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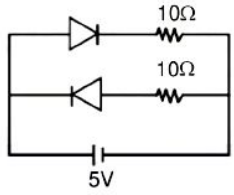
JEE-MAIN-2021

FEBRUARY ATTEMPT

25.02.21_SHIFT - I

PHYSICS

1. In the given circuit find the current through battery, given that the diode used is ideal diode.



(1) 0.5 A (2) 1 A (3) 1.5 A (4) 2 A

Ans. **(1)**

Sol. $i = \frac{5}{10} = 0.5A$

2. A proton and an α–particle are accelerated same potential difference. Find ratio of their de-Broglie wavelength

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

Ans. **(1)**

Sol. $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mqv}}$

$\frac{\lambda_P}{\lambda_\alpha} = \sqrt{\frac{4m \times 2e}{m \times e}} = 2\sqrt{2}$

3. Electric field in space is $\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}$, where E_0 is a positive constant the flux of electric field passing through a sheet of area 0.3 m^2 lying in Y-Z plane is ϕ_1, another sheet of area 0.4 m^2 lying in x-z plane has flux ϕ_2 passing through it. Find ratio $\phi_1 : \phi_2$?

(1) 9/16 (2) 16/9 (3) 3/4 (4) 4/3

Ans. **(1)**

Sol. Flux $\Rightarrow f = \vec{E}.\vec{A}$

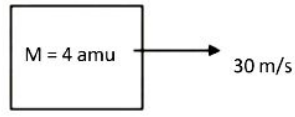
For Y-Z plane, $A_1 = 0.3\,\hat{i}$

Then $|\phi_1| = \left(\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}\right).(0.3\hat{i}) = \frac{0.9}{5}E_0$

For X-Z plane, $A_2 = 0.4\,\hat{i}$

$|\phi_2| = \left(\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}\right).0.4\hat{j} = \frac{1.6}{5}E_0$ so $\frac{\phi_2}{\phi_1} = \frac{1.6}{0.9} = \frac{16}{9} = 1.78$

4. A box filled with gas moving with constant velocity 30 m/s. Having monoatomic gas of mass (4 u). Now block is suddenly stopped. Then find the change in temperature of gas



Monoatomic gas

(1) 10K (2) 1 K (3) 0.3K (4) 0.144 K

Ans. **(4)**

Sol. $\frac{1}{2} \times n \times Mv^2 = n \,.\, Cv\, \Delta T$

$$= n.\frac{3}{2} \times R\Delta T$$

$$\Delta T = \frac{Mv^2}{3R} = \frac{4 \times 30 \times 30 \times 10^{-3}}{3 \times 8.314}$$

$$= 0.144 \text{ K}$$

5. For a lens when object is placed at two positions i.e. 20 cm and 10 cm respectively, the image formed is of same size. Find focal length of lens ?

(1) 20/3 cm (2) 40/3 cm (3) 10 cm (4) 20 cm

Ans. **(1)**

6. **Statement–1 :** A rod free to move of length L unit heated. by ΔT temperature. There is No thermal stress develop in it.

Statement–2 : Length of rod will increase.

(1) Statement–1 is false and Statement–2 is true

(2) Statement–1 is True and Statement–2 is False

(3) Statement–1 and Statement–2 both are true and statement–2 is the correct explanation of statement–1

(4) Statement–1 and Statement–2 both are true and statement–2 is not correct explanation of statement–1

Ans. **(4)**

7. A drop is charged to 2V Now 512 drop & identical are combined to form a single drop there the voltage of bigger drop is?

(1) 148 V (2) 128 V (3) 125 V (4) 127 V

Ans. **(2)**

Sol. $R \rightarrow$ radius of bigger drop

$r \rightarrow$ radius of small drop

$V_{\text{bigger drop}}$ 512 $V_{\text{smaller drop}}$

$$\frac{4}{3}\pi R^3 = 512\, \frac{4}{3}\pi r^3$$

$$R = 8r$$

$$V = \frac{Kq}{r}$$

$$V' = \frac{K \times 512}{R}$$

$$\frac{V'}{V} = 64$$

$$V' = 128 \text{ Volt}$$

8. Relation between P and V for a process is $P = KV^3$ for a gas. The temperature of gas is changed from 100°C to 300°C. If the work done for the process is x nR. Then find the value of x.

Ans. **25**

Sol. $\int PdV$

$= \int kV^3 dV$

$= \left.\frac{kv^4}{4}\right|_{V_1}^{V_2}$

$= \frac{kV_2^4 - kV_1^4}{4}$ $\qquad kV_2^3 = P_2,\ kV_1^3 = P_1,\ kV_2^4 = P_2V_2,\ kV_1^4 = P_1V_1$

$= \frac{nR(T_2 - T_1)}{4}$ $\qquad kV_2^4 - kV_1^4 = nR(T_2 - T_1)$

$= \frac{nR(300 - 100)}{4} = 50\ nR$

9. Engine of train is crossing a signal with speed n and last coach of train is crossing the signal with speed v speed of. Find speed with which mid point of train crossing

(1) $\frac{u+v}{2}$ (2) $\sqrt{u^2+v^2}$ (3) $\sqrt{\frac{u^2+v^2}{2}}$ (4) $\frac{u^2}{v}$

Ans. **(3)**

Sol. $V^2 = u^2 + 2al$

$V^1 = u^2 + 2a\left(\frac{\ell}{2}\right)$

$V^1 = \sqrt{\frac{u^2+v^2}{2}}$

10. A gas having $C_p = \frac{7R}{2}$ and $C_y = \frac{5R}{2}$. Then find the ratio of $\Delta U : \Delta W : \Delta Q$ in isobaric process ?

(1) 5 : 2 : 7 (2) 2 : 7 : 5 (3) 5 : 2 : 3 (4) 3 : 2 : 7

Ans. **(1)**

Sol. $\Delta U = nC_v\Delta T$

$\Delta W = nR\Delta T$

$\Delta Q = nC_p\Delta T$

11. A pendulum of length 2 m having time period 2 sec on a planet. Then find acceleration due to gravity of planet :

(1) π^2 m/s^2 (2) $2\pi^2$ m/s^2 (3) $4\pi^2$ m/s^2 (4) 9.8 m/s^2

Ans. **(2)**

Sol. $T = 2\pi\sqrt{\frac{\ell}{g_{planet}}}$

$g_{planet} = \frac{4\pi^2\ell}{T^2}$

$g_{planet} = 2\pi^2$

12. When object is placed at a distance 10 cm & 20 cm from convex lens. Size of image obtained is same find focal length of the lens ?

(1) 15 cm (2) 16 cm (3) 20 cm (4) 10 cm

Ans. **(1)**

Sol. As size of image is same

$$\left.\begin{array}{l} |m_1| = |m_2| \\ \text{So } \left|\frac{f}{f+u_1}\right| = \left|\frac{f}{f+u_2}\right| \end{array}\right]$$

$$\left.\frac{f}{f+u_1} = -\frac{f}{f+u_2}\right] \rightarrow \text{as one image in real \& other is virtual}$$

$f + u_2 = -f - u_1$

$2f = -u_2 - u_1$

$2f = -(-10) - (-20)$

$2f = 10 + 20$

$f = 15$ cm

13. The Ratio of magnetic field by Ring at a distance of 0.05m & 0.2m from centre on axis of ring is 8 : 1. Find radius of ring ?

(1) 0.25 m (2) 0.1 m (3) 0.3 m (4) 0.5 m

Ans. **(2)**

Sol. $B = \frac{\mu_0 NIR^2}{2(X^2+R^2)^{3/2}}$

$\frac{B_1}{B_2} = 8$

$\frac{\frac{\mu_0 NIR^2}{2(X_1^2+R^2)^{3/2}}}{\frac{\mu_0 NIR^2}{2(X_2^2+R^2)^{3/2}}} = 8$

$\frac{(X_2^2+R^2)}{X_1^2+R^2} = 4$

$(0.2)^2 + R^2 = 4\left((0.05)^2+R^2\right)$

$\frac{4}{100} + R^2 = 4\left(\frac{25}{106\times100} + R^2\right)$

14. Resonance tube of diameter d = 6 cm. Sounded with tuning fork of frequency f = 504 Hz. If speed of sound is equal to 336 m/s. than find the height of air column.

(1) 14.87 cm (2) 10.32 cm (3) 24.52 cm (4) 23.32 cm

Ans. **(1)**

Sol. $V = f\lambda$

$\lambda = V/f$

$\lambda = \frac{336}{504}$

$\ell + e = \frac{\lambda}{4}$

$(\ell + 0.3\times6)\times10^{-2} = \frac{336}{4\times504}$

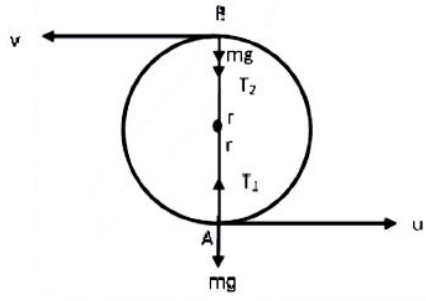
ℓ = 14.87 cm

15. A particle is moving in a vertical circle with radius 1 m. If the ratio of $\frac{T_{max}}{T_{min}} = 5$ find the velocity at highest point ?

(1) 5 m/s (2) 10 m/s (3) 15 m/s (4) 20 m/s

Ans. **(1)**

Sol.



We know that

$T_{max.} - T_{min} = 6mg$

and given that $T_{max}/T_{min.} = 5$

Solving these $T_{max} = \frac{15}{2}mg$

and $T_{min} = \frac{3}{2}mg$

$T_2 = T_{min} = \frac{mv^2}{r} - mg$

$\frac{5}{2}mg = \frac{mv^2}{r}$

$v = 5$ m/s

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16. Potential energy is region is given by $U = \frac{\alpha}{r^{10}} - \frac{\beta}{r^5}$ at equilibrium. Inter molecular distance between particle is given as $r = \left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$. Then a will be :

Ans. 1

Sol. $U = \frac{\alpha}{r^{10}} - \frac{\beta}{r^5}$

$F = -\frac{dU}{dr} = \frac{\alpha(-10)}{r^{11}} - \frac{\beta(-5)}{r^6}$

At Eq. $F = 0$

$\frac{\alpha(10)}{r^{11}} = \frac{5\beta}{r^6}$

$r^5 = \frac{10\alpha}{5\beta}$

$r = \left(\frac{2\alpha}{\beta}\right)^{\frac{1}{5}} = \left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$

$\frac{a}{b} = \frac{1}{5}$

$\therefore \quad a = 1$

$b = 5$

17. Two Sources of light whose Ratio of intensities are $\frac{I_2}{I_1} = 2x$. Find the value of $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$.

(1) $\frac{\sqrt{2x}}{2x+1}$ (2) $\frac{2\sqrt{2x}}{2x+1}$ (3) $\frac{2\sqrt{2x}}{x+1}$ (4) $\frac{2\sqrt{2x}}{2x-1}$

Ans. **(2)**

Sol. $$\frac{I_{max} - I_{min}}{I_{max} + I_{min}} = \frac{(\sqrt{I_2} - \sqrt{I_1})^2 - (\sqrt{I_2} - \sqrt{I_1})^2}{(\sqrt{I_2} + \sqrt{I_1})^2 + (\sqrt{I_2} - \sqrt{I_1})^2}$$

$$= \frac{\left(\sqrt{\frac{I_2}{I_1}} + 1\right)^2 - \left(\sqrt{\frac{I_2}{I_1}} - 1\right)^2}{\left(\sqrt{\frac{I_2}{I_1}} + 1\right)^2 + \left(\sqrt{\frac{I_2}{I_1}} - 1\right)^2}$$

$$= \frac{(\sqrt{2x}+1)^2 - (\sqrt{2x}-1)^2}{(\sqrt{2x}+1)^2 + (\sqrt{2x}-1)^2}$$

$$= \frac{(2x+1+2\sqrt{2x}) - (2x+1-2\sqrt{2x})}{(2x+1+2\sqrt{2x}) + (2x+1-2\sqrt{2x})} = \frac{4\sqrt{2x}}{4x+2} = \frac{2\sqrt{2x}}{2x+1}$$

18. Three particles proton, α-particles & deuteron enters in a uniform magnetic field with same linear momentum. The correct ratio of magnetic forces and velocities on the particles are respectively

(1) 2 : 1 : 4 & 3 : 4 : 6 (2) 1 : 2 : 4 & 3 : 2 : 3

(3) 2 : 1 : 3 & 4 : 3 : 2 (4) 2 : 1 : 1 & 4 : 1 : 2

Ans. **(4)**

Sol. $F = q\,V\,B$

$= \frac{q(mv)B}{m}$

$F \alpha \frac{q}{m}$

$F_1 : F_2 : F_3 : = \frac{1}{1} : \frac{2}{4} : \frac{1}{2}$

$= 4 : 2 : 2$

$= 2 : 1 : 1$

$P = mv \Rightarrow V \alpha \frac{1}{m}$

$V_1 : V_2 : V_3 : = \frac{1}{1} : \frac{1}{4} : \frac{1}{2} = 4 : 1 : 2$

19. The pitch of a micrometer screw gauge is 1 mm and the circular scale has 100 divisions. When there is nothing between the jaws, the zero of the circular scale's 8 division below the main scale. When a wire is put between the jaws, the 1st division of main scale is visible and 72nd division of circular scale coincides with the main scale. The radius of wire is :

(1) 1.8 mm (2) 0.9 mm (3) 1.04 mm (4) 0.82 mm

Ans. **(4)**

Sol. $LC = \frac{\text{pitch}}{\text{number of division}} = \frac{1}{100}$

$\text{error} = 8 \times \frac{1}{100}$

$\text{Reading } (2R) = 1 + 72 \times \frac{1}{100} - 8 \times \frac{1}{100}$

$2R = 1.64; \quad R = 0.82 \text{ mm}$

20. Match the column

(a)	Planck's constant	(i)	$[M^1L^2A^{-1}T^{-3}]$
(b)	Kinetic Energy	(ii)	$[M^1L^2T^{-1}]$
(c)	Potential electric	(iii)	$[M^1L^1T^{-1}]$
(d)	Momentum	(iv)	$[M^1L^2T^{-2}]$

Ans. (a) – (ii), (b) – (iv), (c) – (i) (d) – (iii)