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JEE (MAIN) 2024
(Session-2)

MEMORY BASED QUESTIONS & SOLUTIONS

SHIFT-1

DATE & DAY: 04th April 2024 & Thursday

PAPER-1

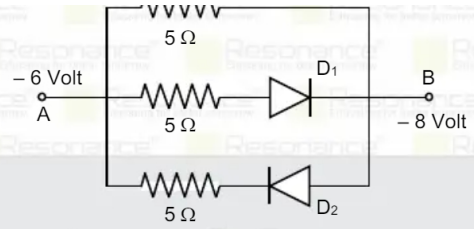
Duration: 3 Hrs.
Time: 09:00 - 12:00 IST

SUBJECT: PHYSICS

REGISTERED & CORPORATE OFFICE (CIN: U80302RJ2007PLC024029):
CG Tower, A-46 & 52, IPIA, Near City Mall, Jhalawar Road, Kota (Rajasthan) - 324005
0744-2777777 | 73400 10345 | contact@resonance.ac.in | www.resonance.ac.in | Follow Us: @ResonanceEdu | @Resonance_Edu

PART : PHYSICS

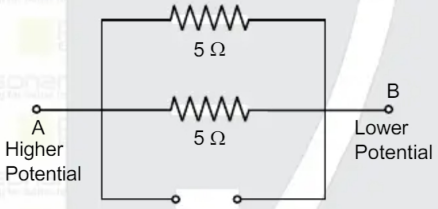
1. Find equivalent resistance between A and B.



(1) $\frac{5}{3}\Omega$ (2) $\frac{5}{2}\Omega$ (3) 5 Ω (4) 10 Ω

Ans. **(2)**

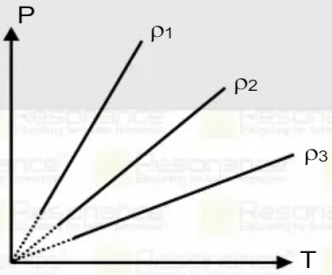
Sol. Diode D_1 will be in forward bias, so it will pass the current, and the Diode D_2 will be in reverse bias, so it will block the current



$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{5}$$

$$\Rightarrow R_{eq} = \frac{5}{2}\Omega$$

2. A gas is undergone through constant volume process. Pressure V/s temperature graph at three densities ρ_1, ρ_2 and ρ_3 are shown in the figure. Choose the correct option?



(1) $\rho_1 > \rho_2 > \rho_3$ (2) $\rho_1 < \rho_2 < \rho_3$ (3) $\rho_1 = \rho_2 + \rho_3$ (4) $\rho_1 = \rho_2 = \rho_3$

Ans. **(1)**

Sol. $PV = nRT$ whre $n = \frac{m}{M_0}$

$$P = \frac{m/vol}{M_0} RT \Rightarrow P = \frac{\rho R}{M_0} T$$

for constant volume process, $P \propto T$

so the graph will be straight line whose

$$\text{slope} = \frac{\rho R}{M_0} \Rightarrow \text{Slope} \propto \rho \ , \ \text{Slope} \uparrow \ \Rightarrow \rho \uparrow$$

So, $\rho_1 > \rho_2 > \rho_3$

3. $x = t^4 + 6t^3 + 2t$, where x is in meter and time in second. Find acceleration (m/s^2) at t = 5 sec.

(1) 500 (2) 480 (3) 360 (4) 120

Ans. **(2)**

Sol. $x = t^4 + 6t^3 + 2t$

$v = \frac{dx}{} = 4t^3 + 18t^2 + 2$

$\frac{dt}{}$

$a = \frac{dv}{dt} = 12t^2 + 36t$

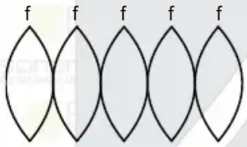
$t = 5 \Rightarrow a(5) = 12 \times 5 \times 5 + 36 \times 5$
$= 300 + 180 = 480\ m/s^2$

4. Five identical thin converging lenses are placed in contact with each other. If their equivalent power is 25 D, then the focal length of each lens will be

(1) 20 cm (2) 10 cm (3) 5 cm (4) 25 cm

Ans. **(1)**

Sol.



$P_{eq} = 25D = \frac{1}{f_{eq}}$

$f_{eq} = \frac{1}{25} m = \frac{100}{25} cm = 4cm$

$\frac{1}{f_{eq}} = \frac{1}{f} + \frac{1}{f} + \frac{1}{f} + \frac{1}{f} + \frac{1}{f}$

$\frac{1}{f_{eq}} = \frac{5}{f} \Rightarrow f = 20\ cm$

5. Find I_{rms} if $I = 6 + \sqrt{56}\ \sin(100\ \pi t + \frac{\pi}{3})$

(1) 6 (2) 8 (3) 10 (4) 12

Ans. **(2)**

Sol. $i = a + b \sin(\omega t + \theta)$

$I_{rms} = \sqrt{a^2 + \frac{b^2}{2}}$

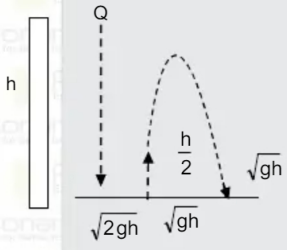
$= \sqrt{36 + \frac{56}{2}} = \sqrt{36 + 28} = 8$

6. A Ball is dropped from height h it rebounds to height h/2 find the loss of the energy and the velocity before it reaches ground again?

(1) 50%, $\sqrt{gh}$ (2) 50%, $\sqrt{2gh}$ (3) 40%, $\sqrt{gh}$ (4) 40%, $\sqrt{2gh}$

Ans. **(1)**

Sol.



$v_f = \sqrt{2g\left(\frac{h}{2}\right)} = \sqrt{gh}$

loss of energy $= E_i - E_f = \frac{1}{2} mv_i^2 - \frac{1}{2} mv_f^2$

$= \frac{1}{2} m(2gh) - \frac{1}{2} m(gh)$

$= \frac{1}{2} mgh = 50\%$ Loss

7. If w work is done on the soap bubble of radius R then find final radius of soap bubble.

(1) $\sqrt{\frac{T(2\pi R^2)+w}{8\pi T}}$ (2) $\sqrt{\frac{T(10\pi R^2)+w}{8\pi T}}$ (3) $\sqrt{\frac{T(8\pi R^2)+w}{8\pi T}}$ (4) $\sqrt{\frac{T(12\pi R^2)+w}{8\pi T}}$

Ans. **(3)**

Sol. $U_i + w = U_f$

$2(T.\ 4\pi R^2) + w = 2(4\pi R_f^2)\ T$

$R_f^2 = \frac{T8\pi R^2 + w}{8\pi T}$

$R_f = \sqrt{\frac{T(8\pi R^2)+w}{8\pi T}}$

8. Two forces F_1 & F_2 act on a body. One force is thrice of other. If resultant force is same as larger force then the angle between two forces is $\cos^{-1}\left(\frac{1}{n}\right)$, then $|n|$ = ?

(1) 2 (2) 4 (3) 6 (4) 9

Ans. **(3)**

Sol. $|\vec{F}_1| = F$

$|\vec{F}_2| = 3F$

$|\vec{F}_1 + \vec{F}_2| = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$

$3F = \sqrt{F^2 + 9F^2 + 6F^2\cos\theta}$

$6F^2\cos\theta = -F^2$

$\cos\theta = -\frac{1}{6}$

$\theta = \cos^{-1}\left(\frac{1}{-6}\right) = \cos^{-1}\left(\frac{1}{n}\right)$

$n = -6$

$|n| = 6$

9. A rod of length L, mass M is bent in the form of semicircle and now a point mass m is placed at its center. Find force experienced by the point mass.

Ans. $\frac{2GMm\pi}{L^2}$

Sol. $L = \pi R$

mass per unit length $\lambda = \frac{M}{L}$

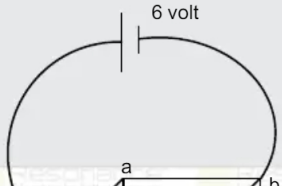
Eg at center $= \frac{2G\lambda}{R} = \frac{2GM\pi}{L^2}$

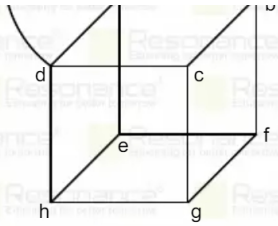
$F = mE_g$

$= m\left(\frac{2GM\pi}{L^2}\right)$

$F = \frac{2GMm\pi}{L^2}$

10. Each side of the cube has a resistance of 2Ω. Find the potential difference between the points e and f.

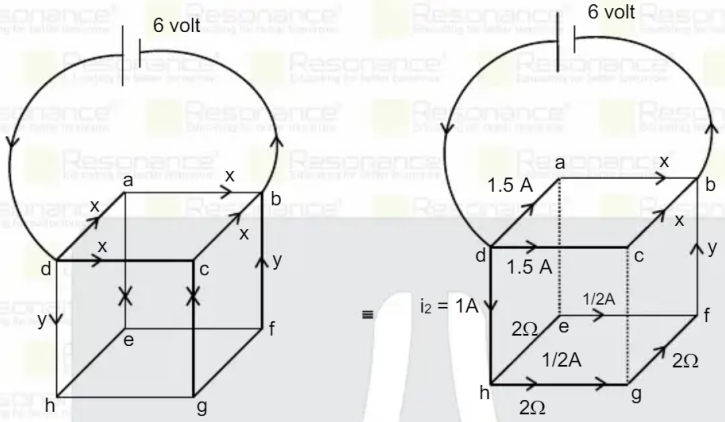




(1) 1 volt (2) 2 volt (3) 3 volt (4) 1.5 volt

Ans. (1)

Sol.



$i_2 = \frac{6}{6} = 1A \Rightarrow \Delta V_{ef} = i_{ef} R_{ef} = \left(\frac{1}{2}\right)(2) = 1$ volt

11. $\vec{E} = \hat{i} E_0 \sin(\omega t - kz)$

Find $\vec{B}$ = ? with direction

Ans. $\vec{B} = \frac{E_0}{C}(\hat{j})\sin(\omega t - kz)$

Sol. $\vec{k} = k(\hat{k})$

$B_0 = E_0/C$

$\hat{B} = \hat{k} \times \hat{E}$

$\hat{B} = \hat{k} \times \hat{i} = \hat{j}$

$\vec{B} = \vec{B}_0 \sin|kz - \omega t + \pi|$

$\vec{B} = \frac{E_0}{C}(\hat{j})\sin(\omega t - kz)$ Ans.

12. Elongation caused by a load of 3N in a wire is a when 2N force is applied elongation is b what load will be required for elongation 3a–2b.

(1) 4 (2) 5 (3) 9 (4) 10

Ans. (2)

Sol.

$F = kx \quad k = \frac{YA}{\ell} = \text{const}$

$3 = ka$

$2 = kb$

$F' = k(3a - 2b)$

$= k\left(3\times\frac{3}{k} - 2\times\frac{2}{b}\right)$

$F' = 5$

$Y = \frac{F/A}{\left(\frac{\Delta\ell}{\ell}\right)} = \frac{F\ell}{A\Delta\ell}$

$Y = \frac{3\ell}{Aa} = \frac{2(\ell)}{Ab} = \frac{F(\ell)}{A(3a-2b)}$

$a = \frac{3\ell}{AY}$

$b = \frac{2\ell}{AY}$

$3a - 2b = \frac{F'\ell}{AY}$

$3\left[\frac{3\ell}{AY}\right] - 2\left[\frac{2\ell}{AY}\right] = \frac{F'\ell}{AY}$

$(9-4)\left(\frac{\ell}{AY}\right) = \frac{F'\ell}{AY}$

$F' = 5$

13. An Infinite charge sheet of uniform surface charge density $\sigma = 2\lambda$ is situated in x-y plane and an infinite long wire of linear charge density λ is placed at (0,0,4) parallel to sheet. If net electric field at (0, 0, 2) is $\frac{x\lambda}{4\varepsilon_0}$, find value of x ?

Ans. $\frac{4\pi-1}{\pi}$

Sol. $\vec{E}_{wire} = \frac{2k\lambda}{r}\left(-\hat{k}\right) = \frac{\lambda}{4\pi\varepsilon_0}(-\hat{k}) \quad , \quad r = 2$

$\vec{E}_{sheet} = \frac{\sigma}{2\varepsilon_0}(\hat{k}) = \frac{2\lambda}{2\varepsilon_0}\hat{k} = \frac{\lambda}{\varepsilon_0}\hat{k}$

$\vec{E}_{net} = \frac{\lambda}{\varepsilon_0}\left(1-\frac{1}{4\pi}\right)\hat{k} = \frac{(4\pi-1)}{\pi}\frac{\lambda}{4\varepsilon_0}\hat{k}$

$x = \frac{4\pi-1}{\pi}$

14. Debroglie wavelength of electron moving in fourth orbit of hydrogen atom is $b\pi a$, where a is bohr radius. then find value of b?

(1) 4 (2) 8 (3) 6 (4) 9

Ans. **(2)**

Sol. $mvr = \frac{nh}{2\pi}, \quad r \propto n^2 \Rightarrow r = 4^2a = 16a$

$mv = \frac{4h}{2\pi}\times\frac{1}{16a}$

$\lambda = \frac{2\pi\times 16a\times h}{4h}$

$= 8\pi a = b\pi a$

$b = 8$

15. A change of 40° C on Celsius scale is equivalent to what change in temperature on Fahrenheit scale.
(1) 52° F (2) 72° F (3) 17° F (4) 50° F

Ans. **(2)**

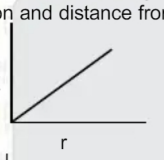
Sol. $\frac{C-0}{100}=\frac{F-32}{180}$

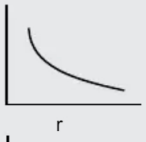
$\frac{\Delta C}{100}=\frac{\Delta F}{180}$

$\Delta F = 1.8\ \Delta C$

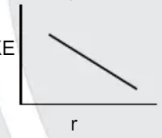
$\Delta F = 1.8\ (40°) = 72°$ Fahrenheit

16. An electron is revolving around an infinite charged wire. Which graph shows the relation between KE of electron and distance from wire :

(1) 

(2) 

(3) 

(4) 

Ans. **(3)**

Sol. $\frac{2\lambda k}{r}e=\frac{mv^2}{r}$

$KE=\frac{1}{2}mv^2=k\lambda e=$ (constant)

17. A mixture of blue light (λ_1 = 450 nm) and red light (λ_2 = 650 nm) is sent through each slit in YDSE. If n^{th} maxima of the blue coincides with some maxima of red first time, then what will be value of n.
(1) 10 (2) 13 (3) 9 (4) 15

Ans. **(2)**

Sol. n^{th} maxima of blue = m^{th} maxima of red

$n\beta_1 = m\beta_2$

$(n)\left(\frac{\lambda_1 D}{d}\right)=m\left(\frac{\lambda_2 D}{d}\right)$

$\frac{n}{m}=\frac{\lambda_2}{\lambda_1}=\frac{650\text{ nm}}{450\text{ nm}}=\frac{13}{9}$

n = 13

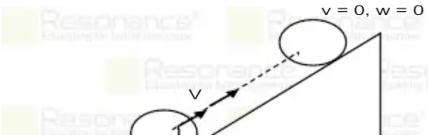
Their maxima will co-inside first time when n =13 and m = 9
so 13^{th} maxima of blue will match with 9^{th} maxima of red.

18. A solid sphere and a hollow sphere are rolled up (pure rolling) with same speed (v) on a rough incline plane. If the maximum heights attained by them are h_1 and h_2 respectively, then find the ratio of $\frac{h_1}{h_2}$.

(1) $\frac{5}{3}$ (2) $\frac{3}{5}$ (3) $\frac{10}{9}$ (4) $\frac{21}{25}$

Ans. **(4)**

Sol.



From energy conservatran : -

KE↓ = PE↑

$\frac{1}{2} mv^2 + \frac{1}{2} I_{cm} \omega^2 = mgh$

where $v = \omega R \Rightarrow \omega = \left(\frac{V}{R}\right)$

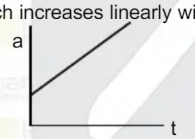
$\frac{1}{2} mv^2 \left(1+\frac{k^2}{R^2}\right) = mgh$

for solid sphere $\frac{k^2}{R^2} = \frac{2}{5}$

For hollow sphere $\frac{k^2}{R^2} = \frac{2}{3}$

$\frac{h_1}{h_2} = \frac{1+\frac{2}{5}}{1+\frac{2}{3}} = \frac{7}{5} \times \frac{3}{5} = \frac{21}{25}$

19. A wooden block is initially at rest on a smooth surface. Now a horizontal force is applied on a block which increases linearly with time the a – t graph for the block would be:

(1) 

(2) 

(3) 

(4) 

Ans. **(1)**

Sol. F = kt + c

ma = kt + c

$a = \frac{k}{m} t + c$ a-t graph will be a straight line

$\Rightarrow a \propto t$

20. $\theta_1 = 0^\circ c$

$\theta_2 = 100^\circ c$

$R_1 = 8$

$R_2 = 10$

$\theta = 400^\circ c$

R=?

Ans. **16.00**

Sol. $R = R_o(1+\alpha\Delta\theta)$

$10 = 8(1+\alpha \times 100)$

$\frac{10}{8} - 1 = \alpha \times 100 = \frac{2}{8}$

$\alpha = \frac{1}{400}$

$R = 8\left\{1+\frac{1}{400} \times 400\right\}$

R = 16

21. An electron is projected along the axis of a solenoid which carries constant current i. The trajectory of

electron shall be?
(1) circular path
(2) uniform motion along the axis
(3) uniform accelerated motion
(4) parabola

Ans. **(2)**

Sol. $\vec{V} \parallel \vec{B}$, $\Rightarrow Fm = 0$

$\Rightarrow a = 0$

$\Rightarrow v =$ constant

$\Rightarrow$ Uniform motion along axis of solenoid

22. In given equation $y = A \sin\omega t \cos\left(\frac{nx}{\lambda}\right)$. Find the dimensions of n.

(1) $M^1L^{-2}T^0$ (2) $M^0L^0T^0$ (3) $M^0L^1T^{-2}$ (4) $M^2L^1T^{-2}$

Ans. **(2)**

Sol. $\left[\frac{nx}{\lambda}\right] = m^0L^0T^0$

$[n] = \frac{\left[M^0L^0T^0\right][\lambda]}{[x]}$

$= \frac{\left[M^0L^0T^0\right][L^1]}{[L^1]}$

$= M^0L^0T^{0s}$