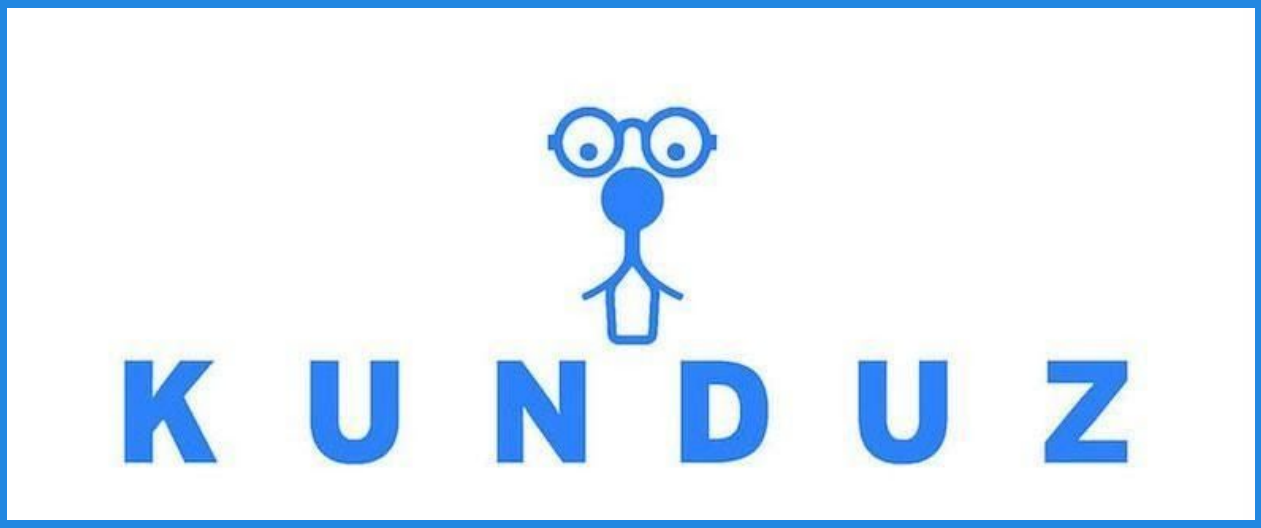
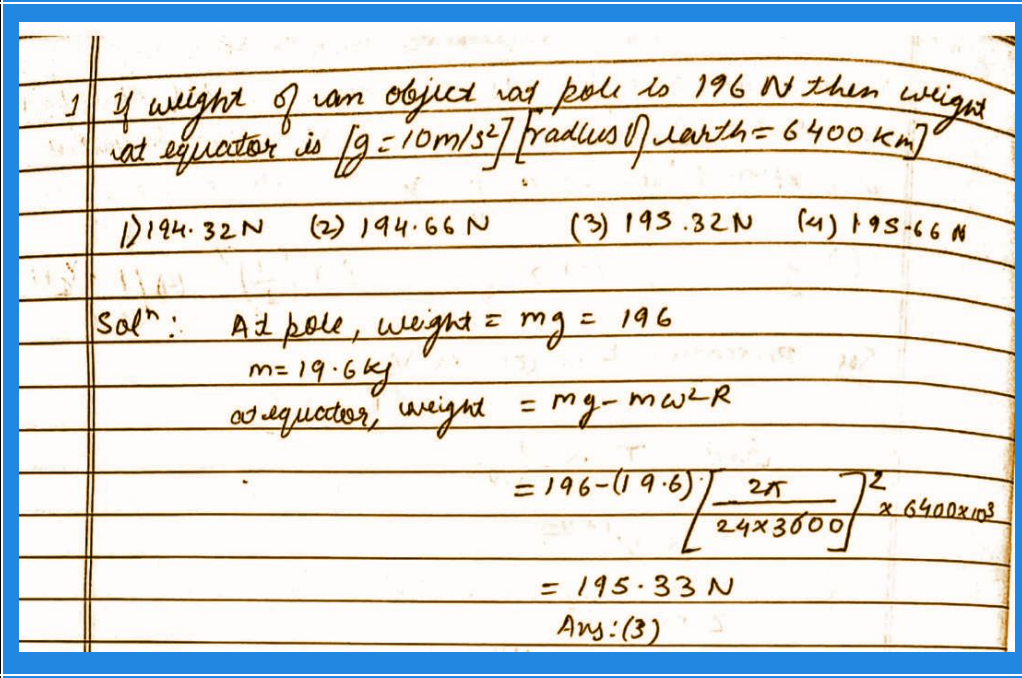
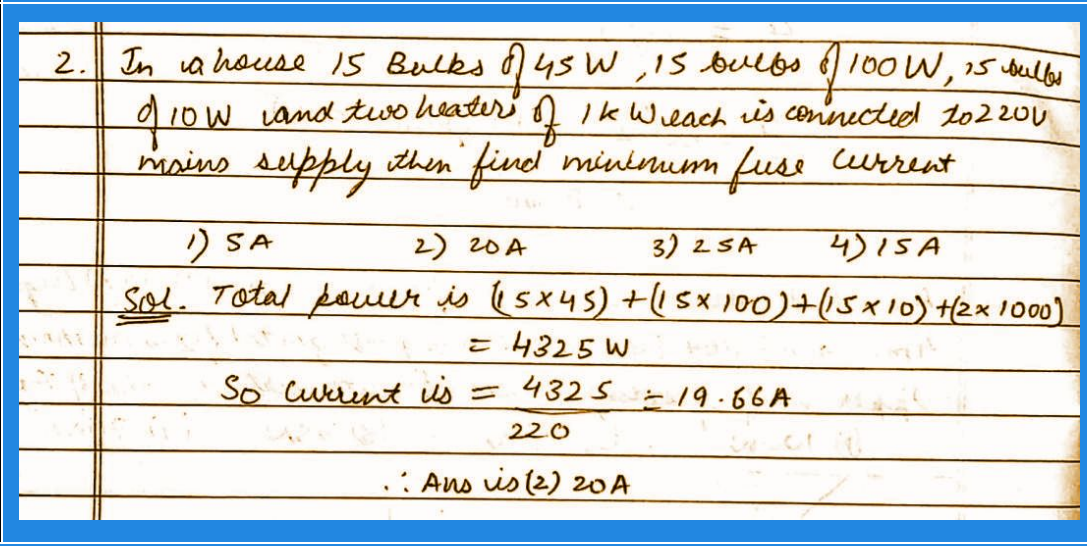


Jan 9 2020 shift 2 Physics prepared by KUNDUZ tutors

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Question no.	Questions and Answers
1	
2	

3

3. In an adiabatic process volume is doubled then find the ratio of final average relaxation time & initial relaxation time. Given $\frac{C_p}{C_v} = \gamma$

(1) $\frac{1}{2}$ (2) 2 (3) $\left(\frac{1}{2}\right)^{\gamma}$ (4) $\left(\frac{1}{2}\right)^{\frac{\gamma}{2}+1}$

Sol. Relaxation time $(\tau) \propto \frac{V}{\sqrt{T}}$

and $T \propto \frac{1}{V^{\gamma-1}}$

$\tau \propto V^{1+\frac{\gamma-1}{2}}$

$\tau \propto V^{\frac{1+\gamma}{2}}$

$\frac{\tau_f}{\tau_i} = \left(\frac{2V}{V}\right)^{\frac{1+\gamma}{2}}$

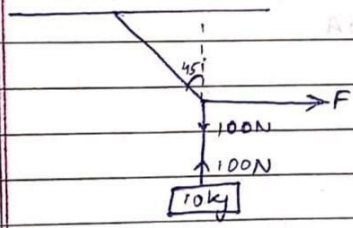
$\frac{\tau_f}{\tau_i} = (2)^{\frac{1+\gamma}{2}}$ (No option match)

∴ Bonus

4

4. A block of mass 10 kg is suspended from string of length 4 m. When pulled by a force F along horizontal from midpoint upper half of string makes 45° with vertical, value of F is

(1) 100N (2) 90N (3) 75N (4) 70N



$\therefore \frac{T}{\sqrt{2}} = 100N$

also, $\frac{T}{\sqrt{2}} = F$

$\therefore F = 100N$

Ans is (1) 100N

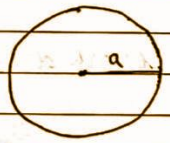
5

5. The surface mass density of a disc of radius 'a' varies with radial distance as $\sigma = A + Br$ where A & B are positive constants then moment of inertia of the disc about an axis passing through its centre and $\perp^r$ to the plane.

(1) $2\pi a^4\left(\frac{A}{4} + \frac{Ba}{5}\right)$ (2) $2\pi a^4\left(\frac{Aa}{4} + \frac{B}{5}\right)$

(3) $\pi a^4\left(\frac{A}{4} + \frac{Ba}{5}\right)$ (4) $2\pi a^4\left(\frac{A}{5} + \frac{Ba}{4}\right)$

Sol^n $\sigma = A + Br$



$$\int dm = \int \sigma(A+Br)2\pi r\,dr$$

$$I = \int dm\, r^2$$

$$= \int_0^a (A+Br)2\pi r^3 dr$$

$$= 2\pi\left(\frac{Aa^4}{4} + \frac{Ba^5}{5}\right)$$

$$= 2\pi a^4\left(\frac{A}{4} + \frac{Ba}{5}\right)$$

6

6) Cascaded Carnot engine is an arrangement in which heat sink of one engine is source for other. If high temperature for one engine is T_1, low temperature for other engine is T_2 (Assume work done by both engine is same). Calculate lower temperature of first engine.

(1) $\frac{2T_2T_1}{T_1+T_2}$ (2) $\frac{T_1+T_2}{2}$ (3) 0 (4) $\sqrt{T_1T_2}$

Soln Let Q_H : Heat input to 1st engine

Q_L : Heat rejected from 1st engine

Q_L' : Heat rejected from 2nd engine

Work done by 1st engine = Work done by 2nd engine

$$Q_H - Q_2 = Q_L - Q_L'$$

$$2Q_L = Q_H + Q_L'$$

$$\Rightarrow 2 = \frac{T_1}{T} + \frac{T_2}{T}$$

$$\Rightarrow T = \frac{T_1+T_2}{2}$$

Ans: (2) $\frac{T_1+T_2}{2}$

7

7) Activity of a substance changes from 7005^{-1} to 5005^{-1} in 30 minute. Find its half life in minutes.

(1) 66 (2) 62 (3) 56 (4) 50

Soln: $\ln\left[\frac{A_0}{A_t}\right] = \lambda t$

$\Rightarrow \ln 2 = \lambda t_{1/2}$ — (i)

$\Rightarrow \ln\left(\frac{700}{500}\right) = \lambda(30\text{ min})$ — (ii)

(i)/(ii) $\Rightarrow \frac{\ln 2}{\ln(7/5)} = \frac{t_{1/2}}{(30\text{ min})} \Rightarrow t_{1/2} = 61.8\text{ min}$

$\therefore$ (2) 62 min is the right Ans

8

8) In YDSE, separation between slits is 0.15 mm, distance between slits & the screen is 1.5 m and wavelength of light is ~~550~~ 589 nm, then fringe width is

(1) 5.9 mm (2) 3.9 mm (3) 1.9 mm (4) 2.3 mm

$$\beta = \frac{\lambda D}{d} = \frac{589 \times 10^{-9} \times 1.5}{0.15 \times 10^{-3}} = 5.9 \text{ mm}$$

9

9) An ideal fluid is flowing in a pipe in streamline flow. Pipe has maximum and minimum diameter of 6.4 cm and 4.8 cm respectively. Find out the ratio of minimum to maximum velocity

(1) $\frac{81}{256}$ (2) $\frac{9}{16}$ (3) $\frac{3}{4}$ (4) $\frac{3}{16}$

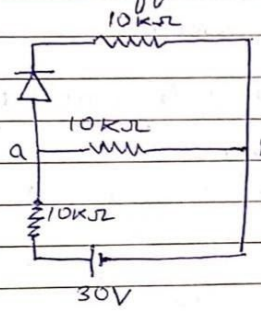
Soln using equation of continuity

$$A_1 V_1 = V_2 A_2$$

$$\frac{V_1}{V_2} = \frac{A_2}{A_1} = \left(\frac{4.8}{6.4}\right)^2 = \frac{9}{16}$$ Answer is (2) $\frac{9}{16}$

10

10) There is a electric circuit as shown in the figure. Find potential difference between points a and b

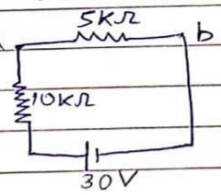


(1) 0 V
(2) 15 V
(3) 10 V
(4) 5 V

Soln

Diode is in forward bias, so it'll behave as simple wire

simplified circuit:



$\therefore V_{ab} = \frac{30}{5+10} \times 5 = 10V$

$\therefore$ (3) 10V is correct Ans

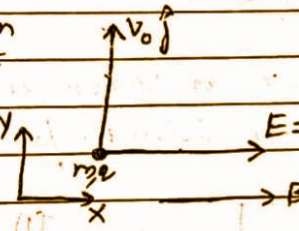
11

11) A particle of mass m and positive charge q is projected with a speed of v_0 in y-direction in the presence of electric and magnetic field are in x-direction. Find the instant time at which the speed of particle becomes double of the initial speed.

(1) $t = \frac{mv_0\sqrt{3}}{qE}$ (2) $t = \frac{mv_0\sqrt{2}}{qE}$ (3) $t = \frac{mv_0}{qE}$

(4) $t = \frac{mv_0}{2qE}$

Soln



As $\vec{v} = v_0\hat{j}$ (magnitude of velocity does not change in y-z plane)

$\therefore (2v_0)^2 = v_0^2 + v_x^2$; $v_x = \sqrt{3}v_0$

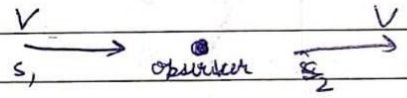
$\therefore \sqrt{3}v_0 = 0 + \frac{qE}{m}t$; $t = \frac{mv_0\sqrt{3}}{qE}$

12

12) Two sources of sound moving with same speed v and emitting frequency 1400 Hz are moving such that one source S_1 is moving towards observer and S_2 is moving away from observer. If observer hears beat frequency of 2 Hz then find the source speed. Given $V_{sound} >> V_{source}$

$V_{sound} = 350$ m/s

(1) $\frac{1}{4}$ (2) 4 (3) 2 (4) $\frac{1}{2}$



$$f_0\left(\frac{c}{c-v}\right) - f_0\left(\frac{c}{c+v}\right) = 2$$

Solving, $v = \frac{1}{4}$ m/s $\therefore$ Ans is (1) $\frac{1}{4}$ m/s

13

13) An electron and a photon have same energy E find the ratio of de Broglie wavelength of electron to wavelength of photon. Given mass of electron is m and speed of light is c

(1) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$ (2) $\left(\frac{E}{m}\right)^{1/2} c$ (3) $\frac{\sqrt{2mE}}{c}$ (4) $\left(\frac{E}{2m}\right)^{1/2}$

Sol^n λ_d for electron $= \frac{h}{\sqrt{2mE}}$

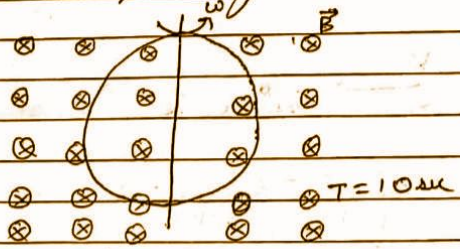
λ for photon $= \frac{hc}{E}$

$$\text{Ratio} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc}$$

$$= \frac{1}{c}\sqrt{\frac{E}{2m}}$$

14

14 A ring is rotated about diametric axis in a uniform magnetic field perpendicular to the plane of the ring. If initially the plane of the ring is perpendicular to the magnetic field. Find the instant time at which EMF will be maximum and minimum respectively.



at $t = 0$

(1) 2.5 sec, 5 sec (2) 5 sec, 7.5 sec (3) 2.5 sec, 7.5 sec

(4) 10 sec, 5 sec

14/25

Soln $\omega = \frac{2\pi}{T} = \frac{\pi}{5}$

when $\omega t = \frac{\pi}{2}$

$\therefore \phi$ will be minimum

$\therefore e$ will be maximum

$t = \frac{\frac{\pi}{2}}{\frac{\pi}{5}} = 2.5$ sec

when $\omega t = \pi$

$\therefore \phi$ will be maximum

$\therefore e$ will be minimum

$t = \frac{\pi}{\frac{\pi}{5}} = 5$ sec

$\therefore$ Ans is (1) 2.5 sec, 5 sec

15

15) Electric field in space is given by $\vec{E}(t) = E_0\frac{(\hat{i}+\hat{j})}{\sqrt{2}}\times \cos(\omega t + kz)$. A positively charged particle at $(0, 0, \frac{\pi}{k})$ is given velocity $v_0\hat{k}$ at $t=0$. Direction of force acting on particle is

(1) $t=0$ (2) antiparallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$

(3) parallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (4) $\hat{k}$

Soln: Force due to electric field is in direction $-\frac{(\hat{i}+\hat{j})}{\sqrt{2}}$ because at $t=0$, $E = -\frac{(\hat{i}+\hat{j})}{\sqrt{2}}E_0$

Force due to Magnetic field is in direction of $(\vec{v}\times\vec{B})$ and $\vec{v}\parallel\vec{k}$

$\therefore$ It is parallel to $\vec{E}$

$\therefore$ Net force is antiparallel to $\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

Ans: (2)

16

16) Focal length of convex lens in air is 16 cm ($\mu_{glass} = 1.5$). Now the lens is submerged in a liquid of $\mu_l = 1.42$. Find the ratio of focal length in medium to focal length in air has closest value

(1) 9 (2) 17 (3) 1 (4) 5

Soln $\frac{1}{f_a} = \left(\frac{\mu_g}{\mu_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f_m} = \left(\frac{\mu_g}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\Rightarrow \frac{f_a}{f_m} = \frac{\left(\frac{\mu_g}{\mu_m} - 1\right)}{\left(\frac{\mu_g}{\mu_a} - 1\right)} = \frac{\left(\frac{1.50}{1.42} - 1\right)}{\left(\frac{1.50}{1} - 1\right)} = \frac{0.08}{(1.92)(0.5)}$

$\therefore \frac{f_m}{f_a} = 8.875 \approx 9$

17

17) A lift of mass 920 kg has capacity of 10 persons. If average mass of person is 68 kg. Friction force between lift and lift shaft is 6000 N. The minimum power of motor required to move lift upward with const. velocity 3 m/s is [g = 10 m/s²]

(1) 66000 W (2) 63248 W (3) 48000 W (4) 56320 W

Sol^n :- Net force on motor will be F_m

$F_m = [920 + 68(10)]g + 6000$

$= 22000N$

So required power for motor

$\Rightarrow P_m = \vec{v} \cdot \vec{F_m}$

$= 22000 \times 3$

$= 66000$ Watt

Ans (1) 66000 W

18

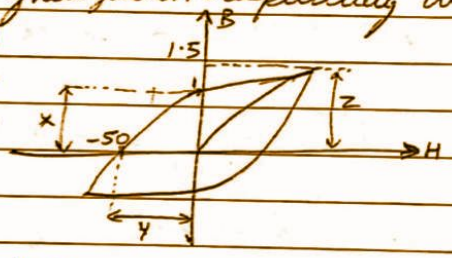
18) The hysterisis curve for a material is shown in the figure. Then for the material retentivity, coercivity and saturation magnetization respectively will be

(1) 50 A/m, 1 T, 1.5 T

(2) 1.5 T, 50 A/m, 1 T

(3) 1 T, 50 A/m, 1.5 T

(4) 50 A/m, 1.5 T, 1 T



Sol^n x = retentivity

y = coercivity

z = saturation magnetization

∴ Ans is (3)

19

19) An inductor of inductance 10mH and a resistance 5Ω is connected to a battery of 20V at $t=0$. Find the ratio of current in circuit at $t=\infty$ to current at $t=40$ sec.

(1) 1.06 (2) 1.48 (3) 1.15 (4) 0.84

Soln $i = i_0\left(1 - e^{-t/L/R}\right)$

$= \frac{20}{5}\left(1 - e^{-t/0.01/5}\right)$

$= 4\left(1 - e^{-500t}\right)$

$i_\infty = 4$

$i_{40} = 4\left(1 - e^{-500\times 40}\right)$

$= 4\left(1 - \frac{1}{(e^2)^{10000}}\right) = 4\left(1 - \frac{1}{7.29^{10000}}\right)$

$\frac{i_\infty}{i_{40}} \simeq 1$ slightly greater than 1

$\therefore$ ans is (1) 1.06

20

20) Find dimension of $\frac{B^2}{2\mu_0}$

(1) $ML^{-1}T^{-2}$ (2) ML^2T^{-2} (3) $ML^{-1}T^2$ (4) $ML^{-2}T^{-1}$

Soln Energy density in magnetic field $= \frac{B^2}{2\mu_0}$

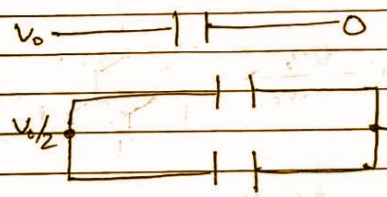
$= \frac{\text{Force} \times \text{displacement}}{(\text{displacement})^3} = \frac{MLT^{-2} \times L}{L^3}$

$= ML^{-1}T^{-2}$

$\therefore$ Ans (1)

21

21) A capacitor of 60pF charged to 20V. Now battery is removed then capacitor is connected to another identical uncharged capacitor. Find heat loss in nJ



$V_0 = 20V$

Heat loss $= U_i - U_f$

$= \frac{1}{2}CV_0^2 - 2\left[\frac{1}{2}C\left(\frac{V_0}{2}\right)^2\right]$

$= \frac{CV_0^2}{4}$

$= \frac{(60\times10^{-12})(20)^2}{4}$ J

$= 6\times10^{-9}$ J $= 6$ nJ

Ans is 6

22

22) When m gram of steam at 100°C is mixed with 200 gm of ice at 0°C. It results in water at 40°C. Find the value of m in gram. (given: Latent heat of fusion $L_f = 80$ cal/g, Latent heat of vaporization $L_v = 540$ cal/gm, specific heat of water $(C_w) = 1$ cal/g/°C)

Soln:- $M_{ice}L_f + m_{ice}(40-0)C_w = m_{steam}L_v + m_{steam}(100-40)C_w$

$\Rightarrow 200(80+40(1)) = m[540+60(1)]$

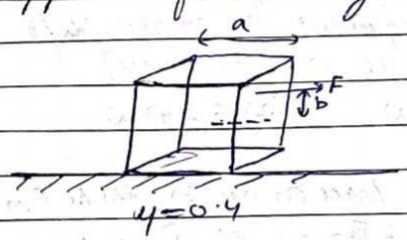
$\Rightarrow 200(120) = m(600)$

$\Rightarrow m = 40$ gm

Ans is 40

23

23) A solid cube of side 'a' is shown in the figure. Find maximum value of $100\frac{b}{a}$ for which the block does not topple before sliding.



For not toppling: $f\left(\frac{a}{2}+b\right) \leq mg\frac{a}{2}$

$\Rightarrow \frac{\mu a}{2} + \mu b \leq \frac{a}{2}$

$\Rightarrow 0.4b \leq 0.3a$

$\Rightarrow b \leq \frac{3a}{4}$

$\Rightarrow b \leq 0.75a$ ~~Its limiting~~ in limiting case.

But its not possible b can be maxm equal to $0.5a$

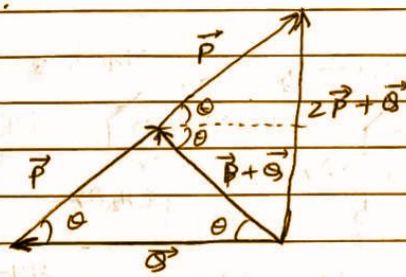
$\therefore \left(100\frac{b}{a}\right)_{max} = 50$

Ans = 50

24

24) Magnitude of resultant of vectors $\vec{P}$ and $\vec{Q}$ is equal to magnitude of $\vec{P}$. Find the angle between $\vec{Q}$ and resultant of $2\vec{P}$ and $\vec{Q}$

Soln:-



$\therefore$ Ans is 90° as shown in figure. (geometry)

25

25) A battery of unknown emf connected to a potentiometer has balancing length 560 cm. If a resistor of resistance 10Ω is connected in parallel with the cell the balancing length change by 60cm. If the internal resistance of the cell is $\frac{n}{10}\Omega$, the value of n is.

Sol" Let the emf of cell be ε, internal resistance be r and potential gradient x

Only cell connected:

$\varepsilon = 560x$ —(1)

After connecting the resistor

$\frac{\varepsilon \times 10}{10+r} = 500x$ —(2)

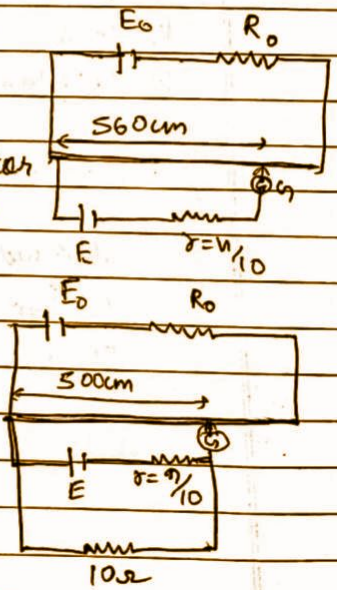
from (1) & (2)

$\frac{560 \times 10}{10+r} = 500$

$56 = 50 + 5r$

$r = \frac{6}{5} = 1.2\Omega$

$n = 12$



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