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JEE MAIN (APRIL) 2023 (10-04-2023-FN)

Memory Based Question Paper

PHYSICS

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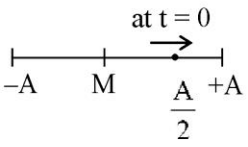
PHYSICS

1. At t = 0 particle is at $\frac{A}{2}$ from mean position and moving in +ve x-direction. At general time its equation is A sin ($\omega t + \phi$). Value of ϕ is?

(1) $\frac{\pi}{3}$ (2) $\frac{\pi}{6}$ (3) $\frac{5\pi}{6}$ (4) $\frac{\pi}{2}$

Ans. (2)

Sol.



$x = A \sin(\omega t + \phi)$

at t = 0 $\quad x = \frac{A}{2}$

$\frac{A}{2} = A\sin[\omega(0) + \phi]$

$\sin\phi = \frac{1}{2}$

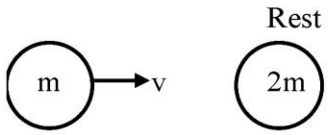
$\phi = \frac{\pi}{6}$

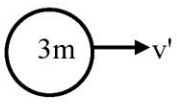
2. A ball of mass 'm' moving with velocity 'v' collides and sticks to the body of mass '2m', initially at rest. Find the final velocity of combined mass.

(1) $\frac{v}{3}$ (2) $\frac{v}{4}$ (3) $\frac{v}{8}$ (4) $\frac{v}{10}$

Ans. (1)

Sol.





$mv = 3m\,v'$

$\boxed{\frac{v}{3}\text{m/s} = v'}$

3. $y = A \sin (6t + 0.003 x)$. Find speed of wave 'x' is in centimeter :

(1) 10 m/s (2) 20 m/s (3) 30 m/s (4) 40 m/s

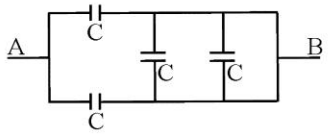
Ans. **(2)**

Sol. $\omega = 6$ rad/sec

$k = 0.003$ rad/cm

$$v = \frac{\omega}{k} = \frac{6}{0.3} = 20 \text{ m/s}$$

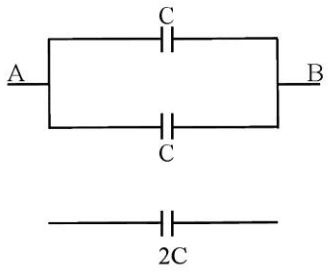
4. Find equivalent capacitance between A and B



(1) 4C (2) 2C (3) C/2 (4) 5C/3

Ans. **(2)**

Sol. Circuit is reduced to



5. The de-Broglie wavelength of gas particle is λ for temperature 300 k, find the de-Broglie wavelength when temperature is 600 k?

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

Ans. **(1)**

Sol. $\lambda = \frac{h}{\sqrt{2mk}}$ $\left(\because k = \frac{3}{2}kT\right)$

$$\lambda \propto \frac{h}{\sqrt{T}}$$

$$\lambda_1\sqrt{T_1} = \lambda_2\sqrt{T_2}$$

$$\lambda\sqrt{\frac{300}{600}} = \lambda'$$

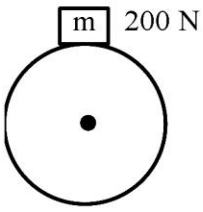
$$\frac{\lambda}{\sqrt{2}} = \lambda' \text{(new wavelength)}$$

6. If the weight on the surface of a planet of mass, radius R is 200 N. Find weight at depth R/2 from surface of planet.

(1) 200 N (2) 300 N (3) 100 N (4) 400 N

Ans. (3)

Sol.



$$200 = \frac{GM}{R^2}m$$

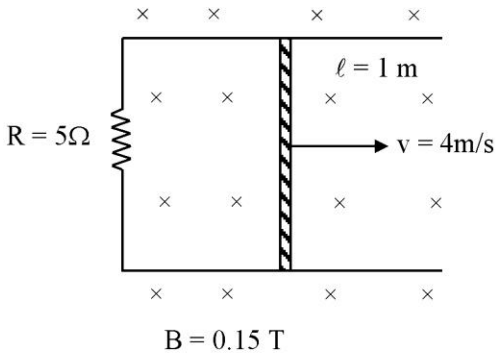
$$M = \frac{4}{3}\pi R^3 \rho$$

$$200 = \frac{G4}{3}\pi \rho R m$$

weight $\propto R$

Hence at $\frac{R}{2}$ from centre weight = 100 N

7. Force acting on rod is :



(1) 0.18 N (2) 0.018 N (3) 1.8 N (4) 18 N

Sol. $F = i\,\ell\,B$

$$= \left(\frac{\varepsilon}{R}\right)\ell B = \left(\frac{vB\ell}{R}\right)\ell B = \frac{vB^2\ell^2}{R} = \frac{4}{5}\times\left(\frac{15}{100}\right)^2 \times 1^2$$

$$= \frac{4}{5}\times\frac{225}{10^4}$$

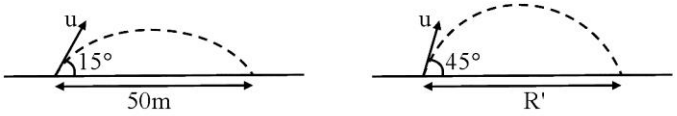
$$= \frac{180}{10^4} = 0.018\text{N}$$

8. If a projectile is thrown with speed u at an angle 15°, the range obtained is 50 m. What will be range obtained if the same particle is thrown at an angle of 45° with same speed u.

(1) 50 m (2) 100 m (3) 200 m (4) 150 m

Ans. **(2)**

Sol.



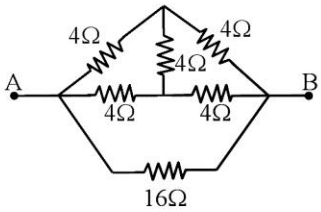
$$50 = \frac{u^2 \sin 30}{g}$$

$$R_1 = \frac{u^2 \sin 90}{g}$$

$$\frac{50}{R_1} = \frac{1}{2}$$

R' = 100 m

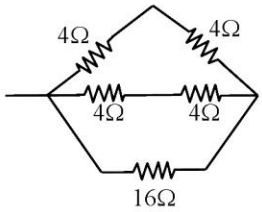
9. Find R_{eq} across A and B



(1) $\frac{16}{5}\Omega$ (2) $\frac{18}{5}\Omega$ (3) 4 Ω (4) 6 Ω

Ans. **(1)**

Sol. The Circuit can be required to



$$\Rightarrow \quad R_{eq} = \frac{16 \times 4}{16 + 4} = \frac{16}{5}\Omega$$

10. If frequency of electromagnetic wave is f then frequency of energy density of electromagnetic wave is

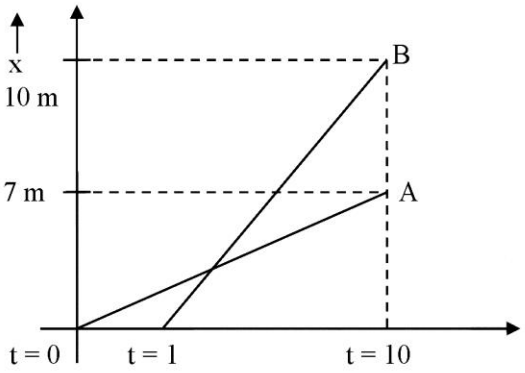
(1) 1.2 f (2) f (3) $\frac{f}{2}$ (4) 2f

Ans. (4)

Sol. $E = E_0 \sin(\omega t - kx)$

$$\frac{du}{dv} = \varepsilon_0 E_0^2 \sin^2(\omega t - kx)$$

11.



A. A takes less time to reach home.

B. B takes less time to reach home.

C. A is faster.

D. B is faster.

E. A's home is farther than B.

Correct statements are :

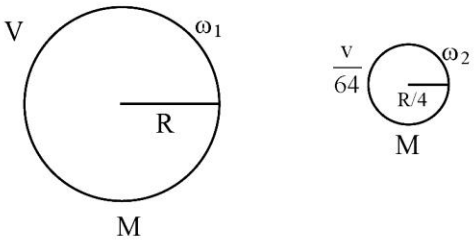
(1) B, C (2) B, D (3) A, C (4) A, D, E

Ans. (2)

12. The volume of Earth shrinks to 1/64 of its initial value, mass staying the same then ratio of initial and final value of time periods of rotation of Earth about its axis is t_1/x where $t_1 = 24$. Find x :

Ans. 16

Sol. From conservation of angular momentum



$$MR^2\omega_1 = M\left(\frac{R}{4}\right)^2\omega_2$$

$$\Rightarrow \quad MR^2\omega_1 = \frac{MR^2}{16}\omega_2$$

$$\Rightarrow \quad \frac{\omega_1}{\omega_2} = \frac{1}{16} \quad \Rightarrow \quad \frac{T_2}{T_1} = \frac{1}{16} \Rightarrow \frac{T_1}{T_2} = \frac{16}{1} = \frac{t_1}{x}$$

$$\therefore \quad t_1 = 24 \quad \Rightarrow \quad \frac{16}{1} = \frac{24}{t_2} \quad \Rightarrow \quad x = 16$$

13. **Statement 1:** Current sensitivity doubles when number of turns is doubled

Statement 2: Both voltage sensitivity and current sensitivity increases equally an increasing no of turns.

(1) Statement-1 and statement-1 both are correct.

(2) Statement-1 and statement-1 both are wrong.

(3) Statement-1 is wrong and statement-2 is correct.

(4) Statement-1 is correct and statement-2 is wrong.

Ans. **(4)**

Sol. **BINA** = $C\phi \rightarrow \frac{\phi}{I} = \frac{BNA}{C}$: Current sensitivity voltage sensitivity= $\frac{\phi}{V} = \frac{BNA}{CR}$

as N $\uparrow \Rightarrow$ R$\uparrow \Rightarrow$ V.S Remains same.

14. Two gases A and B having same initial state (P, V, n, T). Now gas 'A' is compressed to $\frac{V}{8}$ by isothermal process and other gas B is compressed to $\frac{V}{8}$ by adiabatic process. Find ratio of Final pressure of gas A and B (Both gases are monoatomic)

(1) 1/4 (2) 1/8 (3) 1/12 (4) 1/64

Ans. **(1)**

Sol. Isothermal process equation

$PV = P_A (V/8)$

$8P = P_A$

Adiabatic process equation

$PV^{5/3} = P_B (V/8)^{5/3}$

$32P = 8^{5/3} P = P_B$

$$\frac{P_A}{P_B} = \frac{8P}{32P} = \frac{1}{4}$$

15. Mirror is moved towards the object by 4 cm, then find how much distance image will shift

(1) 8 cm (2) 4 cm (3) 12 cm (4) 16 cm

Ans. **(1)**

Sol. Image distance shift = $2 \times 4 = 8$ cm

16. The magnetic field intensity inside current carrying solenoid is $H = 2.4 \times 10^3$ A/m. If Length and no. of turns of solenoid is 15 cm and 60 turns. Find current flowing in solenoid.

(1) 4 A (2) 6 A (3) 0.6 A (4) 60 A

Ans. **(2)**

Sol. $B = \mu_0 \frac{N}{L} i$

$$\frac{B}{\mu_0} = \frac{N}{L} i$$

$$H = \frac{N}{L} i$$

$$2.4 \times 10^3 = \frac{60}{15 \times 10^{-2}} i$$

$6 \text{ A} = i$

17. **Statement 1 :** Maximum power is dissipated when resonance occurs.

Statement 2 : Maximum power is dissipated containing pure resistance due to zero phase difference.

(1) Statement I and II both are correct and II is the correct explanation of I.

(2) Statement I and II both are correct and II is not the correct explanation of I.

(3) Both statement I and II are wrong.

(4) Statement I is true, II is false.

Ans. **(1)**

18. Base band signal of amplitude 3V is modulate with carrier wave of amplitude 15 V Ratio of maximum to minimum, amplitude in amplitude modulate wave

(1) $\frac{3}{4}$ (2) $\frac{4}{5}$ (3) $\frac{3}{2}$ (4) $\frac{3}{7}$

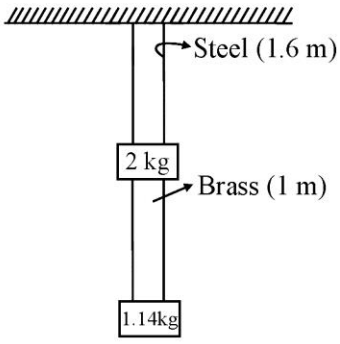
Ans. **(3)**

Sol. $A_{max} = A_m + A_c = 18$

$A_{min} = A_c - A_m = 12$

$$\frac{A_{max}}{A_{min}} = \frac{3}{2}$$

19. Radius of both wires is 0.2 cm, elongation in steel wire is $x \times 10^{-6}$ m and Young's modulus of steel is 2×10^{11} N/m^2. Find x.

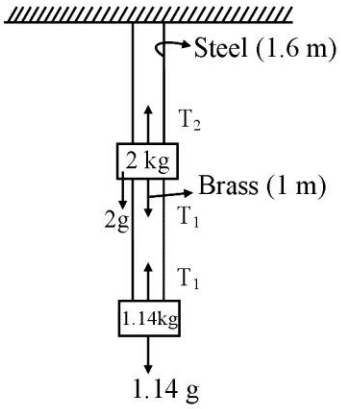


Ans. 20

Sol. Tension is steel wire $T_2 = 2g + T_1$

$T_2 = 20 + 11.4$

$= 31.4$ N



Elongation in steel wire $\Delta L = \frac{T_2 L}{Ay}$

$$\Delta L = \frac{31.4 \times 1.6}{\pi(0.2 \times 10^{-2})^2 \times 2 \times 10^{11}}$$

$$\Delta L = \frac{16}{2 \times 4 \times 10^{-6} \times 10^{11}}$$

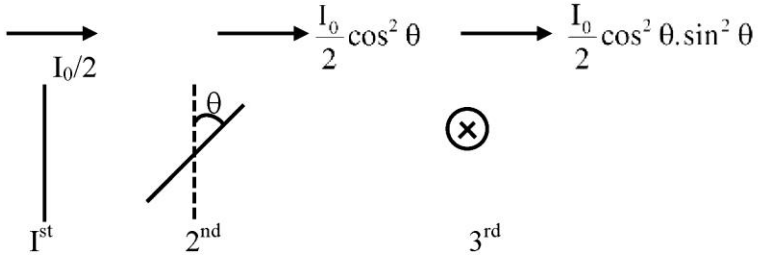
$= 2 \times 10^{-5}$ m

$= 20 \times 10^{-6}$ m

20. A light of intensity 32 w/m^2 enters in a system of 3 polaroid's. Angle between 3rd and 1st polaroid is 90°. Light ray passes the system with intensity 3 w/m^2. So angle between 1st and 2nd polaroid is.

Ans. 30°

Sol. $I_0 = 32$ w/m^2



$$I_{net} = 3 = \frac{32}{2}\cos^2\theta.\ \sin^2\theta$$

$$\frac{3}{4} = 4\sin^2\theta.\cos^2\theta = (\sin 2\theta)^2$$

$\frac{\sqrt{3}}{2} = \sin(2\theta)$

Hence, $\theta = 30°$

21. For an object radiating heat at 300 K, the wavelength corresponding to maximum intensity is λ. If the temperature of body is increased by 300 K, the new wavelength corresponding to maximum intensity will be

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

Ans. **(1)**

Sol. $\lambda = \frac{b}{T}$

$T' \rightarrow 2T$

$\lambda' \rightarrow \frac{\lambda}{2}$

22. A quantity ℓ is given as $\ell = \frac{a^2b^3}{c\sqrt{d}}$. Given error in the calculation of a, b, c and d are 1%, 2%, 3% and 4% respectively find the maximum percentage error in quantity ℓ.

Ans. **13**

Sol. $\frac{\Delta L}{L} = 2\left|\frac{\Delta a}{a}\right| + 3\left|\frac{\Delta b}{b}\right| + \left|\frac{\Delta c}{c}\right| + \frac{1}{2}\left|\frac{\Delta d}{d}\right|$

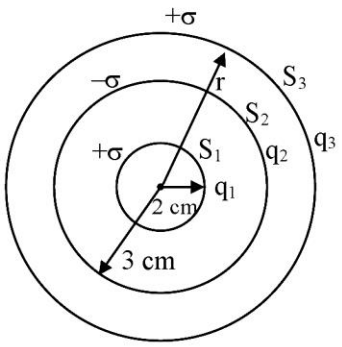
$= \left(2\times1 + 3\times2 + 3 + \frac{1}{2}\times4\right)\%$

$= 13\%$

23. Three concentric spheres have charge densities σ, – σ, σ respectively. Radius of inner two spheres are 2 cm and 3 cm. If potential of inner and outer spherical shell are same. Then radius of outer sphere is _____ cm :

Ans. **5**

Sol.



$$\frac{kq_1}{2}+\frac{kq_2}{3}+\frac{kq_3}{r}$$

$$=\frac{k(q_1+q_2+q_3)}{r}$$

$$\sigma\times 4\pi\times 2-\sigma\times 4\pi\times 3$$

$$=\frac{\sigma[4\pi\times 2^2-4\pi\times 3^2]}{r}$$

$$\therefore \quad r=5 \text{ cm}$$

24. The angular momentum of e^- in H-atom in first orbit is L. Find the change in angular momentum if e^- is in second orbit of H-atom.

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

Ans. (2)

Sol. $mur=\frac{nh}{2\pi}$

$L \propto n$

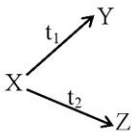
for $n = R$, $L' = 2L$

$\Delta L = L'-L = 2L - L = L$

25. A radioactive sample of nuclei X decays simultaneously into two different nuclei Y and Z with half-life of the decays processes as 12 minutes and 3 minutes respectively. Find the time after which 50% of nuclei of the sample X has decayed.

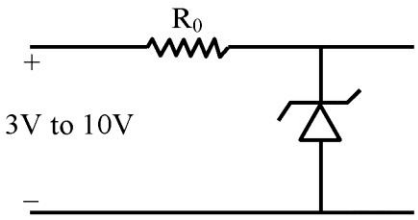
Ans. 2.4 min

Sol.



$$t_{1/2} = \frac{t_1 t_2}{t_1 + t_2} = \frac{3 \times 12}{15} = 2.4 \text{ min}$$

26. Zener breakdown voltage is 8 volt. If power of Zener Diode is 1.6 watt find R_0.



Ans. 10 Ω

Sol. $P_z = V_z I_z$

$1.6 = 8.I_z$

$I_z = 0.2$ A

$10 - 0.2R - 8 = 0$

$0.2R = 2$

$R = 10\ \Omega$