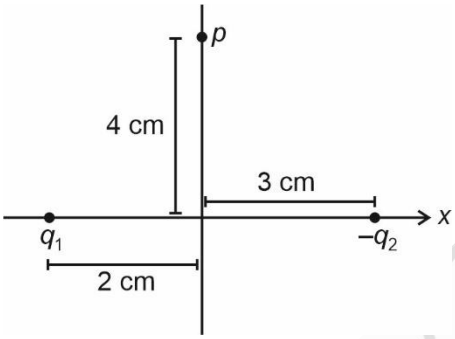
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Figure shows two charges q_1 and $-q_2$ placed on x-axis as shown. If electric field at p is along x-direction, find $\frac{q_1}{q_2}$.



(1) $\frac{4\sqrt{5}}{25}$

(2) $\frac{8\sqrt{5}}{25}$

(3) $\frac{12}{25}$

(4) $\frac{16\sqrt{5}}{25}$

Answer (2)

Sol. $E_1 \sin\theta_1 = E_2 \sin\theta_2$

$$\frac{k_{q_1}}{(20)} \times \frac{4}{\sqrt{20}} = \frac{k_{q_2}}{(25)} \frac{4}{5}$$

$$\frac{q_1}{q_2} = \frac{8\sqrt{5}}{25}$$

2. A disk of mass M, radius R is rotating about an axis passing through its centre and perpendicular to its plane with angular speed ω. If another disk of mass $\frac{M}{2}$ and radius R is gently placed over it what will be their common angular velocity after some time?

(1) $\frac{\omega}{5}$ (2) $\frac{\omega}{2}$

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

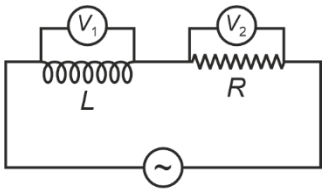
Answer (3)

Sol. $I_1\omega = (I_1 + I_2)\omega'$

$$\frac{MR^2}{2}\omega = \frac{3}{2}\left(\frac{MR^2}{2}\right)\omega'$$

$$\omega' = \frac{2\omega}{3}$$

3. In given AC circuit consisting a resistor R and an inductor L and source emf, two voltmeter V_1 & V_2 are connected as shown. If V_2 = 36 volts then inductance of inductor is (Resistance R is $\sqrt{91}\Omega$.)



(1) 0.08 H

(2) 0.8 H

(3) 8 H

(4) 80 H

Answer (1)

Sol. $i\sqrt{R^2+X_L^2}=120 \ \& \ iR=36$

$$\Rightarrow \frac{R^2+X_L^2}{R^2}=\frac{120\times120}{36\times36}=\frac{100}{9}$$

$$9R^2+9X_L^2=100R^2$$

$$9X_L^2=91R^2$$

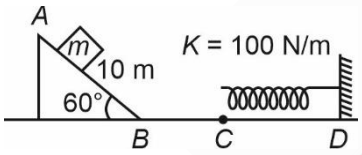
$$X_L=\frac{\sqrt{91}}{3}R$$

$$X_L=\frac{\sqrt{91}}{3}\times\sqrt{91}=\frac{91}{3}$$

$$L_\Omega=\frac{91}{3}$$

$$L=\frac{91}{3\times2\times\pi\times60}$$

4. A block of mass 5 kg is released as shown in the figure. Surface *CD* is rough with μ = 0.5, rest of all the surfaces are smooth. Find the maximum compression in the spring (initially spring is in its natural length.)



(1) 1.5 m

(2) 2.0 m

(3) 3.5 m

(4) 2.5 m

Answer (2)

Sol. $|W_F| = E_i - E_f$

$$+(0.5\times50)\times x=\frac{50\times10}{2}-\frac{1}{2}\times100\times x^2$$

x = 2.0 m

5. A physical quantity *P* depends on electric field (*E*) and permittivity of free space (ε_0) as

$$P\propto E\,\varepsilon_0{}^2,$$

Find dimension of *P*

(1) $\left[M^1L^{-5}T^5I^3\right]$

(2) $\left[M^{-1}L^{-5}T^5I^3\right]$

(3) $\left[M^2L^{-5}T^5I^2\right]$

(4) $[MLTI]$

Answer (2)

Sol. $[P]=\left[MLT^{-3}I^{-1}\right]\left[M^{-1}L^{-3}T^4I^2\right]^2$

$$=\left[M^{-1}L^{-5}T^5I^3\right]$$

6. An electron and a proton has same de Broglie wavelength. If K_e and K_p are their respective kinetic energies, then

(1) $K_p > K_e$

(2) $K_e > K_p$

(3) $K_e = K_p$

(4) Nothing can be said

Answer (2)

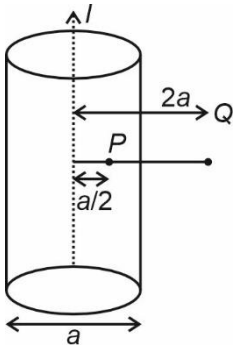
Sol. $\lambda=\frac{h}{p}$

$$K_e=\frac{p^2}{2m}$$

$$K_e\propto\frac{1}{m}$$

7. Find ratio of magnetic field at point *P* to that at point *Q*.

Point *P* is inside the solid cylinder and *Q* is outside the cylinder. Current is uniform through the cross-section of cylinder.



(1) 2 : 1 (2) 1 : 1

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

Answer (2)

Sol. **For *P* :**

$$B_P\, 2\pi\left(\frac{a}{2}\right) = \mu_0\, j\, \pi\frac{a^2}{4}$$

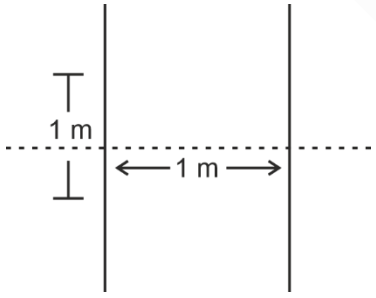
$$B_P = \frac{\mu_0\, j\, a}{4}$$

For *Q* :

$$B_Q\, 2\pi(2a) = \mu_0\, j\, \pi a^2$$

$$B_Q = \frac{\mu_0\, \hat{j}\, a}{4}$$

8. In a YDSE shown a monochromatic light of wavelength 500 nm is incident. At point *P*, 10th maxima is formed. Now the two slits are replaced with a single slit of width *w* placed at the centre. If first diffraction minima is observed at *P*, find *w*.



(1) 0.5 mm

(2) 1 mm

(3) 0.1 mm

(4) 0.2 mm

Answer (3)

Sol. $10\frac{\lambda D}{d} = \frac{\lambda D}{w}$

$$w = \frac{d}{10} = 0.1\,\text{mm}$$

9. An object is projected such that its horizontal range and maximum height are same, then angle of projection is

(1) $\tan^{-1}(2)$

(2) $\tan^{-1}(1)$

(3) $\tan^{-1}(3)$

(4) $\tan^{-1}(4)$

Answer (4)

Sol. $R = \frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$

$$2\sin\theta\cdot\cos\theta = \frac{\sin\theta\cdot\sin\theta}{2}$$

$\tan\theta = 4$

10. A wave is given by the equation $y = A\sin\{\pi(330t - x)\}$, then frequency of the wave is

(1) 330 Hz (2) 660 Hz

(3) 165 Hz (4) $\frac{1}{330}$ Hz

Answer (3)

Sol. $y = A\sin(wt\text{-}kn)$

$\Rightarrow \quad \omega = 330\pi = 2\pi\,\upsilon$

$\Rightarrow \quad \upsilon = 165$ Hz

11. On two separate inclined plane (one smooth and other rough). Inclination of angle θ with horizontal. Two particles (starting from rest) travels same length in time t and nt respectively where $n > 1$. Friction coefficient for earth surface as

(1) $1-\frac{1}{n^2}$ (2) $\left(1-\frac{1}{n^2}\right)\sin\theta$

(3) $\left(1-\frac{1}{n^2}\right)\cos\theta$ (4) $\left(1-\frac{1}{n^2}\right)\tan\theta$

Answer (4)

Sol. $t=\sqrt{\frac{2l}{g\sin\theta}}$

$$nt=\sqrt{\frac{2l}{g(\sin\theta-\mu\cos\theta)}}$$

$$\frac{1}{n^2}=\frac{\sin\theta-\mu\cos\theta}{\sin\theta}$$

$$\frac{1}{n^2}=1-\mu\cot\theta$$

$$\mu=\left(1-\frac{1}{n^2}\right)\tan\theta$$

12. A vernier caliper having least count $\frac{1}{20N}$ cm and one main scale division is 1 mm, then value of one vernier scale division is

(1) $\frac{N+1}{2N}$ mm (2) $\frac{2N+1}{2N}$ mm

(3) $\frac{2N-1}{2N}$ mm (4) $\frac{2N+2}{2N}$ mm

Answer (3)

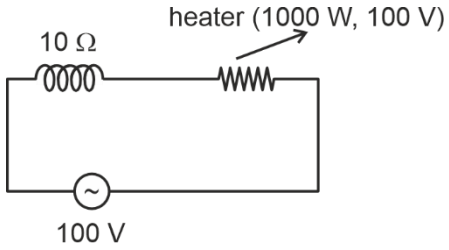
Sol. L.C. = 1 MSD – 1 VSD

$$\frac{1}{20N}\text{ cm}=1\text{ mm}-1\text{ VSD}$$

$$\text{VSD} = 1\text{ mm}-\frac{1}{2N}\text{ mm}$$

$$=\frac{2N-1}{2N}\text{ mm}$$

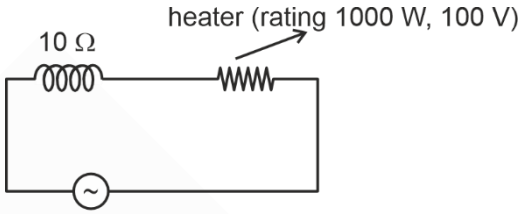
13. A heater with rating (1000 W, 100 V) is connected with AC source in series with inductor of reactance of 10 Ω as shown. Power dissipated in heater is



(1) $500\sqrt{2}$ W (2) $250\sqrt{2}$ W

(3) 500 W (4) 1000 W

Answer (3)



Sol.

$$R=\frac{100\times100}{1000}=10\ \Omega$$

$$X_L = 10\ \Omega$$

$$P=\frac{100\times100}{2\times10}=500\text{ W}$$

14. **Statement-I:** Mean free path is inversely proportional to the diameter of gas molecules, at constant volume, temperature.

Statement-II : Energy of n moles of gas is directly proportional to temperature.

(1) Both statements I and II are true and statement II is the correct explanation of statement I

(2) Both statements I and II are true and statement II is not the correct explanation of statement I

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

Answer (2)

Sol. Theoretical

$$\lambda=\frac{KT}{\sqrt{2}\,\pi d^2\left(\frac{N}{V}\right)}$$

15. Find binding energy of nuclei ${}^{12}_{5}X$, if its mass is m_o, m_p is mass of proton and m_n is mass of neutron.

(1) $\left(12m_p + 5m_n - m_o\right)C^2$

(2) $\left(5m_p + 12m_n - m_o\right)C^2$

(3) $\left(m_o - 5m_p - 7m_n\right)C^2$

(4) $\left(5m_p + 7m_n - m_o\right)C^2$

Answer (4)

Sol. $\Delta m = \left(5m_p + 7m_n - m_o\right)$

B.E. $= \left(5m_p + 7m_n - m_o\right)C^2$

16. A screw gauge with a pitch of 1 mm and a circular scale with 100 divisions is used to measure the thickness of aluminium sheet. Negative zero error of 0.05 mm is there.

What is the thickness of the sheet when main scale reading is 4 mm and 60th division coincides with the main scale line

(1) 10.05 mm

(2) 10.10 mm

(3) 10.15 mm

(4) 10.20 mm

Answer (1)

Sol. Reading = MSR + CSR × LC – Zero error

= 4 mm + 60 × 0.01 mm – (–0.05 mm)

= 10.05 mm

17.

18.

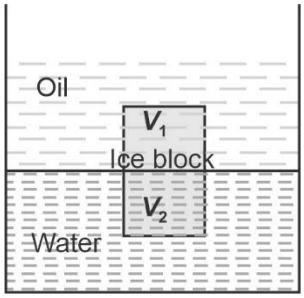
19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. An ice block of density 0.9 g/cc is sub-merged as shown in figure.



Density of oil = 0.8 g/cc

Density of water = 1 g/cc

Volume inside water = V_2

Volume inside oil = V_1

Find ratio $\frac{V_1}{V_2}$.

Answer (1)

Sol. $mg = \rho_{oil}V_1g + \rho_{water}V_2g$

$\left(V_1 + V_2\right)\rho_{ice} = \left(\rho_{oil}\right)V_1 + \rho_{water}V_2$

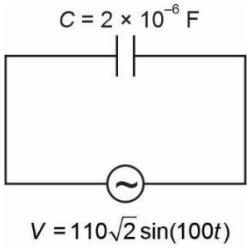
$\left(V_1 + V_2\right)\cdot 0.9 = 0.8V_1 + V_2$

$9V_1 + 9V_2 = 8V_1 + 10V_2$

$V_1 = V_2$

$\frac{V_1}{V_2} = 1$

22. A capacitive AC circuit is given. The rms value of current is k mA. Find the value of k.



Answer (22)

Sol. $i_{rms} = \dfrac{V_0}{\sqrt{2}x_C}$

$i_{rms} = \dfrac{V_0\omega_C}{\sqrt{2}} = 22$ mA

$\boxed{k = 22}$

23. At certain instant, kinetic energy and potential energy for particle executing SHM are 0.4 J and 0.5 J respectively. Find amplitude of SHM, if frequency of oscillations is $\dfrac{25}{\pi}$ Hz and mass of particle is 0.2 kg, in cm.

Answer (6)

Sol. $\dfrac{1}{2}m4\pi^2f^2A^2 = 0.9$ J

$\dfrac{1}{2}0.2\times4\pi^2\times\dfrac{625}{\pi^2}A^2 = 0.9$

$A = \dfrac{3}{2\times25} = 6$ cm

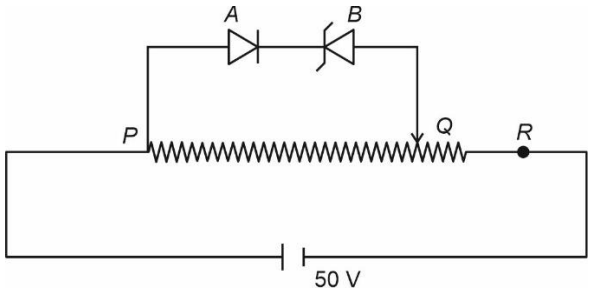
24. A planet is revolving in a circular orbit of radius R around sun with speed v. If another planet is revolving in circular orbit of radius $\dfrac{R}{4}$, its velocity is nv, find n.

Answer (2)

Sol. $v = \sqrt{\dfrac{GM}{R}}$

$v_2 = 2v$

25. A p-n junction diode (A) of potential barrier 3.8 V is connected with zener diode (B) of potential barrier 1.2 V as shown in figure. The length PR is 20 cm, then the maximum value of PQ (in cm) for which their is no current flow through diode_____ cm.



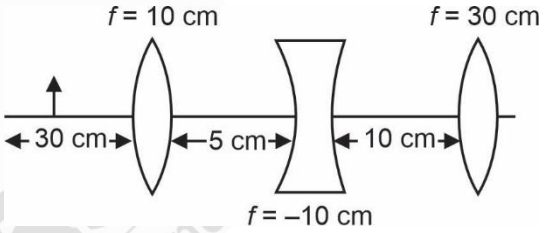
Answer (2)

Sol. $(V)_{PQ}^{max} = 5$ V

So, $PQ = \dfrac{20}{50}\times5$

$= 2$ cm

26. Find the distance (in cm) of image from rightmost lens.



Answer (30)

Sol. $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

$\dfrac{1}{v} - \dfrac{1}{-30} = \dfrac{1}{10}$

$\dfrac{1}{v} = \dfrac{1}{10} - \dfrac{1}{30} = \dfrac{3-1}{30}$

$v = 15$ cm

27.

28.

29.

30.