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JEE (MAIN) 2024

MEMORY BASED QUESTIONS & SOLUTIONS

SHIFT-2

DATE & DAY: 27th January 2024 & Saturday

PAPER-1

Duration: 3 Hrs.
Time: 03:00 PM - 06:00 PM

SUBJECT: PHYSICS

REGISTERED & CORPORATE OFFICE (CIN: U80302RJ2007PLC024029):
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PART : PHYSICS

1. Find maximum wavelength in paschen series for hydrogen.

(1) 1.54 μm (2) 1.87 μm (3) 1.23 μm (4) 2.36 μm

Ans. **(2)**

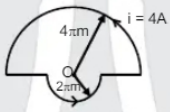
Sol. n = 4 to n = 3

$$\frac{hc}{\lambda} = E_4 - E_3 = 13.6\left(\frac{1}{9} - \frac{1}{16}\right) eV$$

$\Rightarrow \frac{1.2375\times10}{\lambda} = \frac{13.6\times7}{144}$

$\Rightarrow \lambda = 1.87\ \mu m$

2. Find B_{net} at point O



(1) 1×10^{-7} Tesla (2) 4×10^{-7} Tesla (3) 2×10^{-7} Tesla (4) 3×10^{-7} Tesla

Ans. **(4)**

Sol. $B_{net} = \frac{\mu_0 I}{4\pi}\left(\frac{1}{2}+\frac{1}{4}\right) T \odot$

$B_{net} = \frac{4\pi\times10^{-7}\times4}{4\pi}\left(\frac{3}{4}\right) T \odot$

$B_{net} = 3 \times 10^{-7}\ T \odot$

3. **Assertion :** Angular velocity of moon revolving about earth is more than angular velocity of earth revolving around Sun.
Reason : Time taken by moon to revolve around earth is less than time taken by earth to revolve around sun.
(1) Both Assertion (A) and Reason (R) are the true and Reason (R) is a correct explanation of Assertion (A).
(2) Both Assertion (A) and Reason (R) are the true but Reason (R) is not a correct explanation of Assertion (A).
(3) Assertion (A) is true and Reason (R) is false.
(4) Assertion (A) is false and Reason (R) is true.

Ans. **(1)**

Sol. $T = \frac{2\pi}{\omega}$

4. If the work function of a metal is 6.63 eV. The find the threshold frequency of metal
(1) 1.9×10^{15} Hz (2) 1.6×10^{15} Hz (3) 2×10^{16} Hz (4) 1.2×10^{15} Hz

Ans. **(2)**

Sol. $\phi = 6.63$ eV

$h\upsilon_{th} = \phi$

$\upsilon_{th} = \frac{6.63\times1.6\times10^{-19}}{6.63\times10^{-34}}$ Hz

$\upsilon_{th} = 1.6 \times 10^{15}$ Hz

5. Statement 1 : Positive zero error is added in measured value.

Statement 2 : Defect may occur during manufacturing of measuring instruments.

(1) Statement 1 is true while statement 2 is false

(2) Statement 1 is false while statement 2 is true

(3) Both statements are true

(4) Both statements are false

Ans. **(2)**

Sol. Theory Based

6. If $\left(P-\frac{a}{V^2}\right)(V - b) = nRT$ where P, V, R & T are pressure, volume, universal gas constant and temperature, then $\frac{a}{b^2}$ has same dimensional formula as that of

(1) R (2) PV (3) RT (4) P

Ans. **(4)**

Sol. $\left[\frac{a}{v^2}\right] = [P]$

$[b^2] = [v^2]$

$\left[\frac{a}{b^2}\right] = [P]$

7. Find total kinetic energy of 1 mole of oxygen gas at 27°C (Take R = $\frac{25}{3}$ J/mole–K)

(1) 6250 J (2) 3125 J (3) 12500 J (4) 625 J

Ans. **(1)**

Sol. K.E. = $\frac{f}{2}nRT$

K.E. = $\frac{5}{2}(1)\left(\frac{25}{3}\right)(300)$

K.E. = 6250 J

8. Kinetic friction and static friction depend.
(1) Only on surface area
(2) Only on material
(3) Both material and surface
(4) None of these

Ans. **(2)**

Sol. Theory Based

9. A particle looses 1/3rd of its velocity when it strikes a block and covers a distance of 4cm inside the fixed block. Then find D if D is the distance covered by the particle inside block before it stops.

(1) $\frac{63}{5}$cm (2) $\frac{36}{5}$cm (3) $\frac{54}{5}$cm (4) $\frac{21}{5}$cm

Ans. **(2)**

Sol. $4\frac{v^2}{9} - v^2 = 2a \times 4$

$0 - v^2 = 2aD$

$\frac{5}{9} = \frac{4}{D}$

$D = \frac{36}{5}$ cm.

10. In a series LCR circuit where coefficient of self induction L = $\frac{100}{\pi}$mH, capacitance C = $\frac{10^{-3}}{\pi}$F and resistance R = 10 Ω. Find power factor for given circuit. (approximately)

(1) 1 (2) 0.5 (3) 0.4 (4) 0.6

Ans. **(1)**

Sol. $X_L = 2\pi f L = 2\pi \times 50 \times \frac{100}{\pi} \times 10^{-3} = 10\ \Omega$

$X_C = \frac{1}{2\pi fc} = \frac{\pi}{100\pi \times 10^{-3}} = 10\Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(10)^2 + (10-10)^2}$

$Z = 10\ \Omega$

$\cos\phi = \frac{R}{z} = \frac{10}{10}$

$\cos\phi = 1$

11. There in a prism of apex angle of 'A'. Its refractive index is equal to cot A/2 then find minimum angle of deviation?

(1) $\frac{\pi}{2} - A$ (2) $\pi - 2A$ (3) $\pi + A$ (4) $\frac{\pi}{2} + A$

Ans. **(2)**

Sol. $\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$, $\cot\frac{A}{2} = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\cos\frac{A}{2} = \sin\left(\frac{A+\delta_{min}}{2}\right)$

$$\frac{A}{2}+\frac{A+\delta_{min}}{2}=\frac{\pi}{2}$$

$$\Rightarrow \delta_{min} = \pi - 2A$$

12. In an adiabatic process on a gas $P \propto T^3$ find γ of the gas.

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

Ans. **(1)**

Sol. $\frac{nRT}{V} \propto T^3$

T^2V = constant

$TV^{\frac{1}{2}}$ = constant

compare with $TV^{\gamma-1}$ = constant

$\gamma - 1 = \frac{1}{2}$

$\gamma = 3/2$

13. A ring and solid sphere of same mass and radius rolls down a same inclined plane. Find ratio of their kinetic energies on reaching bottom starting from rest from the top.

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

Ans. **(2)**

Sol. K.E. = mgh

So ratio = 1 : 1

14. In a Galvanometer deflection is 60° when flowing electric current is 200 μA through Galvanometer then, find electric current at $\frac{\pi}{10}$ rad deflection.

(1) 50 μA (2) 70 μA (3) 60 μA (4) 80 μA

Ans. **(3)**

Sol. $\because \quad I \propto \theta$

$\therefore \quad \frac{I_1}{I_2}=\frac{\theta_1}{\theta_2}$

$\Rightarrow \quad \frac{200\mu A}{I_1}=\frac{\pi/3}{\pi/10}=\frac{10}{3}$

$\Rightarrow \quad I_2 = 60\ \mu A$

15. Find radiation pressure for perfectly absorbing surface if intensity of radiation = 6×10^6 W /m^2 C = 3×10^6 m/s. refraction index of whole medium in which this event occurring is $\mu = 3$

(1) 0.12 N/m^2 (2) 0.18 N/m^2 (3) 0.24 N/m^2 (4) 0.06 N/m^2

Ans. **(4)**

Sol. $P = \frac{\Delta P_{\text{momentum}}}{\Delta t \times A}$ = pressure

$P = \frac{E}{V} \times \frac{I}{A \times \Delta t} = \frac{I}{V}$ $[E = mv^2]$

$P = \frac{6 \times 10^6}{c/\mu}$ $\left[v = \frac{c}{\mu}\right]$

$P = \frac{6 \times 10^6}{3 \times 10^8} \times 3$

$P = 0.06$ N /m^2

16. **Assertion :** A rod is stretched by two equal forces from both side, when force is removed the rod regain its original configuration

Reason : This happens due to elastic property of the rod.

(1) Assertion is true while Reason is false

(2) Assertion is false while Reason is true

(3) Both Assertion and Reason are true

(4) Both Assertion and Reason are false

Ans. **(3)**

17. Two bodies having mass 4 Kg and mass 5 Kg having same Kinetic energy find the ratio of there linear momentum?

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

Ans. **(2)**

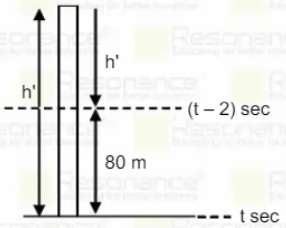
Sol. $\frac{P_1}{P_2} = \frac{\sqrt{2m_1k_1}}{\sqrt{2m_2k_2}} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{5}}$

18. A particle moves 80 m in last 2 sec in free fall condition then find distance covered 2 sec before striking the ground from initially point.

(1) 125 m (2) 115 m (3) 60 m (4) 45 m

Ans. **(4)**

Sol.



h = h' = 80

$\frac{1}{2} gt^2 - \frac{1}{2} g [t - 2]^2 = 80$

$\Rightarrow t = 5$ sec

$\therefore h' = \frac{1}{2} g [t - 2]^2$

= 45 m

19. A simple pendulum have same acceleration at lower position (mean position) & at extreme position. Find its angular amplitude.

(1) $2\tan^{-1}\frac{1}{2}$ (2) $2\cot^{-1}\frac{1}{2}$ (3) $\tan^{-1}\frac{1}{2}$ (4) $\cot^{-1}\frac{1}{2}$

Ans. **(1)**

Sol. Acceleration to question

$$\frac{v^2}{\ell} = g\sin\theta_0$$

$$\Rightarrow \frac{2g\ell(1-\cos\theta_0)}{\ell} = g\sin\theta_0$$

$$\Rightarrow 2(1-\cos\theta_0) = \sin\theta_0$$

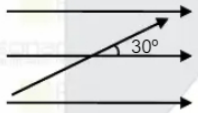
$$\Rightarrow \tan\frac{\theta_0}{2} = \frac{1}{2} \Rightarrow \theta_0 = 2\tan^{-1}\frac{1}{2}$$

20. There exists a uniform electric field of $20\hat{i}$ N/C. A dipole moment $|\vec{P}| = 15$ cm is placed at angle 30° with electric field. Torque on dipole is.

(1) 120 N-cm (2) 110 N-cm (3) 150 N-cm (4) 100 N-cm

Ans. **(3)**

Sol.



$$\vec{\tau} = \vec{p}\times\vec{E}$$

$$= 15\left(\cos30^\circ\hat{i} + \sin30\hat{j}\right)\times 20\hat{i}$$

$$= -15\sin30^\circ \times 20\hat{k})$$

$$= -150\hat{k}$$

$$|\vec{\tau}| = 150 \text{ N-cm}$$

21. Find electric potential at the surface of a nucleus (z = 50) of radius 9×10^{-13} m.

(1) 6×10^4 volt (2) 8×10^4 volt (3) 10×10^4 volt (4) 12×10^4 volt

Ans. **(2)**

Sol. $V = \frac{kq}{r}$

$$\Rightarrow V = \frac{9\times10^9\times50\times1.6\times10^{-19}}{9\times10^{-13}}$$

$$\Rightarrow V = 80 \times 10^3$$

$$\Rightarrow V = 8 \times 10^4 \text{ volt}$$

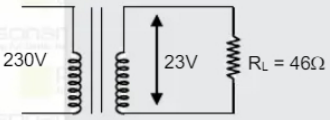
22. If the primary side of a transformer is connected with 230 V. 50 Hz AC supply and the ratio of number of turns of primary to the secondary winding is 10 : 1. Load resistance at secondary coil is 46 Ω then power output at load resistance.

(1) 23 W (2) 6.25 W (3) 11.5 W (4) 46 W

Ans. **(3)**

Sol. $\frac{V_2}{v_1} = \frac{N_2}{N_1} = \frac{1}{10}$

$$V_2 = \frac{V_1}{10} = \frac{230}{10} = 23V$$



$$P_L = \frac{V_2^2}{R_L} = \frac{(23)^2}{46}$$

$$P_L = 11.5 \text{ W}$$

23. **Assertion :** A point charge moving along equipotential surface, then work done by electric force is zero.
Reason : Electric field lines are perpendicular to equipotential surface.
(1) Assertion is true while Reason is false

(2) Assertion is false while Reason is true

(2) Assertion is false while Reason is true

(3) Both Assertion and Reason are true

(4) Both Assertion and Reason are false

Ans. **(3)**

Sol. Theory Based

24. A closed organ pipe has length 150 cm and an another open organ pipe has length 350 cm. Both are vibrating in fundamental mode. If value of beat frequency is 7 Hz. Find the speed of sound.

(1) 300 m/s (2) 294 m/s (3) 280 m/s (4) 310 m/s

Ans. **(2)**

Sol. $f_1 = \frac{v}{4\ell_1}$ (closed pipe)

$f_2 = \frac{v}{2\ell_2}$ (open organ pipe)

$f_1 - f_2 = 7 = \frac{v}{4\times1.5} - \frac{v}{2\times3.5}$

$\Rightarrow \frac{v}{6} - \frac{v}{7} = 7$

$\Rightarrow$ v = 294 m/s