G. C. E (Advanced Level) Examination, August 2014

PHYSICS - I

Provision al Scheme of Marking

2014 - Answers

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

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PHYSICS - I

Provision al Scheme of Marking

A - PART

1. (a) Check Whether there is a zero error in the vernier calliper.
OR
Move the external Jaws until they touch each other to see. Whether the zero mark of the two scales are on the same line.
OR
Determine the value of the least count

any one (01)

(b) $d = \frac{M}{V}$ OR density = $\frac{\text{mass}}{\text{Volume}}$ (01)

(c) 1- Zero error
2- Height (external / outer length of container)

All (01)

(d)

Figum	Reading of the venier calliper	Correct reading	Name of the measurement
(i)	0.02 / 0.2mm	[redacted]	Zero error
(ii)	2.02 / 20.2mm	2.00 20.0mm (x_1)	Outer diameter
(iii)	1.62/ 16.2 mm	1.60 16.0mm (x_2)	inner diameter
(iv)	3.02/ 30.2mm	3.00 30.2mm (x_3)	depth
(v)	3.54 / 35.4 mm	3.52 35.2mm (x_4)	height

correct complete tabale (04)

(e) (i) $V = \pi\left[\left(\frac{X_1}{2}\right)^2 X_4 - \left(\frac{X_2}{2}\right)^2 X_3\right]$ OR

$$V = \pi\left[\left(\frac{X_1}{2}\right)^2 - \left(\frac{X_2}{2}\right)^2\right]X_3 + \pi\left(\frac{X_1}{2}\right)^2 (X_4 - X_3)$$

$$V = \pi\left[\left(\frac{X_1}{2}\right)^2 - \left(\frac{X_2}{2}\right)^2\right]X_4 + \pi\left(\frac{X_2}{2}\right)^2 (X_4 - X_3)$$

(01)

(ii) $V = \frac{\pi}{4}\left[(2.0)^2 \times 3.52 - (1.6)^2 \times 3.0\right]$ OR

$$V = \pi\left[\left(\frac{2.00}{2}\right)^2 - \left(\frac{1.60}{2}\right)^2\right]3.00 + \pi\left(\frac{2.00}{2}\right)^2(3.52 - 3.00)$$

OR

$$V = \pi\left[\left(\frac{2.00}{2}\right)^2 - \left(\frac{1.60}{2}\right)^2\right]3.52 + \pi\left(\frac{1.60}{2}\right)^2(3.52 - 3.00)$$

$V = 4.8\ cm^3$ OR $4.8 \times 10^3\ mm^3$ OR $4.8 \times 10^{-6}\ m^3$
OR (01)

$V = 4.76 cm^3$, $4.76 \times 10^3 mm^3$ $4.76 \times 10^{-6}\ m^3$

(f) $d = \frac{9.6}{4.8}$ 9 cm^{-3} OR $\frac{9.6\ g\ cm^{-3}}{4.76}$

$d = 2000\ kg\ m^{-3}$ (2010 - 2020) $Kg\ m^{-3}$ (01)

2. (a) level : A (01)

Reasons :
(i) To minimize the candensation of water vapour on the inner wall of the container OR
To reduce the exposed area of the container to air.
(ii) Readings Can be taken over a longer period of time.
(iii) To make sure that the heating element is submerged throughout the experiment.
(iv) To have a higher accaracy in the measurement of mass of vapour any two (01)

(b) By reducing the heat loss due to radiation, convection and Conduction.

(c) Resistance/ Resistivity, decreases with temperature.
Resistance / Resistivity, has negative temperature coefficient electrical Conductivity /Conductance, increases with temperature any onw (01)

(d) $Q = mL$
$Pt = (M_0 - M_1) L$
$L = \frac{Pt}{(M_0 - M_1)}$ (01)

(e) (i) $\frac{0.1}{M_0 - M_1} = \frac{1}{100}$

Minimum mass of $(M_0 - M_1)$ = 10 g (01)
(10^{-2} kg)

(ii) $Pt = (M_0 - M_1)_{min} \times L$

$$t = \frac{(m_0 - m_1)_{min} \times L}{P}$$

$$t = \frac{(10 \times 10^{-3}) \times 2.3 \times 10^6}{500}$$ (01)

t = 46 s (01)

(f) $m = (M_0 - M_1) = (P/L)\,t$

Gradient = $\frac{(106 - 26)\ 10^{-3}}{(8 - 2) \times 60}$ OR $\frac{100 - 26}{8 - 2}$ (01)

$= \frac{40 \times 10^{-3}}{3 \times 60}$

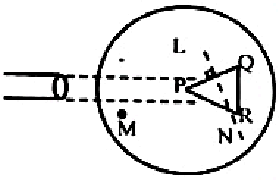
$\therefore\ P/L = \frac{40 \times 10^{-3}}{3 \times 60}$

$L = \frac{3 \times 60 \times 500}{40 \times 10^{-3}}$

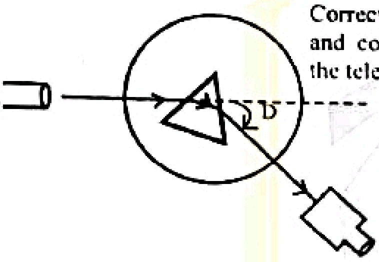
$L = 2.25 \times 10^6\ J\ kg^{-1}$ (01)

3. (a) (i) Telescope
(ii) Prism table (01)

(b) (i) Eyepiece:
The eye piece should be moved in and out adjusted until the cross wires are seen clearly. (01)
(ii) Telescope
A just the telescope to obtain a clear image of a distant object. (01)
(iii) Collimator
The telescope is brought in line with the collimator and the collima for is adjusted while looking through the telescope (or cross wires) Until a clear image of the slit is seen on the cross wires. (01)

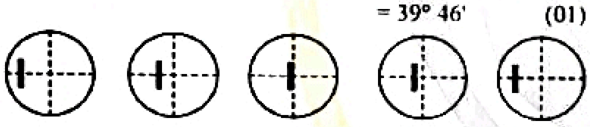
(c)


PQ, (or QR or RP) is Perpendicular to the LN P (cor Q or R) Should be the prism table. (01)

(d) (i)


Correct Ray diagram and correct position of the telescope. (01)

(ii) Angle of minimum deviation D = 183° 15' - 143° 29'
= 39° 46' (01)

(e)


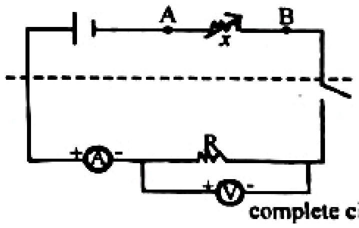
if both positions are correct (01)

(f) $n = \dfrac{\sin\left(\frac{A+D}{2}\right)}{\sin A/2}$ (01)

(g) $n = \dfrac{\sin\left(\frac{60 + 39°46'}{2}\right)}{\sin 60/2}$

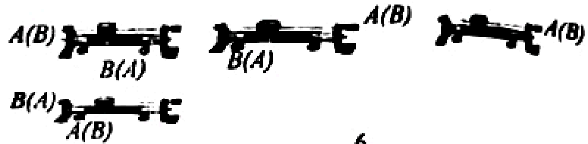
$= \dfrac{\sin 49^0 53^1}{\sin 30^0}$

$= 1.529 \ (1.52 - 1.53)$ (01)

4. (a) (i)


complete circuit diagram (01)

(ii) + and - signs marked as shown across both the Ammeter and voltmeter terminals. (01)

(b)


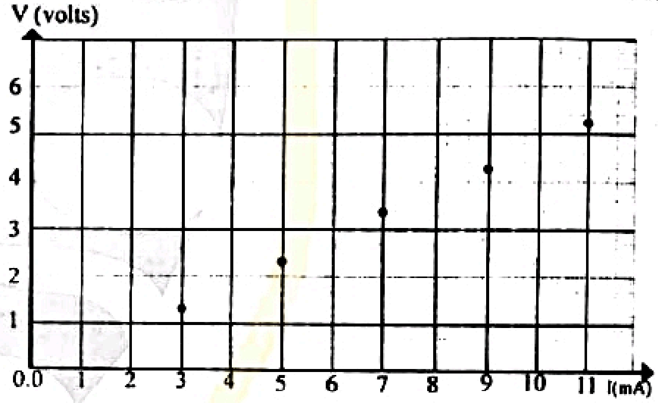
(c) Maximum Current : $I_{max} = \dfrac{6}{500}$
$= 12\ mA$ OR $0.012\ A$ (01)

minimum current $I_{min} = \dfrac{6}{2500 + 500} = \dfrac{6}{2500}$
$= 2.4\ mA$ OR $0.0024\ A$ (01)

(d) Choice : 15 mA
reasons : It provides the maximum accuracy for measurement
OR error / fractinonal error will be small
OR the readings will be accurate
OR it use the major part of the scale
OR If is the most sensitive ammeter. (01)

(e) (i) Value of the readry : 4.3V [4.25 - 4.30v] (01)
Maximum estimated error in the measurement : 0.05V

(ii) Preper selection and labeling of axes with units as above (01)



making all the date points correctly (01)

(f) $\dfrac{RR_i}{R+R_i} = 480$ OR $\dfrac{5000R}{R+5000} = 480$ (01)

$5000R = 480R + 5000 \times 480$

$4520R = 5000 \times 480$

$R = \dfrac{5000 \times 480}{4520}$

$R = 531\,\Omega$

$(530 - 532\,\Omega)$

PART - B

5. (a) (i) R = W (01)
(ii) P↺ $10W_L + 8F_s \sin\theta_s - 18R = 0$ (01)
Substituting R = W and $W_L = 0.2\ W$
$2W + 8F_s \sin\theta_s - 18W = 0$
$F_s \sin\theta_s = 2W$ (01)

$\left[\text{OR } F_s = \frac{0.8W}{Sin\theta_s - 3Cos\theta_s} \right]$

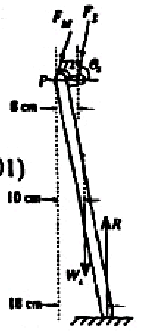


diagram (3)

(iii) $\uparrow y = o$

$F_M \sin 72° + R - F_s \sin \theta_s - W_L = 0$ (01)

$F_M \sin 72° + W - 2W - 0.2W = 0$

$F_M \sin 72° = 1.2W$

$F_M = \frac{1.2W}{0.9}$

$F_M = \frac{4W}{3}$ OR $F_M = 1.33W$ (01)

(iv) $\rightarrow X = 0$

$F_s \cos 72° = F_s \cos \theta_s$? (01)

$\frac{F_s Sinqs}{F_s Cosqs} = \frac{2W}{F_M Cos\,72°}$

$\tan \theta_S = \frac{2W}{\frac{4W}{3}} \times 0.3$

$\tan \theta_S = 5$

$\theta_S = \tan^{-1}(5)$

$\theta_S = 78° \; 41' \; (78° \; 40' - 78° \; 42')$ (01)

(v) $F_S \sin \theta_S = 2W$

$F_S \sin 78° \, 41' = 2W$

$F_S = 2W/1$

$F_S = 2W$

$(1.96W - 2.00W)$ (01)

(b) (i) P $7F_s' + 6.25\, W_L - 10\, R = 0$ (01)

$7F_s' = 10W - 6.25 \times 0.2W$

$F_S' = \frac{10W - 1.25W}{7}$

$F_s^1 = \frac{8.75}{7} W$

$F_s' = 1.25W$ (01)

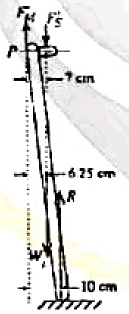


diagram (5)

(ii) Percentage reduction of the magnitude of Fs,

$= \frac{2W - 1.25W}{2W} \times 100\%$

$= \frac{0.75}{2} \times 100\,\%$

$= 37.5\%$ (01)

(C) (i) $\tau = I\alpha$; $\tau = F \times r$

$\tau = W_L \times \frac{l}{2} \sin\theta$

$W_L \frac{l}{2} \sin\theta = I\,\alpha$

$\alpha = \frac{W_L \ell Sin\theta}{2I}$ OR $\alpha = \frac{0.1W\ell.Sin\theta}{I}$ (01)

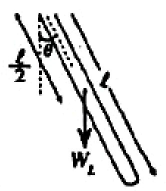


diagram (5)

(ii) $T = 2\pi \sqrt{2\ell/3g} = 2\pi \sqrt{\frac{2 \times 0.9}{3 \times 10}} = 2 \times 3 = \sqrt{0.06}$ s

T = 1.5 S (π =3.14 ; T = 1.575) (01)

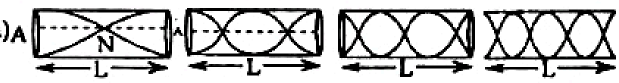
(iii) most effortless speed for the person $= \frac{0.9}{T}$ (01)

$= \frac{0.9}{1.5}$

$= 0.6\ ms^{-1}$ (01)

(If π is taken 3.14 the An swer 0.575 ms^{-1})

6. (a)



$L = \lambda/2$ $\quad L = \lambda$ $\quad L = \frac{3\lambda}{2}$ $\quad L = \frac{4\lambda}{2}$

$f_0 = \frac{V}{2L}$ $\quad f_1 = \frac{V}{L}$ $\quad f_2 = \frac{3V}{2L}$ $\quad f_3 = \frac{4V}{2L}$

Drawing correct standing wave patterns & identifying the node (N) and the antinode (A) in the fundamental mode (01)

Correct standing wave patterns for three overtones (01)

Correct expressions for frequencies (01)

(b) $f_0 = V/2L$ (01)

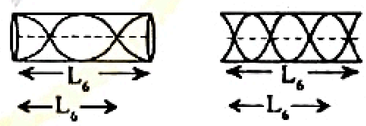
$L_6 = \frac{340}{2 \times 262}$

$= 0.6489m = (6.49 \pm 0.01)10^{-1} m$ OR 0.65 m (01)

$L_2 = \frac{340}{2 \times 392}$

$L_2 = 0.4337m = (4.34 \pm 0.01)10^{-1} m$ OR 0.43 m (01)

(c)



(02)

$L_6 = \lambda$ $\quad L_6 = 2\lambda$

$f' = V/L_6$ $\quad f'' = \frac{2V}{L6}$ (02)

(d) (i) Frequencies of first four standing wave patterns is in part (C)

$\frac{V}{L_6}, \frac{2V}{L_6}, \frac{3V}{L_6}, \frac{4V}{L_6}$ (01)

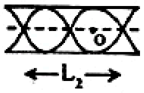
(ii) Frequencies of first four standing wave patterns in part (a)

$\frac{V}{2L_6}, \frac{2V}{2L_6}, \frac{3V}{2L_6}, \frac{4V}{2L_6}$

frequencing of part (c) is always equel to 2 x frequencies part (a)

OR

Inclusion of a small hole has removed 1^{st}, 3^{rd}, 5^{th}... (or oda) harmonics of the open tube. (01)

(e) 

(01)

$L_2 = \frac{3\lambda}{2}$

$\lambda = \frac{2L_2}{3}$

$V = f\lambda$

$f_2 = \frac{3V}{2L_2}$

$f_2 = \frac{3 \times 340}{2 \times 0.4337}$

$= 1175.9\text{Hz}$ $(1172 - 1178 Hz)$ (01)

7. (a) (i) Water repellent window glasses.
(ii) Self cleaning paints.
(iii) Self cleaning cloths / shoes.
(iv) low - drag marine vessels any three (01)

(b) Spherical water bubbles/ drops are formed due to non - wetting (water repellent) property of the surface. (01)

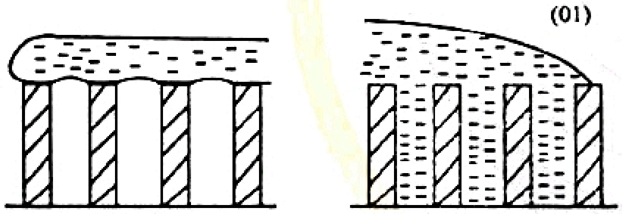
They roll of the surface at the slightest disturbance collecting dirt and dust. (01)

(c) Contact angle of water, $\theta < 90$ hydrophilic
$90° < \theta < 150°$ hydro phobic
$150° < \theta$ Super - hydrophobic
(01)

(d) 

Wetting angle of contaet < 90 Non - Wetting angle of contact > 90°

(01)

(e) 

Nan - Wetting | Wetting

liquid should not be in pores. (01)
Angle contact should be as shown above (01)

liquid should fill the pores (01)

(f) Yes
Compared to the size of the pores the water molecules are very small in size and thus can condense in the pores. (01)

(g) Non - Wetting water repellent nature reduces. the adhesirity (sticky nature) of water to the surface. (01)
There fore, the friction against the motion of the vessel in water is reduced. (01)

(h) nanorods, nanotubes, nonowires. any two (01)

(j) $C_n = \frac{A_n \varepsilon_o}{d}$ — ①

$C = \frac{A \varepsilon_o}{d}$ — ②

$\frac{C_n}{C} = \frac{A_n}{A} = \frac{x + x \times 10^{13} \times \pi d\ell}{x}$

$\frac{C_n}{C} = 1 + 10^{13} \times \pi \times 100 \times 10^{-9} \times 50 \times 10^{-6}$ (01)

$\therefore \frac{C_n}{C} = 1 + 50\pi$

$= 151$ $(\pi = 3)$ OR 158 $(\pi = 22/7)$ (01)

$(158 - 158.2)$

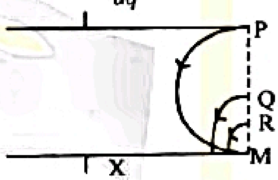
8. (a) $\frac{mV^2}{R} = BqV$ $\left[F = m\frac{v^2}{r} \quad Bqv = m\frac{v^2}{R} \right]$ (01)

$R = \frac{mV}{Bq}$

(b) $R = d/2$

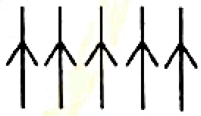
$\therefore \frac{d}{2} = \frac{mV}{Bq}$ (01)

$B = \frac{2mV}{dq}$ (01)



For correct paths of ions entering from P and Q (01)
For Correct path of ion entering from R (01)

(c) (i) Direction of the electric field ↑
OR vertically upward (01)

OR  drawn in the diagram .

(ii) Because there is an additional force acting on the ions due to the electric field and the resultant force is not always perpendicular to the velocity of the ions. (01)

(iii) E - electric field
$F = qE$ $[F = Bqv]$
$\therefore BqV = qE$ (01)
$V_o = Ed$ (01)
$\left[E = \frac{V_o}{d} \right]$
$\therefore V = \frac{V_o}{Bb}$ (01)

(d) (i) Speed of blood flow at X ; $v_x = \frac{2.16 \times 10^{-4}}{0.08 \times 3 \times 10^{-3}}$ (01)

$V_x = 0.09\ \text{ms}^{-1}$ (01)

(ii) Applying the eq. of Continuity
$A_1 V_1 = A_2 V_2$

$\pi \frac{d_x^2}{4} \times V_x = \pi \frac{d_y^2}{4} = V_y$ (01)

$\frac{V_x}{V_y} = \frac{d_y^2}{d_x^2} = \frac{V_x}{B_x d_x} \times \frac{B_y d_y}{V_y}$

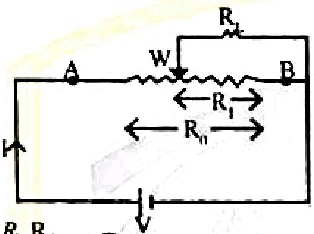
$dy = \frac{V_x B_y}{V_y B_x} \times d_x$

$\upsilon_y = \frac{V_y}{B_y d_y}$
$dy = \frac{d_x^2 B_y \upsilon_x}{V_y}$
$dy = \frac{(3 \times 10^{-3})^2 \times 0.9 \times 0.05}{1.80 \times 10^{-4}}$
$dy = 2.25 \times 10^{-3} m$ (01)
OR 2.25 mm (01)

$dy = \frac{2.16 \times 10^{-4} \times 0.05}{1.80 \times 10^{-4} \times 0.08} \times 3 \times 10^{-3}$ (01)

$dy = 2.25 \times 10^{-1} m$ OR dy = 2.25mm (01)

9. (A) a (i) $\frac{1}{R_w} = \frac{1}{R_1} + \frac{1}{R_L}$



$\frac{1}{R_w} = \frac{R_1 + R_L}{R_1 R_L}$

$R_W = \frac{R_1 R_L}{R_1 + R_L}$

$\therefore R_{AB} = R_0 - R_1 + \frac{R_1 R_L}{R_1 + R_L}$ Ⓐ (01)

(ii) $R_{AB} = R_0 - R_1 \left(1 - \frac{R_1}{R_1 + R_L}\right)$

maximum R_{AB} ; When $R_1 = 0$

$= R_{max} = R_0$ (01)

minimum R_{AB} ; When $R_1 = R_0$

[Second term in the expression in maximum]

$R_{min} = \frac{R_0 R_L}{R_0 + R_L}$ (01)

OR effect of having R_L in parallel with R_1 is reduce the effective value of R_1. There fore when R_L is not in the circuit the potentional divider has its maximum resistance across AB which is equal to R_0 (01)
This effect is maximum When $R_1 = R_0$ and the effective resistance has its minimum value $R min = \frac{R_0 R_L}{R_0 + R_V}$ (01)

(iii) $\frac{\frac{R_0 R_L}{R_0 + R_L}}{R_0} = \frac{99}{100}$ OR $\frac{R_L}{R_0 + R_L} = \frac{99}{100}$ (01)

$100 R_L = 99 R_L + 99 \times 5000$

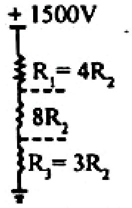
$R_L = 495\ K\Omega$ (01)

(b) (i) $V_{R_2} = V$, then

4V + 8V + 3V = 1500 (01)

15V = 1500

V = 100 V



V = IR

$100 = 1 \times 10^{-3} \times R_2$

$R_2 = 100\ k\Omega$ (01)

$R_1 = 400\ k\Omega$ (01)

$R_3 = 300\ k\Omega$ (01)

(ii) When the electrode is connected, the current through $R_3 = 995 \mu A$ (01)

$\therefore$ Change (ΔV) in the voltage drop across R_3 is given by

$\Delta V - IR = V$

$\Delta V - 995 \times 10^{-6} \times 300 \times 10^3 = 300$ (01)

$\Delta V = (300 - 298.5)$ V

$\Delta V = 1.5V$ (01)

OR $\Delta V = \Delta I \times R$ (01)
$= 5 \times 10^{-6} \times 300 \times 10^{+3}$ (01)
$\Delta V = 1.5V$ (01)

(c) (1) Q = cV

$\Delta Q = 5 \times 10^{-6} \times 1 \times 10^{-6}$

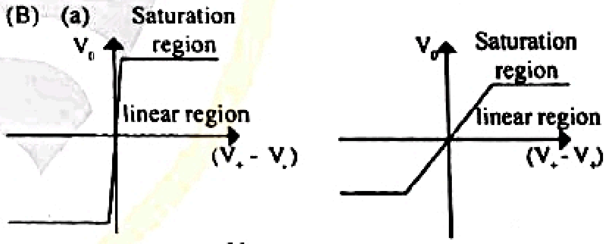
$= 5 \times 10^{-12}$ C (01)

(2) $\Delta V = \frac{\Delta Q}{C}$ (01)

(3) $= \frac{5 \times 10^{-12}}{0.05}$

$= 10^{-10}$ F (100PF) (01)

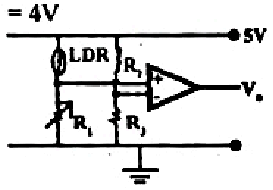
(B) (a)



(b) (i) $\frac{R_2}{R_3} = \frac{V_{R_2}}{V_{R_2}}$ OR $R_2 = \frac{1.5 \times 7000}{3.5}$ (01)

$\therefore R_2 = 3000\Omega$ (01)

(ii) In order to achieve +10V at the output V_0, Voltage at V+ input should be equal to 3.5 + 0.5 = 4V (01)



$\therefore \frac{R_1}{R_{LDR}} = \frac{4}{1}$ OR $R_1 = 4 \times 500$

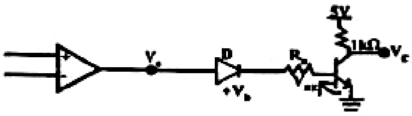
$R_1 = 2000\Omega$ (01)

(iii) $R_{LDR} = 10^5\Omega$ (Very large)

the voltage V_+ becomes smaller than 3.5V (Or V)

There fore $V_0 = -10V$ (01)

(c)



(i) $V_0 = V_D + I_B R_B + V_{BE}$

$10 = 0.7 + 50 \times 10^{-6} \times R_B + 0.7$ (01)

$R_B = \frac{8.6}{50 \times 10^{-6}}$

$R_B = 1.72 \times 10^5 \Omega$ (01)

(ii) $I_C = \beta I_B$

$I_C = 100 \times 50 \times 10^{-6}$

$I_C = 5$ mA (01)

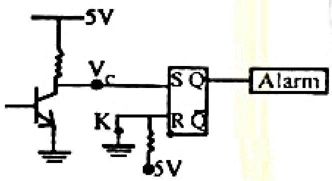
$V_C = 5 - I_C R_C$

$V_C = 5 - 1 \times 10^3 \times 5 \times 10^{-3}$ (01)

$V_C = 0$ (01)

(iii) (1) Potential difference across the diode = 10 V (01)
(2) Collector Voltage under this condition = 5V (01)

(d)



(i) Input logic levels when light fall on LDR S = 0 , R= 0
Input logic levels when intruder crosses the beam
S = 1, R = 0
(01)

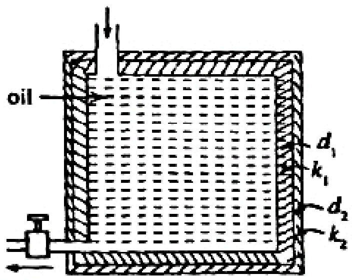
(ii) Alarm sounds continuously since it does not recieve a reset signal (S = 0 and R = 1) to reset the Alarm **OR** Conect truth table. (01)

10.(A) (a) Rate at which solar energy is incident on the dise $= \pi r^2 \times E$ (01)
$= 3 \times 100 \times 1000$
$= 3 \times 10^5$ W (01)

(b) Energy stoered in oil per day

$= 3 \times 10^5 \times 6 \times 60 \times 60 \times \frac{60}{100}$ (01)
$= 3.89 \times 10^9$ J (01)

(c)



(i) $\frac{\Delta Q}{\Delta t} = K_1 A_1 \frac{(\theta_1 - \theta_2)}{d_1}$ —Ⓐ (01)

$= K_2 A_2 \frac{(\theta_2 - \theta_3)}{d_2}$ —Ⓑ (01)

(ii) $\frac{\Delta Q}{\Delta t} = \frac{5 \times 10^9}{10 \times 60 \times 60} \times \frac{1}{100}$ (01)

$= 1.39 \times 10^3$ W

Ⓐ and Ⓑ $\theta_1 - \theta_2 = \frac{\Delta Q}{\Delta t} \cdot \frac{d_1}{K_1 A_1}$ —①

$\theta_2 - \theta_3 = \frac{\Delta Q}{\Delta t} \cdot \frac{d_2}{K_2 A_2}$ —② (01)

①+②

$\theta_1 - \theta_3 = \frac{\Delta Q}{\Delta t}\left[\frac{d_1}{K_1 A_1} + \frac{d_2}{K_2 A_2}\right]$ (01)

$300 = 1.39 \times 10^3 \cdot \left[\frac{0.2}{0..2 \times 16} + \frac{d_2}{0.03 \times 17}\right]$ (01)

$d_2 = 0.078$ m $(7.8\ cm)$

$(7.80 - 7.83\ cm)$ (01)

OR Ⓐ $\Rightarrow 1.39 \times 10^3 = 0.2 \times 16 \frac{(330 - \theta_2)}{0.2}$ 01

$330 - \theta_2 = 86.88$

$\theta_2 = 243.12$ °C 01

Ⓑ $\Rightarrow \frac{\Delta Q}{\Delta t} = K_2 A_2 \frac{(\theta_2 - \theta_3)}{d_2}$

$1.39 \times 10^3 = 0.03 \times 17 \times \frac{(243.12 - 30)}{d_2}$ (01)

$d_2 = \frac{0.03 \times 17 \times 213.12}{1.39 \times 10^3}$

$d_2 = 0.078$m (01)

(iii) Heat loss from the battery will be less then the planned value becaues, the temperature of oil decreases with time, and the rate of heat loss becomes smaller. (01)

(d) M - mass of the distilled water produced per day

$5 \times 10^9 \times \frac{25}{100} \times \frac{50}{100} = M\left(2.25 \times 10^6 + 4200 \times 70\right)$

$6.25 \times 10^8 = M \times 2.544 \times 10^6$ LHS (01) RHS (01)

$\therefore$ M $= 245.68$ kg

$= 245.7\ell$

$(245 - 246.5)$ (01)

(B) $E = \sigma T^4$ **OR** $E_1 = \sigma A T^4$ (01)

E = Total radiated power per unit Surface area of black body
E_1 = Total radiated power
σ = Stefan (-Boltzmann) Constant
A - Surface Area
T = Surface temperature in kelvins (K) (01)

(a) (i) If the radius of the sun is r, the total power radiated from the surface of the sun

$\sigma = 4\pi r^2 \times T^4$

$= 5.67 \times 10^{-8} \times 4\pi \times (7.0 \times 10^{8})^2 \times T^4$ (01)

If the distance from the sun to the surface of the earth is d, the intensity of the solar radiation flux at earth surface

$$= \frac{\sigma 4\pi r^2 T^4}{4\pi d^2}$$

$$1000 = \frac{5.67 \times 10^{-8} \times 4\pi \left(7.0 \times 10^{8}\right)^2 \times T^4}{4\pi \left(1.5 \times 10^{11}\right)^2} \quad (02)$$

$$\therefore T^4 = 1000 \times \left(\frac{1.5 \times 10^3}{7}\right)^2 \times \frac{1}{5.67 \times 10^{-8}}$$

$$= \left(\frac{0.3}{1.4}\right)^2 \times \frac{1}{5.67} \times 10^{17}$$

$$\therefore T = \left[\frac{1}{196} \times \frac{1}{0.63}\right]^{1/4} \times 10^{16}$$

$= 5334.5$ K (01)

(ii) From wein's law $\lambda_m T = C = 2.9 \times 10^{-3}$ (01)

$$\therefore \lambda_m = \frac{2.9 \times 10^{-3}}{5335}$$

$\therefore \lambda_m = 5.44 \times 10^{-7} m$ (01)

$(5.43 - 5.44)$

(iii) Calculated temperature is lower because the radiated power loss due to earth atmospheric absorption has not been considered in the Calculation (01)

(b) (i) If the temperature of the umbra of a sunspot is Tu Comparring with an equal area. A of normal Surface.

$$\frac{\sigma A T_u^4}{\sigma A T^4} = \frac{30}{100} \quad (01)$$

$T_u^4 = 0.3 \times 5335^4$

$T_u = 0.3^{1/4} \times 5335$

$T_u = 3948$ K $(3947\text{-}3949)$

(ii) $\lambda_{mu} T_u = \lambda_m T$ (01)

$$\frac{\lambda_{mu}}{\lambda_m} - 1 = \frac{T}{T_u} - 1$$

$$\Delta\lambda m = \left(T/T_u - 1\right)\lambda m \left(\frac{5335}{3948} - 1\right) \times 5.44 \times 10^{-7}$$

$\Delta\lambda = 1.91 \times 10^{-7} m$ (01)

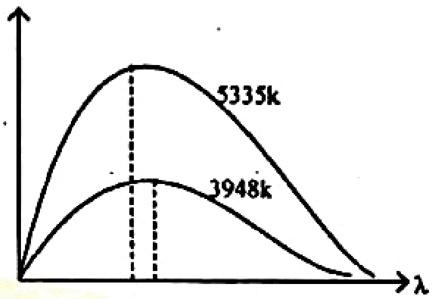
$$\lambda_{mu} - \lambda_m = \frac{C}{T_{mu}} - \frac{C}{T_m} \quad (01)$$

$$= 2.9 \times 10^{-7} \left(\frac{T_m - T_{mu}}{T_{mu} T}\right)$$

$$= 2.9 \times 10^{-7} \frac{(5334 - 3948)}{5334 \times 5948}$$

$= 1.91 \times 10^{-7} m$ (01)

(c)



Correct Two Curves (01)

Significant increase in sunspot per unit area causes λ_m OR red region making the sun appear reddish

Peak emission of radiation of shift more towards longer wavelengths. (01)