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Unleashing Potential

JEE MAIN 2023

APRIL ATTEMPT

PAPER-1 (B.Tech / B.E.)

QUESTIONS & SOLUTIONS

Reproduced from Memory Retention

13 APRIL, 2023

9:00 AM to 12:00 Noon

Duration : 3 Hours | Maximum Marks : 300

SUBJECT - PHYSICS

LEAGUE OF TOPPERS (Since 2020)

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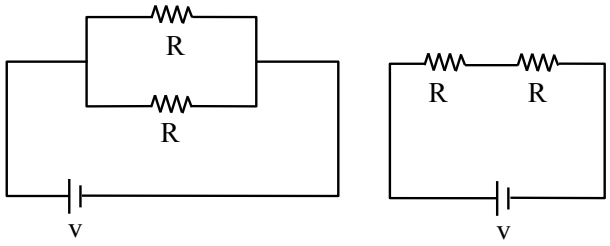
PHYSICS

1. Find the ratio of heat loss.



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

Ans. (2)

Sol. $P_1 = \frac{v^2}{\frac{R}{2}} = \frac{2v^2}{R}$ $P_2 = \frac{v^2}{2R}$

$$\frac{H_1}{H_2} = \frac{P_1 t}{P_2 t} = \frac{4}{1}$$

2. Two sphere of density ρ and $\frac{\rho}{3}$ of radius R and 4R respectively. Find the ratio of magnitude of gravitational field at the surface respectively.

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

Ans. (1)

Sol. $g_1 = \frac{G\rho\left(\frac{4}{3}\pi R^3\right)}{R^2}$

$$g_2 = \frac{G\frac{\rho}{3}\left(\frac{4}{3}\pi(4R)^3\right)}{(4R)^2}$$

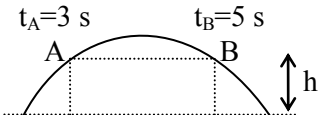
$$\frac{g_1}{g_2} = \frac{3}{4}$$

3. A projectile is projected at an angle 30° from horizontal, the height of projectile is same at t = 3 sec and t = 5 sec. Find the initial speed of the projectile ?

(1) 80 m/s (2) 100 m/s (3) 120 m/s (4) 140 m/s

Ans. **(1)**

Sol.



$T = t_A + t_B = 8$ seconds

$$\frac{2u\sin 30°}{g} = 8$$

$u = 80$ m/s

4. A person is firing 'n' bullets per second, the speed of each bullet is 250 m/s. The thrust force experienced by the person is 125 N, mass of each bullet 10 grams. Find n.

(1) 50 (2) 60 (3) 70 (4) 120

Ans. **(1)**

Sol. $\Delta P = mv$

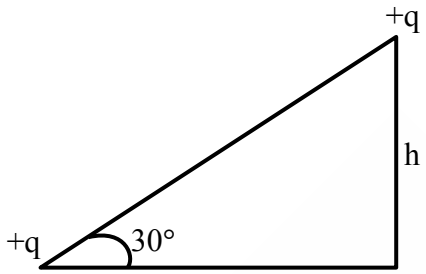
$$F_{Thrust} = \frac{\Delta p}{\Delta t} \text{ \{due to each bullet\}}$$

$$F_{net} = nF_{trust} = n(mv)$$

$$125 = (n)\times\frac{10}{1000}\times 250$$

$50 = n$

5. Two identical charge of mass 20 gm and charge 2 μC are on smooth inclined plane if they are in equilibrium find out h.



(1) 30 cm (2) 40 cm (3) 10 cm (4) 5 cm

Ans. (1)

Sol. $mg\sin\theta = \frac{kq^2 \sin^2\theta}{h^2}$

$$h = \sqrt{\frac{kq^2 \sin\theta}{mg}} = \sqrt{\frac{9\times10^9 \times 4\times10^{-12}}{2\times10^{-2}\times10\times2}}$$

$h = 30$ cm

6. $F = (2 + 3x)$ N

Find work done by force F in between x = 0 to x = 4m.

(1) 32 J (2) 72 J (3) 80 J (4) 60 J

Ans. (1)

Sol. $\mathbf{W} = \int_0^4 F dx$

$$\mathbf{W} = \int_0^4 (2+3x)dx$$

$$\mathbf{W} = \left[\left(2x + \frac{3x^2}{2}\right)\right]_0^4 = 32 \text{ J}$$

7. A coin is placed on disc at 1 cm from centre of disk which is moving with maximum Angular velocity 'ω' without slipping. If angular velocity of disc is $\frac{\omega}{2}$, then at what maximum distance coin should be placed without slipping.

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

Ans. (2)

Sol. $\mu mg = m\omega^2 r_1$ ….(i)

$\mu mg = m\left(\frac{\omega}{2}\right)^2 r_2$ …(ii)

From (i) and (ii)

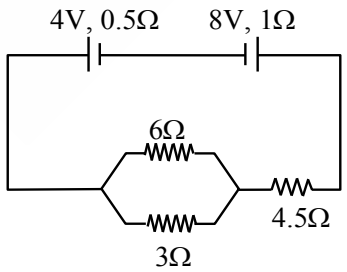
$m\omega^2 r_1 = m\left(\frac{\omega}{2}\right)^2 r_2$

$r_2 = 4r_1$

$r_2 = 4 \times 1$

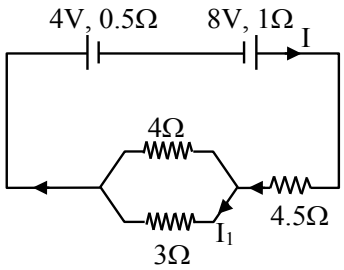
$r_2 = 4$ cm

8. If current passing through 3Ω resistor is $\frac{x}{3}$ amp. then find the value of x?



Ans. 1

Sol. Equivalent emf is $E_{eq} = 8V - 4V = 4V$



Equivalent resistance $R_{eq} = \frac{6\times3}{6+3} + 4.3 + 0.5 + 1 = 8\Omega$

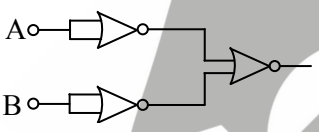
Current in circuit $I = \frac{E_{eq}}{R_{eq}} = \frac{4}{8} = 0.5\Omega$

Current passing through 3Ω resistor $I_1 = \frac{6}{3+6}\times I$

$I_1 = \frac{6}{9}\times\frac{1}{2} = \frac{1}{3}$amp

Value of x is 1.

9. Find out which logic gate is represented by following setup



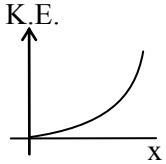
(1) AND (2) OR (3) NAND (4) NOR

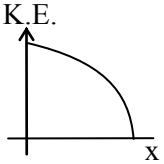
Ans. **(1)**

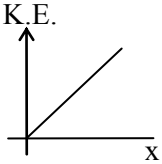
Sol. $\overline{\bar{A}+\bar{B}} = \overline{\bar{A}}.\overline{\bar{B}} = A.B$

AND GATE

10. A particle under SHM is moving from mean position to extreme position. Plot graph of KE v/s position x.

(1) 

(2) 

(3) 

(4) None of these

Ans. **(2)**

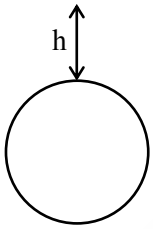
Sol. K.E. $= \frac{1}{2}mv^2$

K.E. $= \frac{1}{2}m\omega^2 (A^2 - x^2)$

11. If signals from an antenna can be received upto 4 km along the ground and it is found that height of antenna is $x \times 10^{-2}$ m. Find the value of x. (Assume radius of Earth to be 6400 km)

Ans. **125**

Sol. $d = \sqrt{2Rh}$



$4000 = \sqrt{2 \times 6400 \times 10^3 \times h}$

$h = 1.25$ m

$h = 125 \times 10^{-2}$ m

12. The equation of a travelling wave is given as $g = A \sin 20 (160t - 0.5x + \phi)$. Find the velocity of wave is (Km/hr).

Ans. **1125**

Sol. $\nu = \frac{\omega}{K} = \frac{160}{0.5} = 320 \text{m/s}$

$= 320 \times \frac{18}{5} = 1125 \text{ Km/hr}$

13. When a rod of length ℓ is stretched by 100 N force its length becomes ℓ_1 and when it is stretched by 120 N force it's length becomes ℓ_2. If $\frac{\ell_1}{\ell_2}$ is $\frac{10}{11}$, then original length (ℓ) of rod is $\frac{\ell_1}{x}$. Find value of x?

Ans. (x = 2)

Sol.

$$\Delta\ell = \frac{F\ell}{Ay}$$

$$\ell_1 - \ell = \frac{100L}{Ay} \qquad \ldots(i)$$

When stretched by 120 N

$$\ell_2 - \ell = \frac{120x}{Ay} \qquad \ldots(ii)$$

$$\frac{(i)}{(ii)} \qquad \frac{\ell_1 - \ell}{\ell_2 - \ell} = \frac{10}{12} = \frac{5}{6}$$

$$6\ell_1 - 6\ell = 5\ell_2 - 5\ell$$

$$\frac{\ell_1}{\ell_2} = \frac{10}{11} \Rightarrow \ell_2 = \frac{11}{10}\ell_1$$

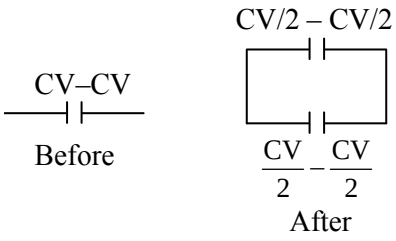
$$6\ell_1 - \left(\frac{11}{10}\ell_1\right) = \ell$$

$$\frac{5}{10}\ell_1 = \ell \Rightarrow \ell = \frac{\ell_1}{2}$$

14. A charged capacitor has potential energy U_1. An identical uncharged capacitor is connected across it. The potential energy stored in the combination now is U_2. Find U_1/U_2?

Ans. 2

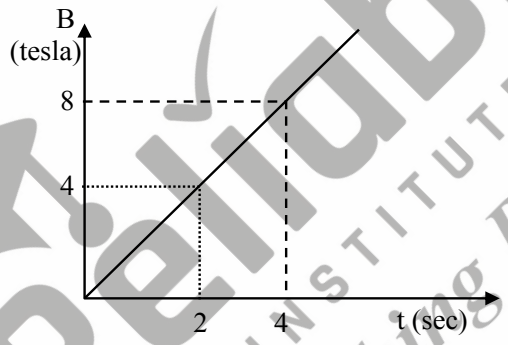
Sol. $U_1 = \frac{1}{2}CV^2$



$$U_2 = \frac{1}{2}\frac{CV^2}{4} \times 2 = \frac{CV^2}{4}$$

$$\frac{U_1}{U_2} = 2$$

15. Area of loop is 4 m^2 and magnetic field which is passing through is varying according to graph. Find out induced emf?



Ans. **8**

Sol. $\phi = BA$ $\{B(t) = 2t\}$

$\phi(t) = 2t \times 4 = 8t$

$\left(\frac{d\phi}{dt}\right) = e = 8$ volt

16. Half life of nuclei A is equal to average life of nuclei of B, then correct relationship between decay constants

(1) $\lambda_A = 2\lambda_B$ (2) $2\lambda_A = \lambda_B$ (3) $\lambda_A \ell n2 = \lambda_B$ (4) $\lambda_A = \lambda_B \ell n2$

Ans. **(4)**

Sol. $\frac{\ell n2}{\lambda_A} = \frac{1}{\lambda_B} \Rightarrow \ell n2\ \lambda_B = \lambda_A$

17. If current sensitivity is increased by 25 % on increasing number of turns by N. Then voltage sensitivity increases by : (consider resistance constant)

(1) 25% (2) 0 % (3) –25 % (4) 50 %

Ans. (1)

Sol. C.S $\propto$ N

$R \rightarrow$ constant

$\Rightarrow$ V.S $\propto N^1$

18. When light of wavelength λ is incident on a metallic surface its stopping potential become V_0. If wavelength of light becomes 2λ its stopping potential becomes $\frac{V_0}{4}$. Then find thresold wavelength.

(1) $\frac{3\lambda}{2}$ **(2)** $\frac{\lambda}{2}$ **(3)** 3λ **(4)** $\frac{5\lambda}{4}$

Ans. **(3)**

Sol. $eV_s = \frac{hc}{\lambda} - \phi$

$eV_0 = \frac{hc}{\lambda} - \phi$ **....(i)**

$\frac{eV_0}{4} = \frac{hc}{2\lambda} - \phi$ **....(ii)**

$\frac{(i)}{(ii)}$ $\quad 4 = \frac{\frac{hc}{\lambda} - \phi}{\frac{hc}{2\lambda} - \phi}$

$\frac{2hc}{\lambda} - 4\phi = \frac{hc}{\lambda} - \phi$

$\frac{hc}{\lambda} = 3\phi \Rightarrow \phi = \frac{hc}{3\lambda} \;=\; \frac{hc}{\lambda_{Th}} \Rightarrow \lambda_{Th} = 3\lambda$

19. An uniform solid sphere is rotating with angular velocity 10 rad/s. Moment of inertia about tangent is $(x \times 10^{-2}) \times$ angular momentum about diameter. Find out x ?

Ans. **35**

Sol. $\frac{7}{2}mR^2 = x \times 10^{-2} \times \frac{2}{5}mR^2 \times 10$

$7 = x \times 10^{-2} \times 20$

$x = \frac{70}{2} = 35$

20. 1 kg of water at 100°C is converted to 1 kg of steam at 100°C. Change in volume is 10^{-3} m^3. Find change in potential energy.

(Given $P_0 = 10^5$ N/m^2)

$P_0 \rightarrow$ Atmospheric pressure

$L_v = 2257$ J/kg

Ans. 2157 J

Sol. $\Delta Q = mL_V = 1 \times 2257$

$\Delta Q = 2257$ J

$W = 10^5 \times 10^{-3} = 100$ J

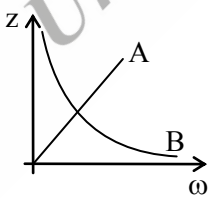
$\Delta Q = W + \Delta U$

$\Delta U = \Delta Q - W$

$\Delta U = 2257 - 100$

$\Delta U = 2157$ J

21. The variation of impedance (z) with angular frequency (ω) for two electrical elements is shown in graph given. If x_L, x_C and R are inductive reactance, capacitive reactance and resistance respectively, then



(1) A is resistor, B is inductor

(2) A is inductor, B is capacitor

(3) A is inductor, B is resistor

(4) A is capacitor, B is inductor

Ans. **(2)**

Sol. $X_L = \omega L$

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

22. If light is passed through rarer to denser medium of critical angle 45°, then the speed of wave in denser medium is :

(1) 3×10^8 m/s (2) $\frac{3\times10^8}{\sqrt{2}}$ m/s (3) $3\sqrt{2}\times 10^8$ m/s (1) 1.5×10^8 m/s

Ans. (2)

Sol. $\sin\theta_C = \frac{\mu_r}{\mu_d} = \frac{1}{\mu} = \frac{1}{\sqrt{2}}$

$\mu = \sqrt{2}$

$v = \frac{C}{\mu} = \frac{3\times10^8}{\sqrt{2}} m/s$

23. An equiconvex lens of radius of curvature 20 cm and refractive index 1.5 has power P_1 in air. If this lens is immersed in liquid of refractive index = $\frac{4}{3}$, it has power P_2 find out $\frac{P_1}{P_2}$

Ans. 4

Sol. $P_1 = \left(\frac{3}{2}-1\right)\left(\frac{2}{R}\right)$

$P_2 = \left(\frac{3/2}{4/3}-1\right)\left(\frac{2}{R}\right)$

$\frac{P_1}{P_2} = \frac{\left(\frac{1}{2}\right)}{\left(\frac{1}{8}\right)} = 4$

24. Temperature scale boiling point = 65ºC. Melting point = 15ºC. Find 95ºx in Fahrenheit.

Ans. 320

Sol. $\frac{x-x_m}{x_B-x_m} = \frac{F-32}{180}$

$\frac{95-15}{65-15} = \frac{F-32}{180}$

$F = 320$

25. In EMW wave amplitude of electric field is 20 v/m. Find out energy in 4×10^{-4} m^3 volume.

(1) 4.42×10^{-13} J/m^3 (2) 8.85×10^{-13} J/m^3

(3) 15×10^{-13} J (4) 1.52×10^{-13} J/m^3

Ans. **(2)**

Sol. $U = 2 \times \frac{1}{2}\varepsilon_0 \left(\frac{E_0}{\sqrt{2}}\right)^2 \times \text{volume}$

$= \frac{\varepsilon_0 E_0^2}{2} \times V$

$= \frac{8.85 \times 10^{-12} \times 400}{2} \times 5 \times 10^{-4} = 8.85 \times 10^{-13}$ J/m^3

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SATYAM CHAKRAVORTY

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