C

$$Q_H = m_H C_w (70 - 50)$$




Amount of heat gain by cold water at 30°C

$$Q_C = m_C C_w (50 - 30)$$

$Q_H = Q_C$ both correct (01)

$m_H Q_w (70 - 50) = m_C C_w (50 - 30)$ (01)

$m_H \times 20 = (100 - m_4) \times 20$ (01)

$[m_C = 100 - m_4]$

$2 m_H = 100$

$m_H = 50$ kg (01)

<u>Alternative Method</u>

Since temperature of the mixture is at the middle of the two temperature (01)

The mass of the hot water needed is equal to the mass of the cold water (01)

$$m_H = \frac{100 \text{ kg}}{2}$$ (01)

$m_H = 50$ kg (01)

*(b)*

Let the minimum capacity of the boiler } = M kg

Heat loss by hot water at 70°C

$$Q_H = (M - m_H) S_W (70 - 66)$$ (01)

Heat gain by cold water at 30°C

$$Q_C = m_C S_W (66 - 30)$$ (01)

$$Q_H = Q_C$$

$$(M - m_H) S_W (70 - 66) = m_C S_w (66 - 30)$$ (01)

To identify M as the minimum capacity (01)

$$(M - m_H) \times 4 = m_C \times 36$$

$$M = 10 m_H$$

(i) M in kilograms $= 10 \times 50 = 500$kg (01)

(ii) Capacity liters $= \frac{500}{10^3} \times 1000$

$= 500$ *liters* (01)

(c) Power of the heater

$$P = \frac{M S_W (\theta_H - \theta_C)}{t}$$ (01)

$$= \frac{500 \times 4200 \times (70 - 30)}{60 \times 60}$$ (01)

$P = 2.33 \times 10^4$ W (01)

$(2.33 - 2.34 \times 10^4$ W)

(d) Power of the small heater

$$P_1 = \frac{50 \times 4200 \times (70 - 30)}{60 \times 60}$$ (01)

$P_1 = 2.33 \times 10^3$ W (01)

$(2.33 - 2.34 \times 10^3$ W)

Alternative method

Power of the small heater

$$P_1 = \frac{500 \times 4200 \times (70 - 66)}{60 \times 60}$$ (01)

$P_1 = 2.33 \times 10^3$ W (01)

$(2.33 - 2.34 \times 10^3$ W)

(B) (a) (i) A - anode / target
B - cathode / filament / heater } (01)

*(ii) D - Power supply for the filament / heater*

Purpose - To produce electrons through thermionic emission (01)

(iii) C - High voltage (dc) power supply (Accelerate voltage)

Purpose - To accelerate electrons from cathode to anode OR

To increase the energy of the electrons (01)

(iv) x - rays are produced when accelerated / energetic electrons strike anode / target (01)

(v) Electrons can travel from the cathode to the anode without colliding with air molecules / decreasing their energy

OR

To increase the efficiency of x - ray production (01)

(b) (i) Maximum kinetic energy

$$E = eV$$
$$= e \times 10^5\ V$$
$$= 100\ KeV \quad (01)$$

(ii) Dissipated as heat or heat the anode / target (01)

(iii) $E' = h\nu$

$$= \frac{hc}{\lambda} \quad \text{OR} \quad (01)$$

$$\lambda = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{50 \times 10^3 \times 1.6 \times 10^{-19}} \quad (01)$$

$$\lambda = 2.48 \times 10^{-11}\ m$$

$[2.47 - 2.48 \times 10^{-11}]$ m (01)

(C) (i) $I = I_o/_2$ (01)

$$\log \frac{I_o}{I_o/_2} = 0.434 \times (51.8)\, t \quad (01)$$

$$t = \frac{\log (2)}{0.434 \times 51.8}$$

$$t = 1.339 \times 10^{-2} m$$

$[(1.33 - 1.34) \times 10^{-2} m]$ (01)

(ii) Beam intensity

$$= \frac{10^{10} \times m^{-2}s^{-1}}{2.5 \times 10^6\ msv} \times 20\ msv$$

$$= 8 \times 10^4\ m^{-2}s^{-1} \quad (01)$$

(iii)

$$\text{Log}\left(\frac{2.56 \times 10^6}{8 \times 10^4}\right) = 0.434 \times 51.8\, t' \quad (01)$$

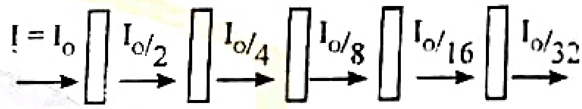
$$t' = \frac{\log 32}{0.434 \times 51.8} = \frac{\log 2^5}{0.434 \times 51.8} = 5\left[\frac{\log 2}{0.434 \times 51.8}\right] = 5t$$

$$t' = 5t$$
$$t' = 5 \times 1.339 \times 10^{-2}\ m$$
$$t' = 6.70 \times 10^{-2}\ m$$

$[(6.69 - 6.70) \times 10^{-2}\ m]$ (01)

Other method

$$\frac{I_o}{I} = \frac{2.56 \times 10^6}{8 \times 10^4} = 32 \quad I = \frac{I_o}{32} \quad (01)$$




Using the above argument

$$t' = 5t$$
$$= 6.70 \times 10^{-2}\ m$$

$[(6.69 - 6.70) \times 10^{-2}\ m]$ (01)