FWC

தொண்டைமானாறு வெளிக்கள நிலையம் நடாத்தும்

ஐந்தாம் தவணைப் பரீட்சை - 2022

Conducted by Field Work Centre, Thondaimanaru.

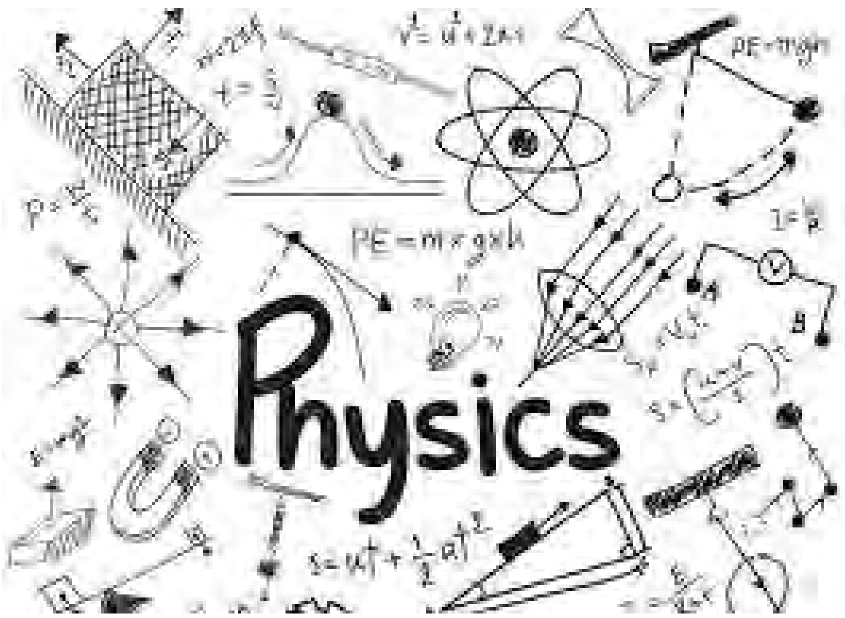
5th Term Term Examination - 2022

தரம் :- 13 (2022)	பௌதிகவியல்	புள்ளித்திட்டம்

பகுதி - I

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

(50 x 1 = 50 *புள்ளிகள்*)



Structured Essay

Part II A

01) a) Set square | Compass, metre ruler | half metre ruler (01)+(01)

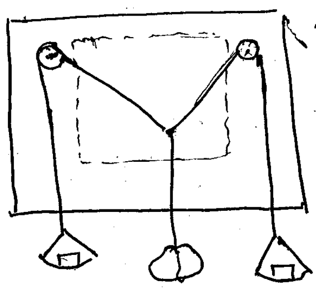
b) Electronic balance | Triple beam balance (01)

c) Pull down the middle mass a little and release and test whether it returns to the original position (02)

d) By applying lubricant to (the axle of) the pulleys (01)

e) Weights act in the vertical plane | If not the tension would not be equal to the weight hung | In addition to the weights frictional forces too will contribute to the tension forces. (02)

f) (02)



(g) Place the mirror strip below the string. Mark two dots when the string covers its own image (02)

(h) Presence of friction in the pulleys (01)
Strings may have weight (01)

(i) (i) To identify the length of OA as 10 units (5 cm) (01)
Scale : 5 g / unit (10 g / cm) OR 1 unit to represent 5g (01)

(ii) Completing the parallelogram (01)

(iii) Mass of the stone $= 12 \times 5 = 60\ g$ (01)

(j) upthrust = apparent weight loss (01)
$= 4 \text{(units)} \times 5 = 20\ g$

Relative density $= \dfrac{\text{weight (in air)}}{\text{upthrust (in water)}} = \dfrac{60}{20} = 3$ (01)

$\boxed{20}$

02) a. Paper rider (01)

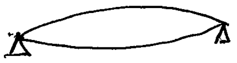
b. i) To determine the mass per unit length of the sonometer wire (01)

ii) 1. Mass of the wire — triple beam balance (01)
2. Length of the wire — metre ruler (01)

c. On the sonometre box (stem normal to the surface) (01)
Energy transfer is efficient OR Air column inside the sonometer box will vibrate with maximum amplitude / will resonate OR surface of the sonometer will vibrate with maximum amplitude (01)

d) (Place the paper rider on (the middle) the wire)
(Place the stem of the vibrated tuning fork on top of the sonometer surface)

Adjust the bridges / one of the bridges until the paper rider jumps off (very) quickly / instantly / to a maximum height ...... (02)

e) (i)  .... (01)

(ii) Transverse, standing ... (01)

(iii) By the ~~spe~~ superposition of two identical waves / incident and reflected waves traveling in opposite direction (01)

f) $a_{max} = g$, $\omega^2 A = g$ } .... (01)
$(\omega = 2\pi f)$ $A = \dfrac{g}{4\pi^2 f^2}$ .... (01)

g) (i) $V = \sqrt{\dfrac{Mg}{m}}$ ...... (01)
(ii) $\dfrac{\lambda}{2} = l \Rightarrow \lambda = 2l$ .... (01)
$f = V/\lambda = \dfrac{1}{2l}\sqrt{\dfrac{Mg}{m}}$ .... (01)

(iii) $f^2 = \dfrac{1}{4l^2} \cdot \dfrac{Mg}{m}$ .... (01)

$\underbrace{l^2}_{y} = \underbrace{\left(\dfrac{g}{4f^2 m}\right)}_{\text{gradient}} \underbrace{M}_{x}$ .... (01)

(iii) $\dfrac{g}{4f^2 m}$ = gradient

$f^2 = \dfrac{g}{4 m \times \text{gradient}} = \dfrac{10}{4 \times 1\times10^{-3} \times 0.01} = \dfrac{10^6}{4}$ ... (01)

$f = 500\ Hz$ .... (01)

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13) a) A - Steam generator, B - Steam trap, C - Heat insulating sheet (03)

b) A - To supply continuous stream of steam ...... (01)
B - To send dry steam to the calorimeter ...... (01)
C - To minize transfer of heat to the calorimeter by radiation OR Prevent the transfer of heat directly from the burner and steam generator ... (01)

c) Electronic balance / Four beam balance ...... (01)

d) D - mercury in glass thermometer - can read temp. close to 100°C (01)
E - alcohol in glass thermometer - smaller L.C more accurate / Precise (01)

e) To send dry steam (without water) to the water ... (01)

f) Sellecting the initial temp. 5°C below the R.T and mixing of steam is commenced with stirring (01)
Mixing of steam is stopped when the temp. is increased by about 10°C (The maximum temp reached will be noted) (01)

(g) Initial temp. should not below the dew point ---- 01 / 02

(h) Mass of empty calorimeter (with stirrer) (X_1)
mass of calorimeter with water (X_2)
Initial temperature of water (X_3)
Maximum temp. of water after mixing with steam (X_4)
mass of the calorimeter with the mixture (contents) (X_5)
All 5 04, Any 4 02

(i) Heat lost by steam = Heat gained by calorimeter and water

$$(X_5 - X_2)L + (X_5 - X_2)c_w(100 - X_4) = [X_1 C + (X_2 - X_1)c_w](X_4 - X_3)$$

L.H.S ------ 01
R.H.S ------ 01

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(4) a) i) Item (4) (ii) Item (1) 01 + 01

b) Non uniformity / uniformity of the potentiometer wire 01
Temp. dependence of the resistance of the pot. wire
OR Temp. coefficient of the resistance of the pot. wire 01

c) Resistance box ------ 01

d) Yes ------ 01
Range can be adjusted by varying the value of R_1 OR
By increasing / varying the length of the pot. wire 01

e) Yes, zero error of the galvanometer does not affect the results of the experiment OR
It is the deflection, not the zero reading of the galvanometer that matters in the experiment OR
Expt. can be continued by observing the deflection from the initial position (any one) ---- 01

f) $E = kl_0$, $V = kl$ OR $\frac{V}{E} = \frac{l}{l_0}$ ------ 01

$V = E\left(\frac{R}{R+r}\right)$ OR $\frac{V}{E} = \frac{R}{R+r}$ ------ 01

$\frac{R}{R+r} = \frac{l}{l_0}$ ------ 01

$r = R\left(\frac{l_0}{l} - 1\right)$ ------ 01

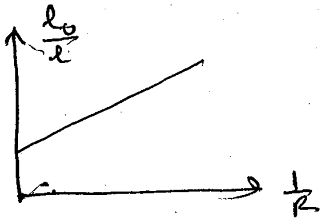
(g) $l_0 = 72.2 + 0.2$; $l = 50.2 - 0.2$ ------ 01 + 01

$r = 10\left(\frac{72.2 + 0.2}{50.2 - 0.2} - 1\right)$

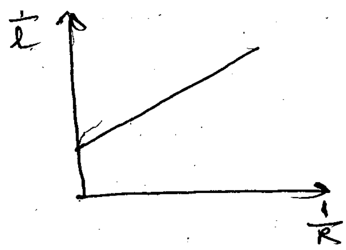
$r = 10 \times \left(\frac{72.4}{50} - 1\right) = 4.48\ \Omega$ ------ 01

(h) $\frac{l_0}{l} = r \cdot \frac{1}{R} + 1$ OR $\frac{1}{l} = \frac{r}{l_0} \cdot \frac{1}{R} + \frac{1}{l_0}$ ------ 01
(y, m, x, c) OR (y, m, x, c)

(i) $x : \frac{1}{R}$; $y : \frac{l_0}{l}$ OR $\frac{1}{l}$ ------ 01

(a) 

OR



Shape of the graph ---------- 01

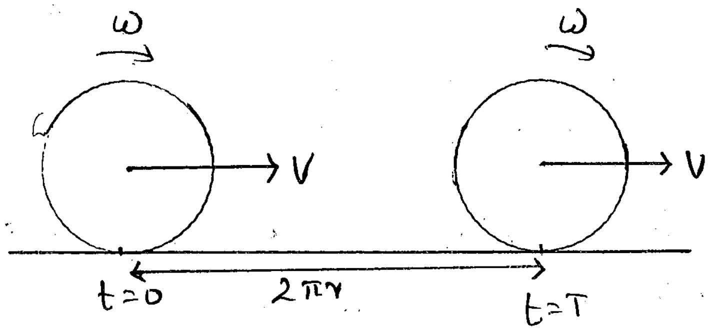
Labelling the axes ---------- 01

$m = r$ OR $\frac{m}{c} = r$ ----- 01

1)

a)

(i)



$V = \frac{S}{t} = \frac{2\pi r}{T}$; $T = 2\pi/\omega$

$V = \frac{2\pi r}{2\pi}\omega$

$V = r\omega$ —— (1)

(ii) $V_{A,O} = \overrightarrow{r\omega}$, $V_{B,O} = \overleftarrow{r\omega}$, $V_{O,E} = \overrightarrow{r\omega}$ —— (1)

$V_{AE} = V_{AO} + V_{OE}$

$= \overrightarrow{r\omega} + \overrightarrow{r\omega}$

$= 2r\omega$ —— (1)

$V_{BE} = V_{BO} + V_{OE}$

$= \overleftarrow{r\omega} + \overrightarrow{r\omega}$

$= 0$ —— (1)

(iii) $K.E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2} \times 12 \times \left(\frac{3}{10}\right)^2 + \frac{1}{2} \times 12 \times \left(\frac{2}{10}\right)^2 \left(\frac{3}{2}\right)^2$ —— (1)

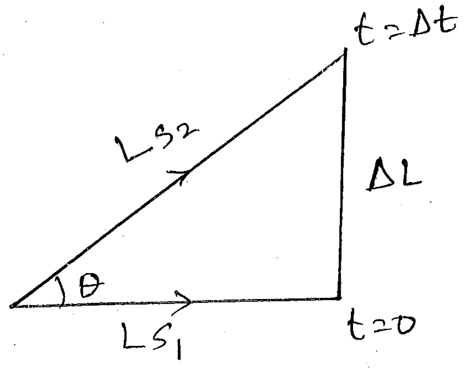
$= 0.81\,J$ —— (1)

(iv) The wheel can only perform rotational motion about the axis O —— (1)

b) (i) $L_s = I\omega_s$ direction $\longrightarrow$

—— (1)

(ii)



— (1)

$\omega_{pr} = \frac{\Delta\theta}{\Delta t}$ — (1) $\quad \Delta\theta = \frac{\Delta L}{L_s}$ — (1)

$= \frac{\Delta L / L_s}{\Delta t}$

$= \frac{1}{L_s} \times \frac{\Delta L}{\Delta t} \quad \tau_p = \frac{\Delta L}{\Delta t}$

$\omega_{pr} = \frac{\tau_p}{L_s}$ — (1)

(iii) $T_{pr} = \frac{2\pi}{\omega_{pr}} = \frac{2\pi}{mgR} \times \frac{mr^2}{2}\omega_s \; ; \; \omega_s = 2\pi f_s = 10\pi$

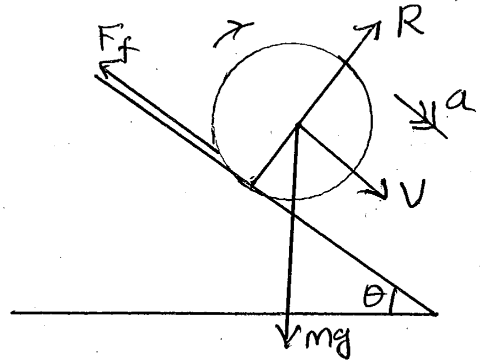
$T_{pr} = \frac{\pi r^2}{gR}\omega_s$

$= \frac{10\pi^2 (0.3)^2}{10 \times 0.18}$ — (1)

$= 5$ sec — (1)

(iv) The wheel falls vertically and oscillates — (1)

c) i)



— (2)

F_f - Frictional force acting on the solid cylinder
R - Normal reaction acts on the solid cylinder.
Mg - weight of the cylinder. —— (1)

(ii) Torque about O is $\tau = F_f r$ —— (1)

(iii)

$$I\alpha = F_f r, \quad ; a = r\alpha$$

$$I\frac{a}{r} = F_f r$$

$$F_f = \frac{Ia}{r^2} \text{ —— (1)}$$

From Newtons 2nd law,

$$Ma = Mg\sin\theta - F_f \text{ —— (1)}$$

$$Ma = Mg\sin\theta - \frac{Ia}{r^2}$$

$$a[Mr^2 + I] = Mg\, r^2 \sin\theta \text{ —— (1)}$$

$$a = Mr^2 \sin\theta / (Mr^2 + Mr^2/2) \qquad I = Mr^2/2$$

$$a = \frac{2}{3} g \sin\theta \text{ —— (1)}$$

(iv) For a solid cylinder to roll down a slope without slipping,

$$F_f \leq \mu R \text{ —— (1)}$$

$$\frac{Ia}{r^2} \leq \mu mg\cos\theta \qquad R = mg\cos\theta$$

(v)

$$\mu \geq \frac{1}{3}\tan\theta \text{ —— (1)}$$

$$\frac{1}{3}\tan\theta = \frac{1}{3}\tan 60^\circ$$

$$= \frac{\sqrt{3}}{3} = 0.58 \; ; \; \mu = 0.6$$

—— (1)

$$\mu \geq \frac{1}{3}\tan\theta$$

∴ The solid cylinder to roll down a slope without slipping —— (1)

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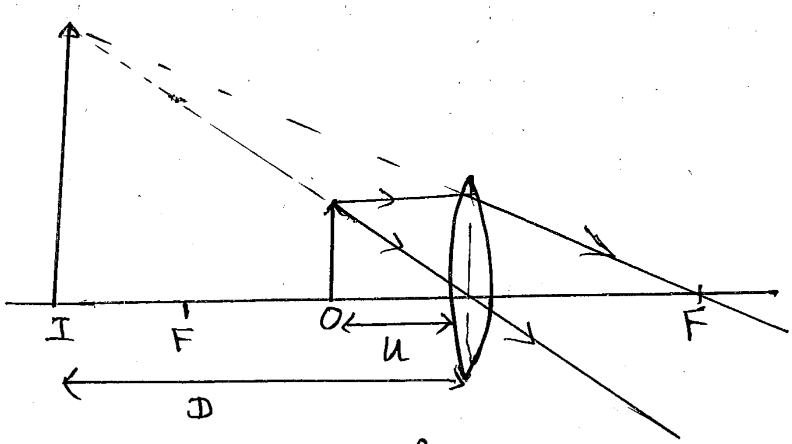
2)

a) (i)



focal length —— 2

ray diagram —— 2

(ii) $u = +u,\ V = +D,\ f = -f$

$$\frac{1}{V} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{D} - \frac{1}{u} = -\frac{1}{f} \quad \text{—— 1}$$

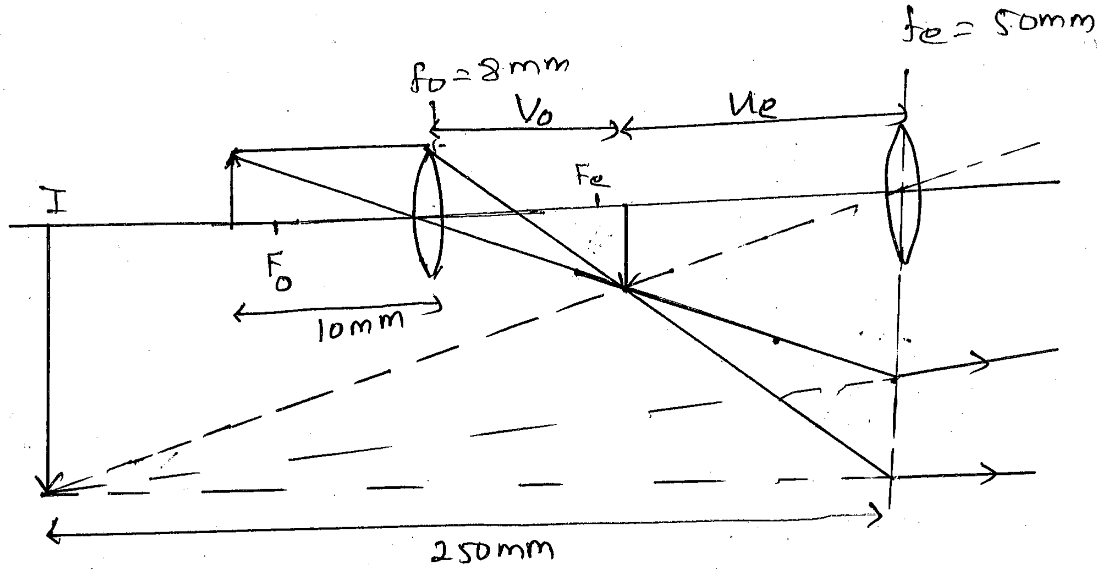
$$1 - \frac{D}{u} = -\frac{D}{f} \quad \text{—— 1}$$

$$1 - M = -\frac{D}{f} \qquad M = 1 + \frac{D}{f} \quad \text{—— 1}$$

b) (i) α – angle subtended at the unaided eye by the object at the near point (least distance of distinct vision) —— 2

β – angle subtended at the eye by the image —— 2

(ii)



Ray diagram for objective —— (2)
Ray diagram for eyepiece —— (2)

1) $u_0 = +10mm$, $f = -8mm$, $V_0 = ?$

$$\frac{1}{V} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{V_0} - \frac{1}{10} = -\frac{1}{8} \quad \text{—— (1)}$$

$$\frac{1}{V_0} = -\frac{1}{8} + \frac{1}{10}$$

$$= \frac{-5+4}{40}$$

$$V_0 = -40 \text{ mm} \quad \text{—— (1)}$$

2) $f = -50mm$, $V_e = 250 mm$, $u_e = ?$

$$\frac{1}{V} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{250} - \frac{1}{u_e} = -\frac{1}{50} \quad \text{—— (1)}$$

$$\frac{1}{u_e} = \frac{1}{250} + \frac{1}{50}, \quad \frac{1}{u_e} = \frac{1+5}{250}, \quad u_e = 41.67mm$$ —— (1)

$\therefore$ Separation $= 40 + 41.67$ mm —— (1)
$= 81.67mm$ —— (1)

3) $M = m_o \times m_e$

$= \frac{V_o}{u_o} \times \frac{V_e}{u_e}$ —— (1)

$= \left(\frac{40}{10}\right)\left(\frac{280}{250} \times 6\right)$ —— (1)

$= 24$ —— (1)

(iii) (1) $u_e = 40\,mm$ —— (1)

$f_e = -50\,mm$

$V_e = ?$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{V_e} - \frac{1}{40} = -\frac{1}{50}$ —— (1)

$\frac{1}{V_e} = \frac{1}{40} - \frac{1}{50} = \frac{5-4}{200}$

$V_e = 200\,mm$ —— (1)

(2) $M = \frac{V_o}{u_o} \times \frac{V_e}{u_e}$ —— (1)

$= \left(\frac{40}{10}\right)\left(\frac{200}{250} \times 6\right)$ —— (1)

$= 19.2$ —— (1)

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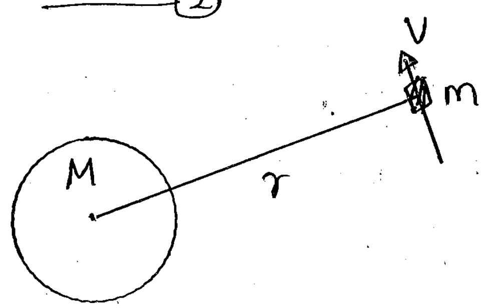
03) a) (i) Newton's law of gravitation —— (3)

ii) $m^3 s^{-2}$ —— (2)

iii)



Force acting on the satellite = Centripetal force

$$\frac{GMm}{r^2} = \frac{mv^2}{r} \quad \text{—— (1)}$$

$$V^2 = \frac{GM}{r} \quad \text{—— (1)}$$

$$; \mu = GM$$

$$V = \sqrt{\mu/r} \quad \text{—— (1)}$$

(iv) Speed of the satellite = $\frac{\text{distance}}{\text{time}}$

$$V = \frac{2\pi r}{T} \quad \text{—— (1)}$$

$$\sqrt{\mu/r} = \frac{2\pi r}{T} \quad \text{—— (1)}$$

$$\mu/r = 4\pi^2 r^2/T^2$$

$$T^2 = 4\pi^2 r^3/\mu$$

$$T = \sqrt{4\pi^2 r^3/\mu} \quad \text{—— (1)}$$

b) Angular speed of the geostationary satellite is equal to the angular speed of earth.

or

Period of geostationary satellite is equal to the period of Earth. —— (2)

i) Angular velocity = $\frac{\text{Angle}}{\text{time}}$

$$\omega = \theta/t \quad \text{—— (1)}$$

If $t = 24h$, $\theta = 2\pi$

$$\omega = 2\pi/24 = \frac{2\times 3}{24} \quad \text{—— (1)}$$

$$\omega = 0.25 \text{ rad } h^{-1} \quad \text{—— (1)}$$

(ii) $T^2 = 4\pi^2 r^3/\mu$ —— (1)

$r^3 = T^2\mu/4\pi^2$

$r^3 = \frac{(24\times3600)^2}{4\pi^2}\mu$ —— (1)

$r = \left[\frac{(24\times3600)^2}{4\pi^2}\mu\right]^{1/3}$ —— (1)

$r = (592\mu)^{1/3}$ —— (1)

(iii) $V = r\omega$

$V = 42000\times10^3 \times \frac{6}{24\times3600}$ —— (1)

$= 2916.67\ ms^{-1}$ —— (1) $(2916 - 2917\ ms^{-1})$

C) (i) Total Energy of meteorite at infinity = Total energy of meteorite at Eath Surface

$0 = -\frac{GMm}{R} + \frac{1}{2}mu^2$ —— (1)

$\frac{1}{2}mu^2 = \frac{GMm}{R}$

$u^2 = 2\mu/R$

$u = \sqrt{2\mu/R}$ —— (1)

(ii) $u = \sqrt{\frac{2\times4\times10^{14}}{6400\times10^3}}$ —— (1)

$= \frac{2\sqrt{20}}{8}\times10^4$

$= 11175\ ms^{-1}$ —— (1)

(iii) Satellite moves towards Earth when it stops circular motion ——— (2)

Deceleration using a parachute ——— (2)

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04) a)

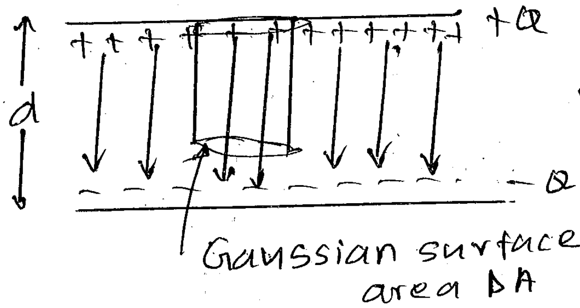
(i) When a neuron is non conducting a signal is called resting potential ——— (2)

(ii) It refers to the potential of the interior with respect to the exterior of the membrane. ——— (2)

(iii) An action potential occurs due to a change in membrane potential above a threshold value (resting potential) due to stimulus ——— (2)

(iv) In depolarization phases ——— (1)

b) (i)



for figure ——— (1)

Charge to be covered by the surface

$= \sigma \cdot \Delta A$

Total flux $\phi = E \cdot \Delta A$ ——— (1)

From Gauss's law

$\phi = \frac{\sigma \cdot \Delta A}{\varepsilon}$ (OR $\phi = Q/\varepsilon$)

——— (1)

$$E \cdot \Delta A = \frac{\sigma \Delta A}{\varepsilon}$$

$$E = \sigma/\varepsilon$$

$$E = \frac{Q}{A\varepsilon} \text{ ——— } (1)$$

(ii) $F = \frac{E}{2} \times Q$ ——— (2)

$$F = \frac{Q^2}{2A\varepsilon} \text{ ——— } (1)$$

(iii) $kx = \frac{Q^2}{2A\varepsilon}$ ——— (2)

$$; x = d_0 - d$$

$$d = d_0 - \frac{Q^2}{2A\varepsilon k} \text{ ——— } (2)$$

(iv) $V = E \cdot d$ ——— (1)

$$V = \frac{Q}{A \cdot \varepsilon}(d_0 - x) \text{ ——— } (1)$$

$$V = \frac{Q}{A\varepsilon}\left[d_0 - \frac{Q^2}{2A\varepsilon k}\right] \text{ ——— } (1)$$

(v) $C = Q/V$ ——— (1)

$$C = \frac{Q A \varepsilon}{Q\left[d_0 - Q^2/2A\varepsilon k\right]} \text{ ——— } (1)$$

(vi) i) When charged

work done by the ion pumps = Energy stored in membrane + Elastic potential energy of membrane.

——— (1)

$$W = \frac{1}{2}kx^2 + \frac{Q^2}{2C} \text{ —— } (1)$$

$$W = \frac{1}{2}\frac{KQ^4}{(2\varepsilon AK)^2} + \frac{Q}{2} \times \frac{Q}{A\varepsilon}\left(d_0 - \frac{Q^2}{2\varepsilon AK}\right) \quad (1)$$

(For the correct substitution)

$$= \frac{Q^4}{8\varepsilon^2 A^2 x} - \frac{Q^4}{4A^2\varepsilon^2 K} + \frac{Q^2 d_0}{2\varepsilon A}$$

$$W = \frac{Q^2 d_0}{2\varepsilon A} - \frac{Q^4}{8A^2\varepsilon^2 K} \text{ —— } (1)$$

2) When k is small, ion pumps work until the distance d reaches zero. That is ion pumps work until the capacitance of membrane reaches infinity. Thus the membrane has no electric energy.

$$\therefore x = d_0 \text{ —— } (2)$$

$$W = \frac{1}{2}kd_0^2$$

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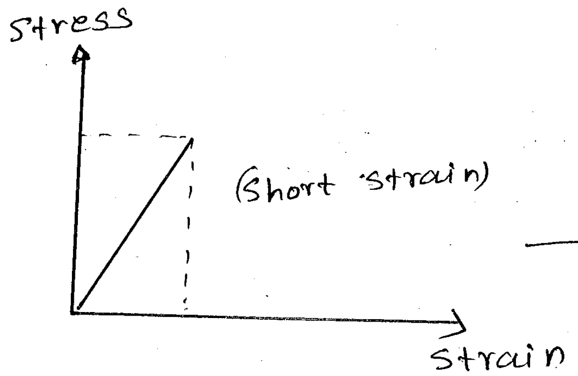
05) a)

(i) Tensile stress } definition —— (2)
Tensile strain } —— (2)

(ii) A - Proportional limit
B - Elastic limit
C - Yield Point
D - Fracture Point } (4)

iii) The ratio of tensile stress, tensile strain is constant, up to point A. —— (2)

(iv)



—— (2)

b) (i) $Y_{\text{state of tension}} = \frac{3 \times 10^7}{0.015}$ —— (1)

$= 2 \times 10^9 \, Nm^{-2}$ —— (1)

$Y_{\text{state of compression}} = \frac{2 \times 10^7}{0.02}$ —— (1)

$= 1 \times 10^9 \, Nm^{-2}$ —— (1)

(ii) 1) $F^1 = \frac{2}{3} F_0$ —— (2)

2) $W = \frac{1}{2} Fe$ —— (1)

$F = \frac{YAe}{l}$ —— (1)

$W = \frac{1}{2} \frac{YAe}{l} \cdot e$ —— (1)

$= \frac{1}{2} Y \cdot \pi \frac{(a^2 - b^2)}{L} \Delta l^2$ —— (2)

c) For fracture state,

$F/A = 2 \times 10^7 \, Nm^{-2}$ —— (1)

$A = \pi (a^2 - b^2)$

$= 3 (2^2 - 1.5^2)$

$= 5.25 \, cm^2$ —— (1)

Force $= A \times 2 \times 10^7$

$= 5.25 \times 10^{-4} \times 2 \times 10^7$ —— (1)

$= 1.05 \times 10^4 N$ —— (1)

d) $(F - mg)\Delta t = m\sqrt{2gh}$ —— ①

$(20\times10^6 \times 3\times10^{-4} - 700)\, 0.14 = 70\sqrt{2gh}$

$\sqrt{2gh} = 10.6$

$h = 10.6^2/20$

$h = 5.618\, m$ —— ①

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06) (A)

a) (i) First law:

The algebraic sum of currents in a network of conductors meeting at a point is zero —— ②

second law:

The directed sum of the potential differences (voltages) around any closed loop is zero —— ②

(ii) $i_1 = i_2 + i_3$ —— ①

(iii) $E = i_1 R_1 + i_2 R_2$ —— ①

(iv) $0 = i_3 R_3 - i_2 R_2$ —— ①

(v) a) From (iii) above,

$30 = 10 i_1 + 10 i_2 \Rightarrow i_1 + i_2 = 3$

From (iv) above,

$0 = 10 i_3 - 10 i_2 \Rightarrow i_2 = i_3$

From (ii) above,

$i_1 = i_2 + i_3$

$i_1 = 2 i_2 = 2 i_3$

But $i_1 = 2A$

$\therefore i_2 = 1A$ —— ①

$i_3 = 1A$ —— ①

b) $V_{BC} = i_1 R_1 = 2 \times 10 = 20V$ —— (1)

$V_{CD} = i_2 R_2 = 2 \times 10 = 20V$ —— (1)

b) i) Resistance of L_1, L_2 $(R) = V^2/P$

$$= \frac{12 \times 12}{12}$$

$$= 12\,\Omega$$ —— (1)

When switch S_1 is operated,

$V = IR$ (for the circuit)

$16 = I \times 8$

$I = 2A$ —— (1)

Potential difference across $L_1 = 1 \times 12$

$= 12V$ —— (1)

or

$V = E - Ir$

$= 16 - 2 \times 2 = 12V$

ii) Resistance of H_1, H_2 $(R) = V^2/P$

$$= \frac{12 \times 12}{24}$$

$$= 6\,\Omega$$ —— (1)

S_1, S_2 should turn on when the head lamps are on,

for the circuit, $V = IR$

$16 = I \times 4$

$I = 4A$ —— (1)

Potential difference across H_1,

$$= E - Ir$$
$$= 16 - 4\times2$$
$$= 8V \text{ ——— (1)}$$

(iii) Power generated by the battery,

$$P = EI$$
$$= 16\times4$$
$$= 64W \text{ ——— (1)}$$

(iv) The brightness will decrease ——— (1)

Because the potential differencewill decrease ——— (1)

(v) The brightness will increase ——— (1)

Because the potential difference will decrease ——— (1)

c) (i) A, B ——— (1)

(ii) 5A ——— (1)

(iii) A, B, C ——— (1)

(iv) 7A ——— (1)

(v) 3A ——— (1)

(vi) 230 V ——— (1)

$\boxed{30}$

06) (B)

a) (i) P ⇒ $Q_1 = \overline{A\cdot A} = \overline{A}$ ——— (1)

∴ NOT ——— (1)

Q ⇒ $Q_2 = \overline{(\overline{A\cdot B})\cdot(\overline{A\cdot B})} = \overline{\overline{A\cdot B}} = A\cdot B$ ——— (1)

∴ AND ——— (1)

$R \Rightarrow Q_3 = \overline{\overline{A}\cdot\overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A+B$ —— 1

$\therefore$ OR —— 1

$S \Rightarrow Q_4 = \overline{(\overline{\overline{A}+\overline{B}})\cdot(\overline{\overline{A}+\overline{B}})} = \overline{\overline{(\overline{A}+\overline{B})}} + \overline{\overline{(\overline{A}+\overline{B})}}$

$= \overline{\overline{\overline{A}}\cdot\overline{\overline{B}}} = \overline{A\cdot B}$ —— 1

$\therefore$ NAND —— 1

(ii)

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

2

for any three entries are correct 1 marks

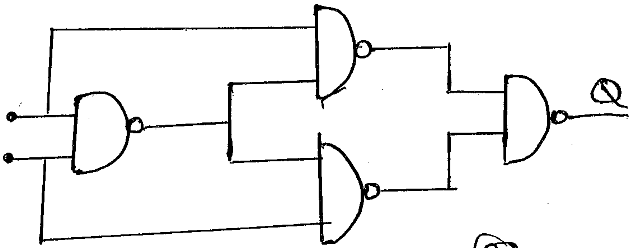
$\therefore$ XNOR —— 1

(iii) $Q = A\cdot\overline{B} + \overline{A}\cdot B$

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

2

for any three entries are correct 01 marks



—— 2

$\therefore$ XOR —— 1

b) i)

A	B	Q
0V	0V	0V
0V	5V	0V
5V	0V	0V
5V	5V	5V

—— 4

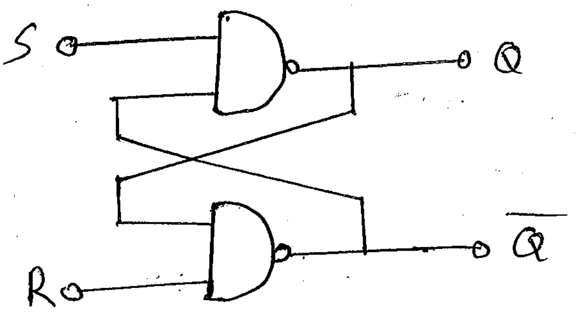
(ii)

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

—— 2

$\therefore$ AND —— 1

c) (i)



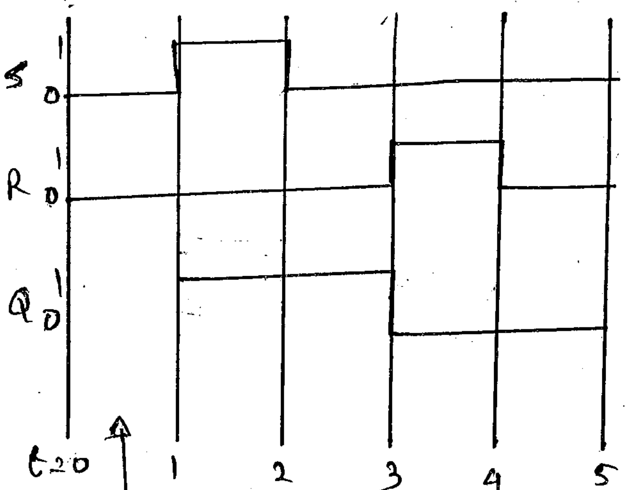
(ii) — (2)

(ii)

S	R	Q	$\bar{Q}$
0	0	No Change / Q_{old}	No change / $\bar{Q}_{old}$
0	1	0	1
1	0	1	0
1	1	Invalid / - / ?	Invalid / - / ?

— (3)

(iii)



(1)

(1)

30

07)

(a) (i) Definition —— (2)

(ii) $\Delta Q = \Delta U + \Delta W$ —— (1) ; ΔQ - Heat given to the system

ΔU - Change in internal energy of the system

ΔW - work done by the system —— (3)

(iii) Definition —— (2)

b) (i)

	Process	Parts	
$A \rightarrow B$	Adiabatic compression	Compressor	(1)
$B \rightarrow C$	Constant volume	Condenser	(1)
$C \rightarrow D$	Adiabatic expansion	Expansion valve	(1)
$D \rightarrow A$	Constant volume	Evaporator	(1)

(ii) $\Delta Q = 0$ —— (1)

$\Delta Q = \Delta U + \Delta W \Rightarrow 0 = \Delta U + (-500)$ (1), $\Delta U = 500\,J$ (1)

(iii) $\Delta W = 0$ —— (1)

$\Delta Q = \Delta U + \Delta W \Rightarrow \Delta Q = 3950 + 0$ (1), $\Delta Q = 3950\,J$ (1)

(iv) obtain from brine —— (2)

C) (i) $Q/t = \dfrac{m s_1 \theta_1 + mL + m s_2 \theta_2}{3600}$

$= \dfrac{600}{3600}\left[30 \times 4200 + 3.36 \times 10^5 + 2100 \times 6\right]$ (1) (1) (1)

$= 79.1\,kJ$ —— (1)

(ii) By evaporation, heat is absorbed from the brine

During a cycle $= 3950\,J$

$\therefore$ Number of cycle $= \dfrac{79100}{3950}$ —— (1)

$= 20$ —— (1)

(iii) $Q/t = \dfrac{ms\theta}{t}$

$79.1 \times 10^3 = \dfrac{m}{t} \times 4000 \times 10$ —— (1)

$m/t = 1.97\,kg\,s^{-1}$ —— (1)

(iv) The freezing point of brine is below $-20^\circ C$,

If water is used, the water will freeze —— (2)

30