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. What should be the minimum size of antenna required for successful transmission of wave having wavelength λ?

(1) 2λ (2) $\frac{\lambda}{4}$

(3) $\frac{\lambda}{2}$ (4) λ

Answer (2)

Sol. Theoretical

2. A 10 μC charge is divided into two equal parts and kept at 1 cm distance. Find repulsion between charges.

(1) 225 N (2) 450 N

(3) 2250 N (4) 4500 N

Answer (3)

Sol. $F = \frac{9\times 10^9 \times (5\times 10^{-6})^2}{(10^{-2})^2} = 9\times 25\times 10 = 2250 \text{ N}$

3. Two identical trains cross each other moving on parallel tracks, opposite in direction. Speed of one of the train is 70 km/hr and second train has a speed of 110 km/hr. If it takes 8 seconds for two trains to cross each other then length of trains is equal to

(1) 100 m (2) 200 m

(3) 300 m (4) 400 m

Answer (2)

Sol. Total distance to cover relatively = 2ℓ

$$\Rightarrow \quad 8 = \frac{2\ell}{180\times \frac{5}{18}}$$

$\Rightarrow \quad \ell$ = 200 m

4. A particle is performing S.H.M., whose distance from mean position varies as $x = A\sin(\omega t)$.

Find the position of particle from mean position where kinetic energy and potential energy is equal.

(1) $\left(\frac{A}{2}\right)$ (2) $\left(\frac{A}{\sqrt{2}}\right)$

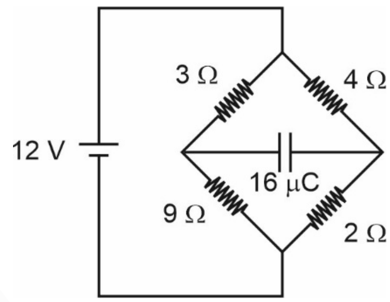
(3) $\left(\frac{A}{2\sqrt{2}}\right)$ (4) $\left(\frac{A}{4}\right)$

Answer (2)

Sol. $\frac{1}{2}m\omega^2\left(A^2 - x^2\right) = \frac{1}{4}m\omega^2 A^2$

$$\Rightarrow \quad A^2 - x^2 = \frac{1}{2}A^2 \Rightarrow x^2 = \frac{A^2}{2} \Rightarrow x = \left(\frac{A}{\sqrt{2}}\right)$$

5. Find energy stored in capacitor in given circuit.



(1) 0.2 mJ (2) 0.4 mJ

(3) 0.6 mJ (4) 0.8 mJ

Answer (1)

Sol. In steady state, capacitor will behave as open circuit

$R_{eq} = 4\ \Omega$ $\quad i = \frac{12}{4} = 3 \text{ A}$

$i_4 = \frac{12}{18}\times 3 = 3 \text{ A}$

i_3 = 1 A

So, P.D. across capacitor

$-3 - V + 8 = 0$

V = 5 volt

Energy stored = $\frac{1}{2}CV^2$

$$= \frac{1}{2}\times 16(\mu\text{C})\times 25$$

= 200 μJ

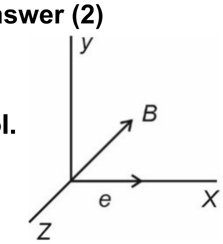
6. An electron is moving along positive x direction in x-y plane. Magnetic field points in negative z direction, then the force due to magnetic field on electron points in the direction

(1) $\hat{j}$ (2) $-\hat{j}$

(3) $\hat{k}$ (4) $-\hat{k}$

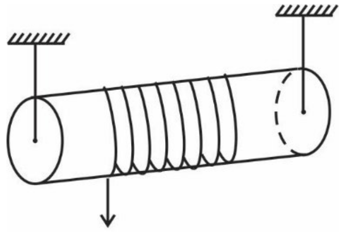
Answer (2)

Sol.



as electron is negative charge $\vec{F} = -e\vec{V}\times\vec{B}$

7. A force of 54.4 N is applied on free end of a string wrapped around a cylinder (solid) of mass 15 kg and radius 10 cm. Angular acceleration of the cylinder is equal to



(1) 94.10 rad/s² (2) 72.5 rad/s²
(3) 14.50 rad/s² (4) 94.50 rad/s²

Answer (2)

Sol. $0.1\times 54.4=\frac{1}{2}\times 15\times(0.1)^2\times\alpha$

$\alpha = 72.53$

8. Planet *A* has density and radius (ρ, *R*) while *B* has ($\rho/2$, 1.5*R*). If g_{AS} and g_{BS} are the acceleration at the surface of planet *A* and *B* respectively, find $\frac{g_{BS}}{g_{AS}}$.

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

Answer (2)

Sol. $\because\quad g=\frac{4\pi}{3}G\rho R$

$$\therefore\quad \frac{g_{BS}}{g_{AS}}=\frac{\rho_B R_B}{\rho_A R_A}=\frac{\left(\frac{\rho}{2}\right)(1.5R)}{\rho R}=\frac{3}{4}$$

9. **Assertion (A):** Binding energy per nucleon for nuclei (Atomic number 30 to 107) is independent of atomic number.

Reason (R): Nuclear force is short range force.

(1) (A) and (R) both are true and (R) explains (A) correctly
(2) (A) and (R) both are true but (R) does not explain A correctly
(3) (A) is true but (R) is false
(4) (A) and (R) both are false

Answer (1)

Sol. For nuclei with atomic number 30 to 107 there is a saturation in nuclear force per nucleon as nucleons being added at large distance do not make much impact on nuclear forces at a specific region.

10. If ratio of amplitudes is 2 : 1 in Young's double slit experiment, then find the ratio of maximum intensity to minimum intensity.

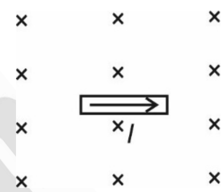
(1) 2 : 1
(2) 25 : 9
(3) 9 : 1
(4) 9 : 4

Answer (3)

Sol. Amplitudes are 2*A* and *A*.

$$\frac{I_{max}}{I_{min}}=\frac{(2A+A)^2}{(2A-A)^2}=\frac{9}{1}$$

11. A conducting rod carries current *I* hang freely in gravity space as shown in figure. If length of rod, current in rod and magnetic field strength are 0.5m, 2A and 0.4T respectively. Then find the mass of rod (Take *g* = 10 m/s²)



(1) 20 gm
(2) 40 gm
(3) 60 gm
(4) 80 gm

Answer (2)

Sol. $ILB=mg\Rightarrow m=\frac{ILB}{g}=\frac{.2\times\frac{1}{2}\times 0.4}{10}$

$=\frac{4}{100}$ kg $= 40$ gm

12. A mixture of gases with adiabatic coefficient equal to $\frac{3}{2}$ is compressed from initial state (P_0, V_0) to one fourth volume adiabatically. Its final pressure will be equal to

(1) P_0 (2) $2P_0$
(3) $4P_0$ (4) $8P_0$

Answer (4)

Sol. PV^{γ} = Constant

$$\Rightarrow P_2=P_1\times\left(\frac{V_1}{V_2}\right)^{\gamma}$$

$$=P_0\times(4)^{\frac{3}{2}}$$

$P_2 = 8P_0$

13. **Assertion:** If radius of ball (5 ± 0.1) mm, then error in terminal velocity is 4%.

Reason: Terminal velocity is directly proportional to radius (r).

(1) Both A and R are correct and R is the correct explanation of A.

(2) Both A and R are correct but R is not the correct explanation of A.

(3) A is true R is false

(4) A is false R is true

Answer (3)

Sol. $V_T = \dfrac{2}{9\eta}|\sigma - \rho| r^2 g \Rightarrow V_T \,\alpha\, r^2$

% error in $V_T = 2 \times \left(\dfrac{0.1}{5} \times 100\%\right) = 4\%$

14. In series LCR circuit, value of resistance inductance and capacitance are 10 Ω, 0.1 H and 2 mF respectively. If angular frequency of AC source is 100 rad/s, then power factor of circuit is

(1) $\dfrac{1}{\sqrt{5}}$ (2) $\dfrac{2}{\sqrt{5}}$

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

Answer (2)

Sol. $\cos\phi = \dfrac{R}{Z}$

$X_L = (0.1 \times 100) = 10\ \Omega$

$X_C = \dfrac{1}{\omega C} = \dfrac{1}{100 \times 2 \times 10^{-3}} = 5\ \Omega$

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

$= \sqrt{10^2 + (10-5)^2} = \sqrt{10^2 + 5^2}$

$= \sqrt{125} = 5\sqrt{5}$

$\therefore \quad \cos\phi = \dfrac{10}{5\sqrt{5}} = \dfrac{2}{\sqrt{5}}$

15. Position of particle located on *x*-axis changes with time (*t*) as $x = 2.5t^2$. Speed of the particle at $t = 5$ seconds is equal to

(1) 5 m/s (2) 10 m/s

(3) 25 m/s (4) 50 m/s

Answer (3)

Sol. $x = 2.5t^2$

$v = \dfrac{dx}{dt}$

$= 5t$

at $t = 5$ s

$v = 25$ m/s

16. **Statement 1:** In purely inductive circuit average power consumed is very high.

Statement 2: In purely inductive circuit only, resonance can be achieved.

(1) (1) and (2) both are true

(2) (1) is false (2) is true

(3) (1) is true (2) is false

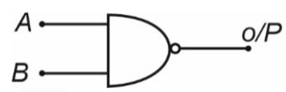
(4) (1) and (2) both are false

Answer (4)

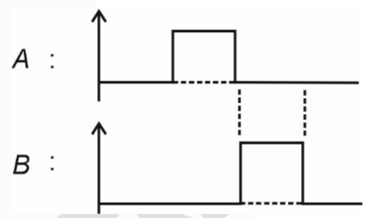
Sol. In purely inductive circuit cosϕ = 0

⇒ Power consumed = 0

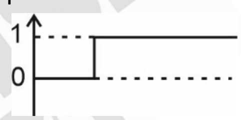
For resonance both *L* and *C* should be available in circuit.

17. 

Input waveform at *A* and *B* are –



Output waveform will be?

(1) 

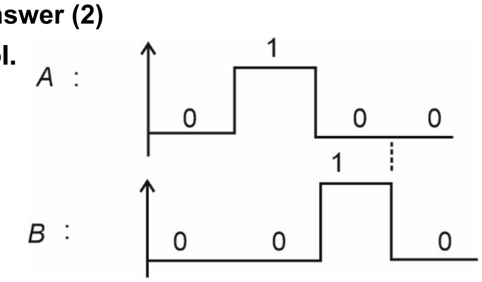
(2) 

(3) 

(4) 

Answer (2)

Sol.



$Y = \overline{A \cdot B}$

A	B	Y
0	0	1
1	0	1
0	1	1
0	0	1

18. Pressure (P), volume (V), temperature (T) are related to each other as per a relation

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

Dimension of $\frac{a}{b}$ are

(1) $[MLT^{-2}]$

(2) $[M^2LT^{-2}]$

(3) $[ML^2T^{-2}]$

(4) $[ML^3T^{-1}]$

Answer (3)

Sol. $[a] = [P][V^2]$

$[b] = [V]$

$$\Rightarrow \frac{[a]}{[b]}=[P][V]$$

$= [ML^2T^{-2}]$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. A bi-convex lens of focal length 10 cm is cut perpendicularly to principal axis. Find power of new lens.

Answer (5)

Sol. After cutting the bi-convex lens, focl length of individual lens is f = 20 cm = 0.2 m

$\therefore \quad P = 1/f = 5$ D

22. Body accelerates from rest to 4 m/s, energy is E. If it accelerates from rest to 24, then energy is nE. Find n.

Answer (4)

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

$$nE=\frac{1}{2}m(24)^2=4E\Rightarrow n=4$$

23. If a substance absorbs 500 nm wavelength radiation and emits radiation of wavelength 600 nm, then the net change in energy is $x \times 10^{-4}$ eV

Find the value of x to the nearest integer.

Answer (41)

Sol. $\frac{hc}{\lambda}=E$

$$\Rightarrow \frac{1240}{500}\text{eV}=E_1=2.48\text{ eV}$$

$$E_2=\frac{1240}{600}=2.07\text{ eV}$$

$\Delta E = 2.48 - 2.07$ eV

$= 0.41$ eV $= 41 \times 10^{-4}$ eV

24. A car of mass 200 kg is revolving in a circular track of radius 70 m with angular velocity of 0.2 rad/sec, then find the centripetal force in newton.

Answer (560)

Sol. $F_C = m\omega^2 r$

$= 200 \times 0.04 \times 70$

$= 560$ N

25.

26.

27.

28.

29.

30.