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. Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).

   Assertion (A): Refractive index of glass is more than air.

   Reason (R): Optical density of a medium is directly related to its mass density.

   In the light of the above statements, choose the correct answer from the options given below

   (1) (A) is false but (R) is true

   (2) (A) is false but (R) is false

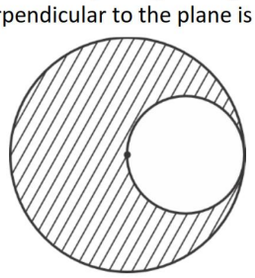
   (3) Both (A) and (R) are true but (R) is not the correct explanation of (A)

   (4) Both (A) and (R) are true and (R) is the correct explanation of (A)

Answer (2)

Sol. Conceptual

2. The figure shows a circular portion of radius $\frac{R}{2}$ removed from a disc of mass m and radius R. The moment of inertia about an axis passing through the centre of the disc and perpendicular to the plane is



(1) $\frac{13}{32}mR^2$ (2) $\frac{mR^2}{2}$

(3) $\frac{mR^2}{4}$ (4) $\frac{13}{64}mR^2$

Answer (1)

Sol. $I = \frac{mR^2}{2} - \frac{3}{2}\left(\frac{m}{4}\right)\left(\frac{R}{2}\right)^2$

$= \frac{13}{32}mR^2$

3. Give below are two statements. One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

   Assertion (A) : A magnetic monopole does not exist.

   Reason (R) : Magnetic lines are continuous and form closed loops.

   In the light of the above statements, choose the correct answer from the options given below :

   (1) (A) is false but (R) is true

   (2) (A) is true but (R) is false

   (3) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

   (4) Both (A) and (R) are true and (R) is the correct explanation of (A)

Answer (4)

Sol. Conceptual.

4. Potential energy is not defined for which of the force

   (1) Gravitational force

   (2) Restoring force

   (3) Friction

   (4) Electrostatic force

Answer (3)

Sol. Potential energy is only defined for conservative forces.

5. Which of the following quantity has same dimensions as $\sqrt{\frac{\mu_0}{\varepsilon_0}}$.

(1) Voltage

(2) Resistance

(3) Inductance

(4) Capacitance

Answer (2)

Sol. $\mu_0 = MLT^{-2}A^{-2}$

$\varepsilon_0 = M^{-1}L^{-3}T^4A^2$

$\sqrt{\frac{\mu_0}{\varepsilon_0}} = ML^2T^{-3}A^{-2}$

6. Equation of a wave is given by $y = A \sin(20\pi x + 10\pi t)$, find minimum distance between two particles having same velocity.

(1) 2.5 cm (2) 5 cm

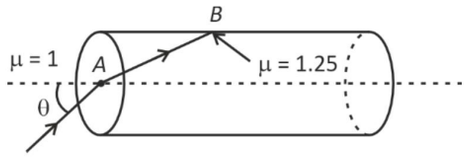
(3) 10 cm (4) 7.5 cm

Answer (2)

Sol. $\frac{2\pi}{\lambda} = 20\pi$ $\frac{\lambda}{2} = 5\text{cm}$

$\lambda = 10$ cm

7. The maximum value of θ (shown in figure) for which total internal reflection can happen at point B is



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

(3) $\cot^{-1}\left(\frac{3}{4}\right)$ (4) $\cos^{-1}\left(\frac{3}{4}\right)$

Answer (2)

Sol. At A

$1 \sin\theta = 1.25 \sin r$

At B

$1.25 \sin(90° - r) = 1 \sin 90°$ (for critical angle of incidence at B)

$\Rightarrow 1 + \sin^2\theta = 1.25^2$

$\sin^2\theta = 1.25^2 - 1^2$

$\sin\theta = \frac{3}{4}$

8. Distance between object and image for a convex lens is 40 cm and magnification is $-\frac{1}{4}$. Find focal length of the lens.

(1) 14.5 cm

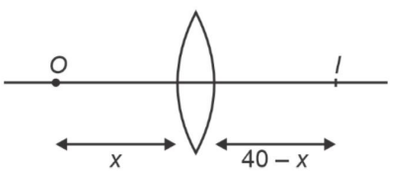
(2) 15 cm

(3) 12.5 cm

(4) 6.4 cm

Answer (4)

Sol.



$\frac{40-x}{x} = \frac{1}{4}$ $\frac{1}{f} = \frac{1}{8} + \frac{1}{32}$

$x = 32$ $f = \frac{32}{5} = 6.4$ cm

9. Flux through a plane parallel to *x*-*z* plane is 6 SI units. Find area of plane if electric field in the region is $\vec{E} = (\hat{i} + 4\hat{j} + \hat{k})10^3$ N/C.

(1) 2×10^{-3} m^2 (2) 2.5×10^{-2} m^2

(3) 1.5×10^{-3} m^2 (4) 2.5×10^{-3} m^2

Answer (3)

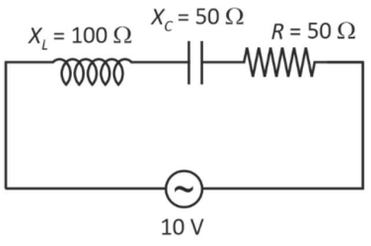
Sol. $\phi = \vec{E} \cdot \vec{A}$

$6 = (\hat{i} + 4\hat{j} + \hat{k}) \times 10^3 \cdot (A\,\hat{j})$

$6 = 4A \times 10^3$

$A = 1.5 \times 10^{-3}$ m^2

10. Find the average power for the given AC circuit



(1) 1 W

(2) 2 W

(3) 0.5 W

(4) 4 W

Answer (1)

Sol. $P_{av} = i_{rms} V_{rms} \cos\phi$ $\cos\phi = \frac{R}{Z}$

$Z = \sqrt{(X_L - X_C)^2 + R^2} = 50\sqrt{2}$

$P_{av} = \frac{10}{50\sqrt{2}} \times 10 \times \frac{50}{50\sqrt{2}} = 1$ Watt

11. Match the columns.

(A) Isothermal process	(P) $\Delta W = 0$
(B) Adiabatic process	(Q) $\Delta U \neq 0$
(C) Isobaric process	(R) $\Delta U = 0$
(D) Isochoric process	(S) $\Delta Q = 0$

(1) (A)→(R), (B)→(Q, S), (C)→(Q), (D)→(P, Q)

(2) (A)→(R), (B)→(S), (C)→(P), (D)→(Q, S)

(3) (A)→(Q), (B)→(Q, S), (C)→(P), (D)→(P, Q)

(4) (A)→(Q), (B)→(P), (C)→(P, Q), (D)→(R)

Answer (1)

12. Assertion: Airplane is made of metal of prevent from lighting strike.

Reason: Electric field in cavity inside conductor at equilibrium remain zero.

(1) Both Assertion and Reason are correct

(2) Assertion is correct but Reason is incorrect

(3) Assertion is incorrect and Reason is correct

(4) Both are incorrect

Answer (1)

Sol. Outer skin of most aeroplane widely made of Aluminium which is a good conductor of electricity keeps the charges due to lighting on the surface only.

13. Charge on capacitor plate is 5×10^{-6}C and induced charge on dielectric slab is 4×10^{-6}C. Find dielectric constant of the slab.

(1) 2

(2) 3

(3) 4

(4) 5

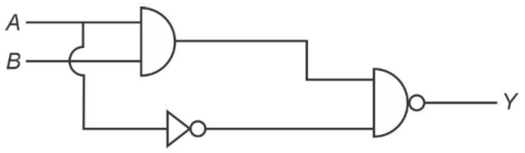
Answer (4)

Sol. $\varepsilon_{in} = \varepsilon\left(1-\frac{1}{k}\right)$

$\frac{4}{5} = 1-\frac{1}{k}$

$\Rightarrow \quad k = 5$

14. Find the output (Y) of the Logic Gate shown in diagram.



(1) 0

(2) 1

(3) $A+\overline{B}$

(4) $\overline{A}\cdot B$

Answer (2)

Sol. $([A\cdot B]\cdot\overline{A}) = (\overline{A\cdot B}) + A$

$= \overline{A}+\overline{B}+A = 1+\overline{B} = 1$

15. A photon of wavelength λ_1 is incident on a photo-sensitive surface of threshold wavelength λ_0. The de-broglie wavelength of fastest photoelectron is

(1) $\sqrt{\frac{h}{2mc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_0}\right)}}$

(2) $\sqrt{\frac{h}{2mc}\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_0}\right)}$

(3) $\lambda_1-\lambda_0$

(4) $\sqrt{\lambda_1^2-\lambda_0^2}$

Answer (1)

Sol. $k = hc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_0}\right)$

$P = \sqrt{2mk}$

$\lambda_{dB} = \frac{h}{P}$

$\lambda_{dB} = \frac{h}{\sqrt{2mhc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_0}\right)}}$

$= \sqrt{\frac{h}{2mc\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_0}\right)}}$

16. Find ratio of average kinetic energy of equal mass of He and Ar gas at 300 K.

(1) 10 : 1

(2) $1:\sqrt{10}$

(3) $\sqrt{10}:1$

(4) $2:\sqrt{5}$

Answer (1)

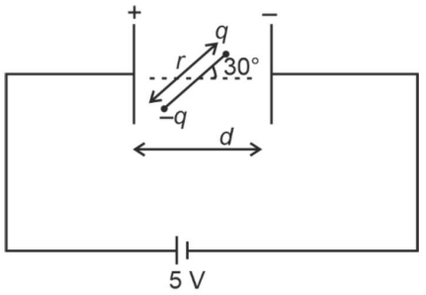
Sol. $U = nC_VT$

$C_{V_1} = C_{V_2}$

$\frac{U_1}{U_2} = \frac{n_1}{n_2} = \frac{(m/4)}{(m/40)} = \frac{10}{1}$

17. An electric dipole is kept between plates of a parallel plates capacitor as shown. Find torque on the dipole.

(d = 1 mm, q = 2 μc, r = 0.5 μm)



(1) 5×10^{-9} Nm

(2) 2.5×10^{-9} Nm

(3) 5×10^{-12} Nm

(4) 2×10^{-8} Nm

Answer (2)

Sol. $\tau = PE \sin\theta$

$$= 2\times10^{-6}\times\frac{1}{2}\times10^{-6}\times\left(\frac{5}{10^{-3}}\right)\times\frac{1}{2}$$

18. The SI unit of the quantity $\frac{2I}{\varepsilon_0 c}$ is (here, I is the moment of inertia, ε_0 is the permittivity of free space and c is the speed of light).

(1) $\frac{kg^2\text{-}m^4}{A^2s^3}$

(2) $\frac{kg^2m^3}{As^3}$

(3) $\frac{kg^2m^3}{A^2s^3}$

(4) $\frac{kgm^2}{As^3}$

Answer (1)

Sol. Unit of $\frac{2I}{\varepsilon_0 c} = \frac{(kg-m^2)}{\left(\frac{c^2}{N-m^2}\right)(m/s)} = \frac{kg^2m^4}{A^2s^3}$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. The velocity of a particle of mass 500 gm is given by $v = 4\sqrt{x}$. Find the force acting of on the particle (in Newton).

Answer (4)

Sol. $a = v\frac{dv}{dx} = 4\sqrt{x}\cdot\frac{4}{2\sqrt{x}} = 8\ m/s^2$

$F = ma = 4$ N

22. An object is released from a plane moving horizontally with a speed 100 m/s at a height 2 km above ground. The horizontal distance travelled (in km) by the object is (take g = 10 m/s^2)

Answer (2)

Sol. $d = v_x\sqrt{\frac{2h}{g}} \Big| = 100\sqrt{\frac{2\times2000}{10}}$
$= 2000$ m or 2 km

23.

24.

25.