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. **Assertion:** At the peak of mountain, time period of pendulum increases.

   Reason: Time period of pendulum increases with decrease in g.

   (1) Assertion is correct, reason is incorrect

   (2) Assertion is incorrect, reason is correct

   (3) Assertion is incorrect, reason is incorrect

   (4) Assertion is correct, reason is correct

Answer (4)

Sol. $T = 2\pi\sqrt{\frac{I}{g}}$

2. The velocity of a particle moving on a straight line varies with time as $v = At^2 + \frac{Bt}{C+t}$ where A, B, C are constants. Find the dimensions of ABC.

   (1) $L^2 T^{-2}$

   (2) $L^2 T^{-1}$

   (3) $L^2 T^{-3}$

   (4) $L T^{-3}$

Answer (3)

Sol. $[v] = [A][t^2] = \frac{[B][t]}{[C]} = LT^{-1}$

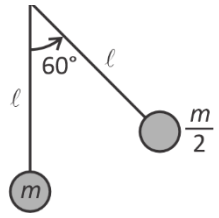
$\Rightarrow [A] = LT^{-3}$

$[B] = LT^{-1}$

$[C] = T$

$[ABC] = L^2 T^{-3}$

3. A pendulum of mass $\frac{m}{2}$ is released from given situation, find speed of another pendulum after collision ($\odot = 1$)

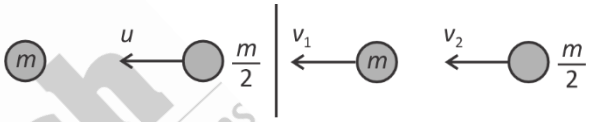


(1) $\sqrt{\frac{3}{2}g\ell}$ (2) $\frac{2}{3}\sqrt{g\ell}$

(3) $\sqrt{\frac{g\ell}{3}}$ (4) $\frac{1}{3}\sqrt{g\ell}$

Answer (2)

Sol. Speed before collision $= \sqrt{2 \cdot g \cdot \frac{\ell}{2}} = \sqrt{g\ell}$



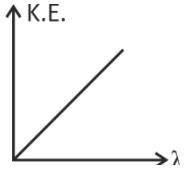
$\frac{m}{2}u = mv_1 + \frac{m}{2}v_2$

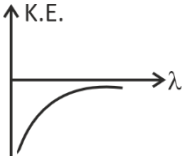
$u = 2v_1 + v_2$

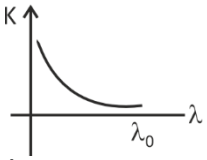
$u = v_1 - v_2$

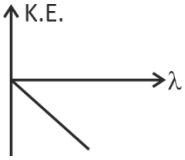
$v_1 = \frac{2u}{3} = \frac{2}{3}\sqrt{g\ell}$

4. The graph between wavelengths (λ) of incident light and kinetic energy (K.E.) of photoelectrons in photoelectric effect is

(1) 

(2) 

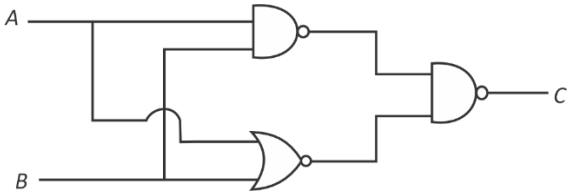
(3) 

(4) 

Answer (3)

Sol. $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + KE$ $K = \frac{a}{\lambda} - b$

5. Identify the logic gate represented by the circuit shown below.



(1) OR Gate (2) NAND Gate

(3) AND Gate (4) NOR Gate

Answer (1)

Sol. $C=\overline{\left(\overline{AB}\right)\left(\overline{A+B}\right)}$ De Morgan Rule

$= AB + A + B$ $\overline{X}\,\overline{Y} = X + Y$

$= A + B$

i.e. OR Gate

6. **Statement-1:** Electromagnetic wave have both energy and momentum.

Statement-2: Rest mass of photon is zero.

(1) Statement-1 is correct, statement-2 is correct

(2) Statement-1 is correct, statement-2 is incorrect

(3) Statement-1 is incorrect, statement-2 is correct

(4) Statement-1 is incorrect, statement-2 is incorrect

Answer (1)

Sol. Because of radiation pressure, EMW exerts force must carry momentum.

According to special relativity theory, no massive particle can attain speed of light.

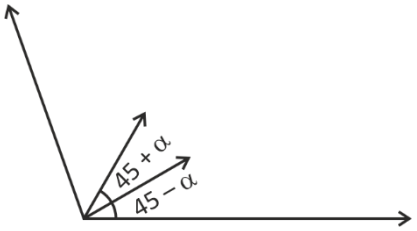
7. Two projectile were launched from same position simultaneously only same speed on of the projectile was launched at angle $(45-\alpha)^\circ$ and the other at an angle of $(45+\alpha)^\circ$. Find the ratio of maximum height of the projectile.

(1) $\frac{1-\sin\alpha}{1+\sin\alpha}$ (2) $\frac{1-\sin2\alpha}{1+\sin2\alpha}$

(3) $\frac{1-\tan\alpha}{1+\tan\alpha}$ (4) $\frac{1-\cos\alpha}{1+\cos\alpha}$

Answer (2)

Sol.



$$\frac{2gh_1=4^2\sin^2(45-\alpha)}{2gh_2=4^2\sin^2(45+\alpha)}$$

$$\Rightarrow \frac{h_1}{h_2}=\frac{\left(\frac{\cos\alpha}{\sqrt{2}}-\frac{\sin\alpha}{\sqrt{2}}\right)^2}{\left(\frac{\cos\alpha}{\sqrt{2}}+\frac{\sin\alpha}{\sqrt{2}}\right)^2}$$

$$\Rightarrow \frac{h_1}{h_2}=\frac{\cos^2\alpha+\sin^2\alpha-2\sin\alpha\cos\alpha}{\cos^2\alpha+\sin^2\alpha+2\sin\alpha\cos\alpha}$$

$$\Rightarrow \frac{h_1}{h_2}=\frac{1-\sin2\alpha}{1+\sin2\alpha}$$

8. A river is flowing with speed 9 km/h. Boat is going downstream. Speed of boat in still water is 27 km/h. A person in boat throws a ball upwards with speed 10 m/s. Find range of the ball as seen by an observer at bank of river

(1) 10 m (2) 20 m

(3) 25 m (4) $20\sqrt{3}$ m

Answer (2)

Sol. $T=\frac{2u}{g}=\frac{2\times10}{10}=2\text{ s}$

$$R=(9+27)\frac{5}{18}\times2$$

$R = 20$ m

9. Which of two physical quantities have same dimensions?

(1) Angular momentum and Planck's constant

(2) Torque and moment of inertia

(3) Impulse and surface tension

(4) Momentum and work done

Answer (1)

Sol. (1) $\frac{L}{h}=\frac{mvr}{Et}=\frac{mv^2}{E}\equiv M^0L^0T^0$

(2) $\frac{\bar{L}}{I}=\frac{rF\sin\theta}{mr^2}\equiv M^0L^0T^{-2}$

(3) $\frac{I}{s}=\frac{Ft}{F/\ell}\equiv LT$

(4) $\frac{p}{\omega}=\frac{mv}{mv^2}=L^{-1}T$

10. If radius of first Bohr's orbit of H-atom is a_0. Then find the radius of 2nd Bohr's orbit of H-atom.

(1) $8a_0$ (2) $4a_0$

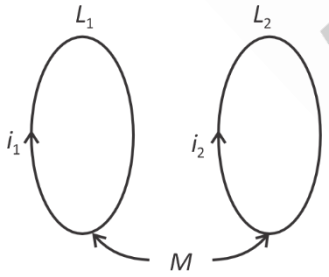
(3) $2a_0$ (4) $6\pi a_0$

Answer (2)

Sol. $a=\frac{a_0n^2}{2}$

So, $a(n=2)=4a_0$

11. Two coils having self-inductance L_1 and L_2 are placed closely such that they have a mutual inductance M. If the carry currents i_1 and i_2 as shown in the figure, then the induced emf in coil 1 is



(1) $-L_1\left(\frac{di_1}{dt}\right)+M\left(\frac{di_2}{dt}\right)$ (2) $-L_1\left(\frac{di_1}{dt}\right)-M\left(\frac{di_2}{dt}\right)$

(3) $-L_1\left(\frac{di_2}{dt}\right)+M\left(\frac{di_1}{dt}\right)$ (4) $-L_1\left(\frac{di_2}{dt}\right)-M\left(\frac{di_1}{dt}\right)$

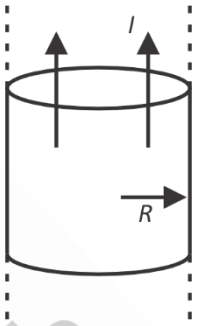
Answer (2)

Sol. $\phi_1=L_1i_1+Mi_2$

$\frac{-d\phi_1}{dt}=-L_1\left(\frac{di_1}{dt}\right)-M\left(\frac{di_2}{dt}\right)$

$\varepsilon_1=-L_1\left(\frac{di_1}{dt}\right)-M\left(\frac{di_2}{dt}\right)$

12. An infinite solid cylindrical wire of radius R carries a current I uniformly distributed along its area. The distance from the centre where the magnetic field is equal to $\frac{\mu_0 I}{4\pi R}$ is



(1) $\frac{R}{2}$ (2) R

(3) $4R$ (4) 0

Answer (1)

Sol. $B_{inside}=\frac{\mu_0 Ir}{2\pi R^2}$

$\Rightarrow r=\frac{R}{2}$

$B_{outside}=\frac{\mu_0 I}{2\pi r}$

$\Rightarrow r=2R$

13. When ball is kept under sea at depth 2.5 km. Find percentage change in it's volume. If bulk modulus of water is 2×10^9 Pa.

(1) 2% (2) 1.5%

(3) 1.25% (4) 2.75%

Answer (3)

Sol. $\beta = \dfrac{\Delta P}{\dfrac{-\Delta V}{V}} \Rightarrow \dfrac{\Delta V}{V} = \dfrac{\Delta P}{\beta}$

$= \dfrac{10^3 \times 10 \times 2500}{2 \times 10^9} \times 100$

$= \dfrac{25}{20}$

$= 1.25\%$

14. Heat given to 0.5 moles of a monoatomic gas at constant pressure is 500 J. Initial temperature of gas was 27°C. Find value of ΔU and ΔT.

(1) 300 J, 48°C (2) 150 J, 24°C

(3) 180 J, 16°C (4) 210 J, 18°C

Answer (1)

Sol. At constant pressure,

$\Delta Q = nC_p\Delta T$

$500 = \dfrac{n.5}{2}R\Delta T$

$\Delta U = nC_v\Delta T = \dfrac{3}{2}nR\Delta T$

$= \dfrac{3}{2} \times 200$

$= 300$ J

$\Delta T = \dfrac{200 \times 3}{0.5 \times 25}$

$\Delta T = 48$

15. **Assertion:** A negative potential is required to stop the photoelectron.

Reason : Speed of electron decreases when a negative potential is applied in a photo cell.

(1) Assertion is correct but Reason is false

(2) Assertion is correct and Reason is also correct

(3) Assertion is false but Reason is correct

(4) Assertion is false and Reason is also false

Answer (2)

Sol. Conceptual

16. If electric dipole of dipole moment $\vec{P}$ is placed in electric field $\vec{E}$ with $\vec{P} \| \vec{E}$. It is rotated slightly (and slowly) and released. Find the time period of oscillation of dipole (moment of inertia of dipole is I).

(1) $T = 2\pi\sqrt{\dfrac{I}{PE}}$

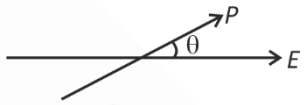
(2) $T = \dfrac{1}{2\pi}\sqrt{\dfrac{PE}{I}}$

(3) $T = 2\pi\sqrt{\dfrac{IE}{P}}$

(4) $T = \dfrac{1}{2\pi}\sqrt{\dfrac{PI}{E}}$

Answer (1)

Sol.



$T_{(R)} = -(\vec{P})(\vec{E})\sin\theta \approx -|\vec{P}||\vec{E}|\theta$

$\alpha = -\omega^2\theta = -\dfrac{PE}{I} \cdot \theta$

$\Rightarrow T = 2\pi\sqrt{\dfrac{I}{PE}}$

17. In adiabatic process of closed system, work done by the gas depends explicitly on

(1) Change in volume

(2) Change in pressure

(3) Change in temperature

(4) Change in number of moles

Answer (3)

Sol. $\Delta\theta = \Delta V + \Delta W \Rightarrow \Delta W = -\Delta V$

$W = \underbrace{-\dfrac{\mu R\Delta T}{\gamma - 1}}_{\text{Only Change in temperature}} = \underbrace{-\dfrac{1}{\gamma - 1}(P_2V_2 - P_1V_1)}_{\text{Both on change in pressure and volume}}$

18. Match the correct option for List-I and List-II, where symbols have usual meanings.

	List-I		List-II
(A)	Electric field inside the spherical shell	(i)	$\frac{\sigma}{2\varepsilon_0}$
(B)	Electric field just outside the spherical shell	(ii)	$\frac{\sigma}{\varepsilon_0}$
(C)	Electric field inside the charged parallel plate capacitor	(iii)	0
(D)	Electric field of infinite charge sheet	(iv)	$\frac{2\sigma}{\varepsilon_0}$

(1) A-(iii), B-(ii), C-(iv), D-(ii)

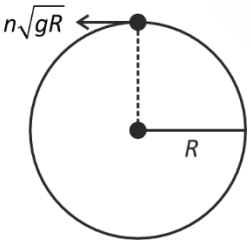
(2) A-(iii), B-(ii), C-(ii), D-(i)

(3) A-(iii), B-(ii), C-(ii), D-(iv)

(4) A-(iv), B-(iii), C-(i), D-(ii)

Answer (2)

19. A particle is able to complete the vertical circular motion with speed $n\sqrt{gR}$ at top-most point. Find the ratio of $\frac{KE_{(Bottom)}}{KE_{(Top)}}$



(1) $\frac{n^2+4}{n}$ (2) $\frac{n}{n^2+4}$

(3) $\frac{n^2+2}{n}$ (4) $\frac{n^2+4}{n^2}$

Answer (4)

Sol. $V_\tau = n\sqrt{gR}$

$$V_{Bottom}^2 = V_\tau^2 + 4gR = n^2gR + 4gR$$

$$\frac{KE_{Bottom}}{KE_{Top}} = \frac{gR(n^2+4)}{gRn^2} = \frac{n^2+4}{n^2}$$

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. In a hydraulic lift, the two sides have areas $A_1 = 25\ cm^2$ and $A_2 = 100\ cm^2$. If a force of 100 N is applied normally on the area A_1, then the force on the area A_2 is _____ N.

Answer (400)

Sol. From Pascal's law

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \text{ or } \frac{100\ N}{25\ cm^2} = \frac{F_2}{100\ cm^2}$$

$\Rightarrow F_2 = 400$ N

22. Find magnitude of component of torque about origin in z-direction when force $\vec{F} = \hat{i} - \hat{j} + \hat{k}$ acts at (1, 1, 1).

Answer (2)

Sol. $\vec{\tau}_2 = \hat{k}(-1,-1) = -2\hat{k}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & +1 & 1 \\ 1 & -1 & 1 \end{vmatrix}$

23.

24.

25.