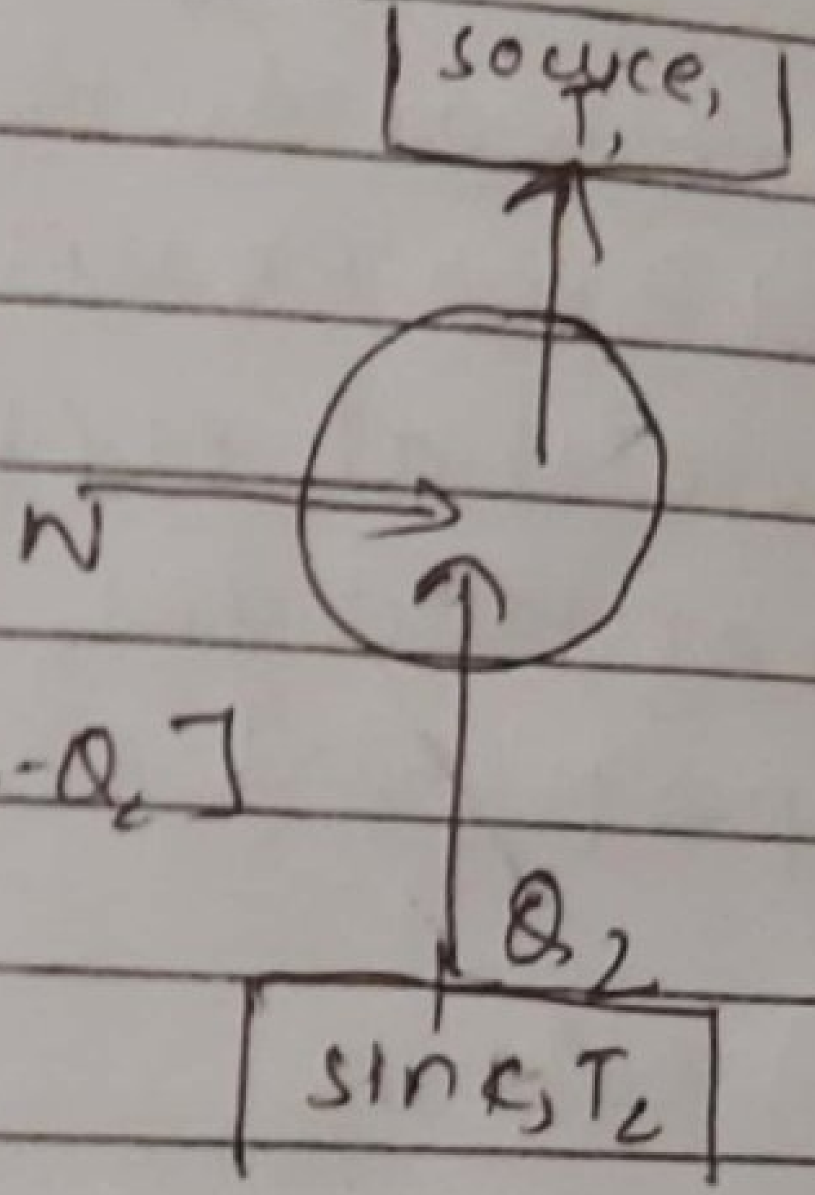
Set-D

Group-B

(1)(a) ⇒ A refrigerator is a heat engine which extracts heat from a cold body and rejects to hot body by doing work. In summer, temperature difference is higher so that high energy is required to cool off the refrigerator in summer than winter.

(b) ⇒



coefficient of performance,

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} \quad [\because W = Q_1 - Q_2]$$

$$\beta = \frac{\frac{Q_2}{Q_1}}{\frac{Q_1}{Q_1} - \frac{Q_2}{Q_1}}$$

$$= \frac{Q_2/Q_1}{1 - Q_2/Q_1}$$

In a carnot cycle, $Q_2/Q_1 = \frac{T_2}{T_1}$,

$$\beta = T_2/T_1 \qquad \therefore \beta = \frac{T_2}{T_1 - T_2}$$

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OR

(a) ⇒ A gas system contains consists of
(a) molecular motion and molecular interaction. The molecular motion possess K.E and the interaction possess P.E. The sum of KE and PE = Total I.E. At same temp, E_k remains same and E_p varies with intermolecular distance. At high pressure, volume & and inter-molecular distance & and mutual attraction betn molecules increase and intermolecular potential energy decreases. But in case of raretied gas, the gas molecules seperate apart and intermolecular P.E increases.

(b)

(i) Adiabatic relation beth Temperature & volume,

$$PV = nRT$$

$$P = n\frac{RT}{V}$$

$$n\frac{RT}{V}V^{\gamma} = \text{constant}$$

$$nRTV^{\gamma-1} = \text{constant}$$

$$TV^{\gamma-1} = \frac{\text{constant}}{R}$$

$$TV^{\gamma-1} = \text{constant}$$

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(i) Temperature & pressure.

$$pV = nRT$$

$$V = \frac{nRT}{p}$$

$$p\left(\frac{nRT}{p}\right)^{\gamma} = \text{constant}$$

$$p^{1-\gamma} T^{\gamma} (nR)^{\gamma} = \text{constant}$$

$$p^{1-\gamma} T^{\gamma} = \text{constant}$$

$$p^{1-\gamma} T^{\gamma} = \text{constant}.$$

(2)

(a) ⇒

progressive	stationary
(i) All particles have same phase and amplitude.	(i) Amplitude varies with position
(ii) speed of motion is same.	(ii) speed varies with position.
(iii) Energy is transported.	(iii) Energy is not transported.

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6. According to second ... the reverse direction if it is working ...

$y = a\sin(\omega t - kx)$

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(iv) same change in pressure and density is with every point.	(iv) pressure and density varies with point.
(v) wave profile move.	(v) wave profile does not move.
(vi) All particles vibrate.	(vi) particles at nodes do not vibrate at any.

(b) ⇒ eqn,

$$y = 0.02\sin(30t - 4x)$$

progressive wave eqn,

~~y = a sin(~~ $y = a\sin\frac{2\pi}{\lambda}(vt - x)$

$a = 0.02$

$\omega = 30$ $\qquad \frac{2\pi}{\lambda} = 4$

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$2\pi f = 30$

$f = \frac{30}{2\pi} = \frac{15}{\pi}$ ~~$= 4.77\,Hz$~~

$\frac{2\pi}{\lambda} = 4$

$\lambda = \frac{2\pi}{4} = \frac{\pi}{2} = 1.571\,m$

speed (v) $= \lambda f = \frac{\pi}{2} \times \frac{15}{\pi} = 7.5\,ms^{-1}$

(3) (a) ⇒ The minimum distance betn the listener and the wall must be 17m to hear an echo. If a room is small, this requirement is not fulfilled. Due to the persistance of hearing (0.1s), our ears cannot detect the repeated sounds i.e. we cannot hear the echo.

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(b) ⇒ We know $v = \sqrt{B/\rho}$

where, B = Bulk modulus of elasticity

AIQ,
Newton,

$B_{isothermal} = P$
so, Velocity $= \sqrt{P/\rho}$

AIQ, (correction)
Laplace

$B_{adiabatic} = \gamma P$

so, velocity $= \sqrt{\gamma P/\rho}$

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(c) ⇒ We have,

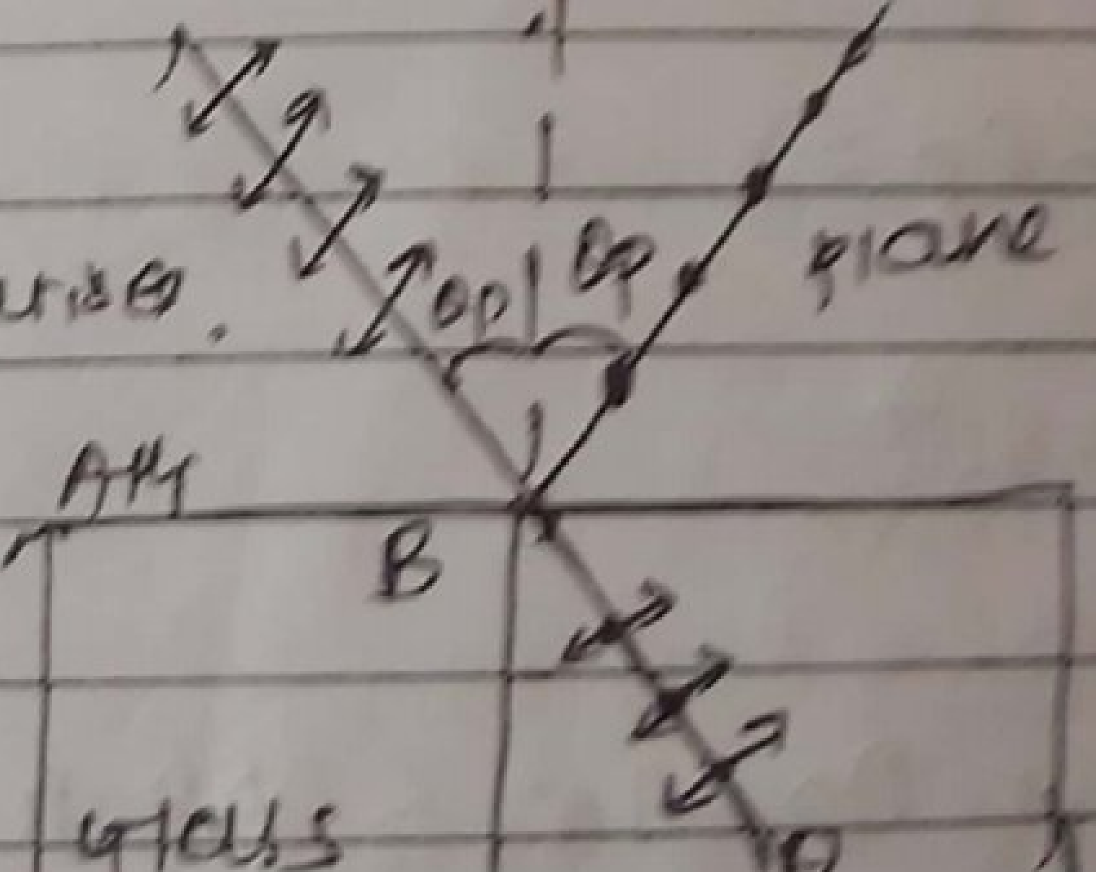
$$v = \sqrt{B/\rho}$$

Where, $\rho = m/v$

Mass ↑ ⇒ ρ ↑ → v ↓

(4) a) → The refractive index of a material depends upon wavelength of light. As polarising angle depends on refractive index, it also depends on wave length of the light.

(b) ⇒



$$\mu = \frac{\sin i}{\sin r} = \frac{\sin \theta_p}{\sin r} \quad \text{—— (1)}$$

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And from Brewster's law

$$\mu = \tan\theta_p = \frac{\sin\theta_p}{\cos\theta_p} \quad \text{--- (ii)}$$

we have,

$$\frac{\sin\theta_p}{\sin r} = \frac{\sin\theta_p}{\cos\theta_p}$$

or, $\cos\theta_p = \sin r$

or, $\sin(90^\circ - \theta_p) = \sin r$

or, $90 - \theta_p = r$

$r + \theta_p = 90^\circ$

As, $r + i = r + \theta_p = 90^\circ$, $\angle CBD$ is also equal to 90°.

→ It states that the tangent of polarizing angle is equal to the refractive index of a material.

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(5) (a) → It states that,

(i) When the magnet flux linking a coil changes, an emf is induced in it.

(ii) This induced emf last so long as the change in magnetic flux continues.

(iii) The induced emf in the coil changes from ϕ_1 to ϕ_2 and induced e.m.f in it is ε, f.

(iii) The induced emf of coil is directly proportional to the rate of change of flux changes.

Mathematically,

$$\varepsilon \propto \frac{\phi_2 - \phi_1}{t}$$

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(5)

(b)

soln;

$R = 6\Omega$

$B = 2.5 T$

$\theta = 90^\circ$

$\mathcal{E} = Blv$

$= 2.5 \times 1.2 \times 2$

$= 5 \times 1.2$

$= 6 N$

$I = \mathcal{E}/R$

$= 6/6$

$= 1 A$

$f = B I_w l$

$= 2.5 \times 6/6 \times 1.2$

$= 3 N$

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(5)

(a)

$$B = \frac{\mu_0 I a^2}{2(a^2+x^2)^{3/2}}$$

At $x = 0$,

$$= \frac{\mu_0 I a^2}{(2a^2)^{3/2}}$$

At $x = 0$

$$B = \frac{\mu_0 i}{2R}$$

At $x = x$

$$B = \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$$

(b) → It means magnetic field ~~varies~~ along the axis of single coil varies with distance x from the centre. So, a single coil cannot produce a magnetic field.

b) Magnetic field at center of coil is maximum and decrease with the increase in distance along the axis of coil.

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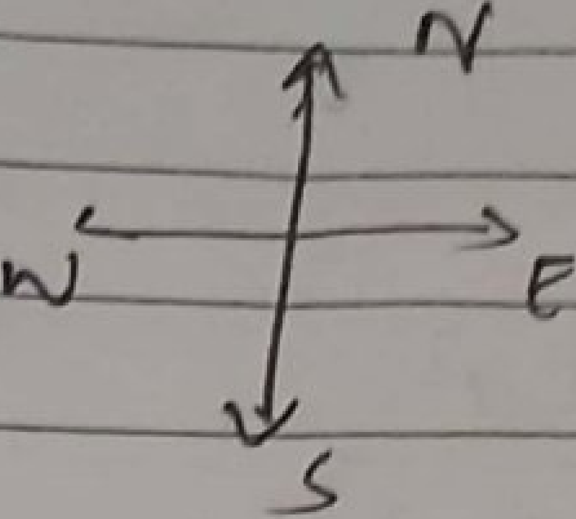
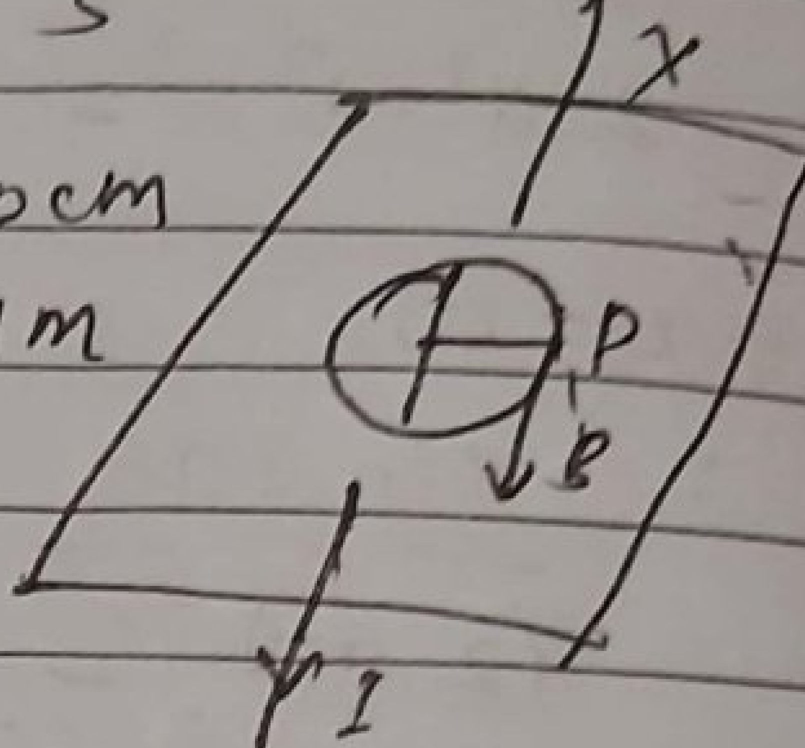
(b)



→ $I = 5\,A$



Distance P from X $(r) = 10\,cm$
$= 0.1\,m$

Earth horizontal magnetic flux density at P due to X,

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.1}$$
$$= 1 \times 10^{-5}\,T$$

According to Fleming's right hand rule, the direction B is from north to south. But direction of horizontal component of earth's magnetic field from south to north.

Resultant flux density at P,

$$B_T = 4 \times 10^{-5} - 1 \times 10^{-5}$$
$$= 3 \times 10^{-5}\,T$$ (from south to north).

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(c) ⇒ moving charge particles constitute a current and we know that current generates magnetic field. Thus a magnetic field is generated by the stream of charged particles during solar activity and it interacts with the Earth's magnetic field causing disturbances in it.

OR

a) ⇒ $B = \mu_0 n I$

$B = \mu_0 N/l$

$B = \mu_0 n I$

$B_1 = \mu_0 N/l \, I$ — ①

$B_2 = \mu_0 \frac{\frac{1}{2} N}{2 l} I$

$B_2 = \mu_0 \frac{1}{4} \frac{N}{l} I$

$B_2 = \frac{1}{4}(\mu_0 \frac{N}{l} I)$

~~$B_2 = \frac{1}{4} \times B_1$~~

$B_1 = 4 B_2$

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(b) ⇒

$l = 1.63 m$

$I = 77.7 A$

$B = 2.96 T$

$B = \mu_0 \frac{N}{l} I$

$2.96 = 4\pi \times 10^{-7} \times \frac{N}{1.63} \times 77.7$

$2.96 \times 1.63 = 4\pi \times 10^{-7} \times N \times 77.7$

or, $4.8248 = 9.768 \times 10^{-5} N$

$N = 49393.93$ turn

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(7)

(a) →

(i) $KE = \frac{1}{2}mv^2$

$K.E \propto m$

mass of proton ↑, KE more ↑

mass of electron ↓, KE less !

$KE \propto \frac{1}{\lambda}$

KE ↑ λ↓, KE of proton is more so λ↓. so less curved than that of electron.

(ii) → neutron is not affected by electric field. nature of trajectory is straight line.

(b) → $KE \propto 1/$[illegible]

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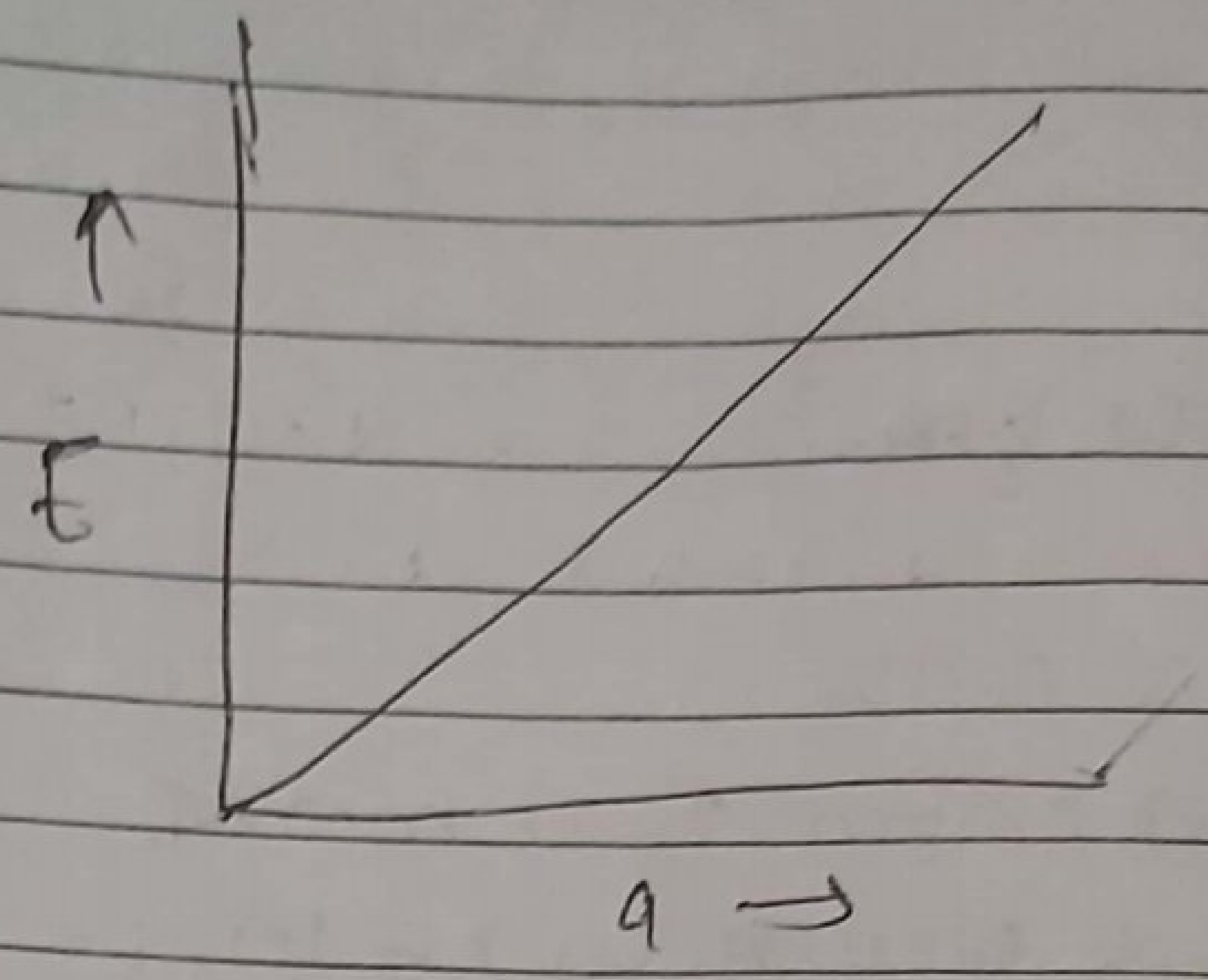
(c) →



OR,

(a) ⇒ ~~photon~~ According to einstein the energy of electromagnetic radiation absorbed or emitted in form of small packets of energy called photons.

(b) ⇒ Rest mass for all photon is 0.

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{or, } m_0 = m\sqrt{1-\frac{v^2}{c^2}}$$

If $v = c$

$M_0 = 0$

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diff^nt

St. M. for all radiation of diff^nt frequencies

(b) ⇒ yes it changes, the diff^nt radiation have diff^nt frequencies.

$$E = mc^2$$

$$mc^2 = hf$$

$$m = E/c^2 = hf/c^2$$

(c) ⇒ $E = hf$

$= 6.62 \times 10^{-34} \times 1$

$= 6.62 \times 10^{-34}\,J$

$= \frac{6.62 \times 10^{-34}}{1.6 \times 10^{-19}}$

$= 4.1375 \times 10^{-15}\,J$

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Group-C

9 (a) ⇒ Resonance is the specific response of a system which is capable to vibrate with a certain frequency to an external force acting with the same frequency.

(b) ⇒ The period of swing of simple pendulum will remain unchanged till the location of centre of gravity of the ice bob, left after melting the ice, remains at a fixed distance from the point to suspension.

(c) → (i) maximum displacements | acceleration are different.

(ii) graph is curved | not a straight line.

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(a) ⇒ $T = 2\pi\sqrt{\frac{R}{g}}$

$\therefore T = 2\pi\sqrt{\frac{6.4\times10^6}{9.8}} = 5075\ s$

$T = \frac{5075}{60} = 84.6\ mins.$

Time taken to cross tunnel $= \frac{T}{2}$

$= \frac{84.6}{2}$

$= 42.3\ min$

OR,

⇒ The property of liquid at rest by virtue of which its surface behaves like a stretched membrane and tries to occupy minimum surface ~~area~~ area.

formation of lead shots : In order to manufacture lead shots, melted lead is allowed to fall in water by spraying it from height. During its fall, the melted lead forms spherical ~~oft~~ drop due to surface tension forces and on entering water, they become solid.

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(b) ⇒ Increase of temperature reduces the surface tension. since hot soap has less surface tension than cold soup so that hot soup spreads throughout in our tongue and we feel tasty.

(c) ⇒ $l = 6cm = 0.06m$

$b = 4cm = 0.04m$

$t = 2mm = 2 \times 10^{-3} m$

$\theta = 0^0$

$T = 7 \times 10^{-2} Nm^{-1}$

Total length of contact $(L) = 2(l+b)$

$= 2(0.06 + 0.04)$

$= 0.2m$

Downward force due of $f = T \times L$

$= 7 \times 10^{-2} \times 0.2$

$= 1.4 \times 10^{-2} N$.

If the plate is placed vertical, then

Total length of contact $(L) = 2(l + t)$

$= 2(0.06 + 0.002)$

$= 0.124m$

Downward force due to $f = T \times L = 7 \times 10^{-2} \times 0.124$

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(10) (a) ⇒ Effective resistance offered by LCR circuit is to the flow of a.c. current ~~through the~~ through the circuit is called impendance of LCR circuit.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

If $\tan\phi = 0$ or, $\phi = 0^0$

$$\omega L = \frac{1}{\omega C}$$

$$\omega^2 = \frac{1}{LC}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$2\pi f = \frac{1}{\sqrt{LC}}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

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(b) → $I_{rms} = I/\sqrt{2}$

rms value ↑ in 220 V a.c, 50 dangerous.

In d.c 220 d.c is the steady value.

(c) ⇒ $V_c = 170$ V

$f = 60$ Hz

$I = 0.85$ A

$C = ?$

P.d across capacitor $V_c = I X_c$

$V_c = \frac{1}{2\pi f C}$

or, $C = \frac{1}{2\pi f V_c} = \frac{0.85}{2 \times 3.14 \times 60 \times 170}$

$\therefore C = 1.32 \times 10^{-5}$ F

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~~(1) (a) → (i) An electrons can't revolve around the nucleus in~~

(i) The electrons can only revolve round the nucleus in those permissible orbits for which angular momentum of the electron is integral multiple of $h/2\pi$.

(ii) An electron emits or absorbs energy only when it jumps from one stationary orbit to other. Electron emits energy when it jumps from higher level to lower level and it absorbs energy from lower to higher level.

(b) → The spectral line is obtained when it jumps from higher to lower energy state. Though there is only one ~~ele~~ electron in H-atom there are several orbits allowed for this electron. Again a sample contains large no. of H-atom.

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(ii) ⇒ 6 different lines.

$E_4 \rightarrow E_1$

$E_4 \rightarrow E_2$

$E_4 \rightarrow E_3$

$E_3 \rightarrow E_2$

$E_3 \rightarrow E_1$

$E_2 \rightarrow E_1$

(iii) ⇒ Usually, all atoms have electron in ground state and when they get energy and gives absorption spectrum.

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(c)

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = 1.097\times10^7\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$$

$$\frac{1}{\lambda} = 1.097\times10^7 \times \frac{1}{4}$$

$$\therefore \lambda_{min} = \frac{4}{1.097\times10^7}$$

$$= 3.64\times10^{-7}\,m$$

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