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. A solid sphere and hollow sphere rolls down purely equal distances on same inclined plane (Starting from rest) in time t_1 and t_2 then.

(1) $t_1 > t_2$ (2) $t_1 < t_2$

(3) $t_1 = 2t_2$ (4) $t_1 = t_2$

Answer (2)

Sol. $a_{SS} = \frac{g\sin\theta}{1+\frac{2}{5}}$ $a_{HS} = \frac{g\sin\theta}{1+\frac{2}{3}}$

$a_{SS} > a_{HS}$ $\Rightarrow$ $t_{SS} < t_{HS}$

2. A solid sphere rolls without slipping on a horizontal plane. What is ratio of translational kinetic energy to the rotational kinetic energy of the sphere.

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

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

(3) $\frac{2}{5}$

(4) $\frac{5}{2}$

Answer (4)

Sol. $\frac{KE_T}{KE_R} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}\cdot\frac{2}{5}mR^2\omega^2}$

$= \frac{5}{2}$

3. If E, p, m and c denote the energy, linear momentum, mass and speed of light, then the equation representing the correct relation could be

(1) $E^2 = p^2c^2 + m^2c^4$ (2) $E^2 = pc^2 + m^2c^4$

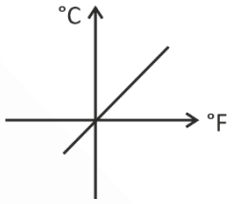
(3) $E = p^2c^2 + m^2c^2$ (4) $E^2 = pc^2 + m^2c^2$

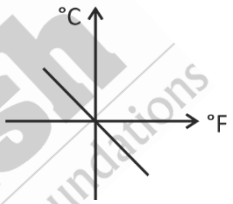
Answer (1)

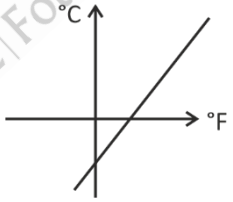
Sol. $[E] = [pc] = [mc^2] = ML^2T^{-2}$

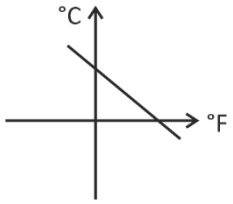
$\Rightarrow$ $[E^2] = [p^2c^2] = [m^2c^4] = [p^2c^2 + m^2c^4]$

4. Which of the following graph correctly represents the relation between Celsius(°c) and Fahrenheit(°F)

(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. $F = \frac{9}{5}C + 32$

$C = \frac{5}{9}F - \frac{5}{9}\times 32$

5. Temperature of a body reduces from 40° to 24°C in 4 minutes in surrounding of 16°C. What is the temperature of body after further 4 minutes?

(1) 20°C (2) 22°C

(3) $\frac{56}{3}$°C (4) 17°C

Answer (3)

Sol. Using Newton's law of cooling

$$\left|<\frac{dT}{dt}>\right| = b(<T> - T_0)$$

$$\frac{16}{4} = b(32-16)$$

$$\frac{24-T}{4} = b\left(\frac{T+24}{2} - 16\right)$$

$$\frac{4\times 4}{24-T} = \frac{16\times 2}{T+24-32}$$

$$48 - 2T = T - 8$$

$$\frac{56}{3} = T$$

6. The position of a particle varies with time as $\vec{r} = (5t^2\hat{i} - 5t\hat{j})$ m. The magnitude and direction of velocity at $t = \frac{1}{2}$ s is

(1) $5\sqrt{2}$ m/s, –45° with +*X* axis

(2) 5 m/s, –45° with +*X* axis

(3) $5\sqrt{2}$ m/s, –45° with +*Y* axis

(4) 5 m/s, +45° with +*Y* axis

Answer (1)

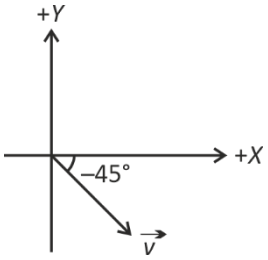
Sol. $\vec{r} = 5t^2\hat{i} - 5t\hat{j}$

$$\vec{v} = \frac{d\vec{r}}{dt} = 10t\hat{i} - 5\hat{j}$$

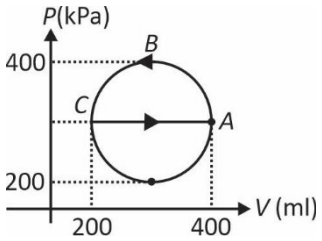
$$\vec{v}\left(t = \frac{1}{2}\text{ s}\right) = 10\left(\frac{1}{2}\right)\hat{i} - 5\hat{j}$$

$$= 5\hat{i} - 5\hat{j}$$

Magnitude = $\sqrt{(5)^2 + (-5)^2} = 5\sqrt{2}$ m/s



7. In given thermodynamic process (Circular in nature), find magnitude of work done by the gas in cycle *ABCA*



(1) 2π (2) 10π

(3) 5π (4) Zero

Answer (3)

Sol. $\omega = \frac{\pi r^2}{2} = \frac{\pi\times(100\times10^3)\times100\times10^{-6}}{2}$

$= 5\pi$

8. Arrange the following in order of decreasing wavelength.

a : Microwave

b : Ultraviolet

c : Infrared

d : X-rays

(1) a > b > c > d

(2) d > c > b > a

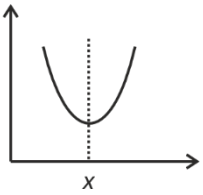
(3) a > c > b > d

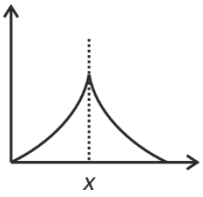
(4) c > a > b > d

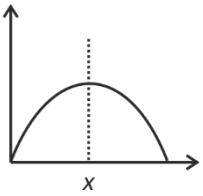
Answer (3)

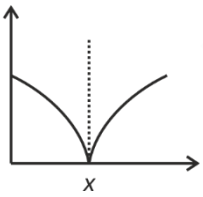
Sol. Theoretical

9. A particle oscillates along x-axis according to law $x = x_0\sin^2(t/2)$ where $x_0 = 1$. Variation of kinetic energy (k) with position (x) is given by graph

(1) 

(2) 

(3) 

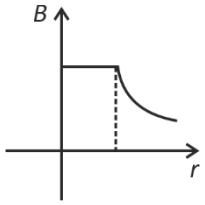
(4) 

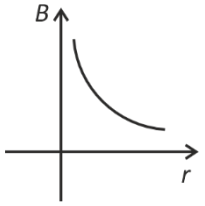
Answer (3)

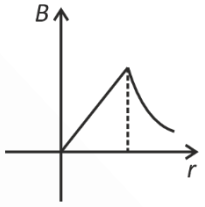
Sol. $x = \sin^2\frac{t}{2} = \frac{1}{2} - \frac{\cos t}{2} \Rightarrow \left(x - \frac{1}{2}\right) = -\frac{\cos t}{2}$

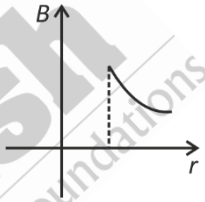
x = 0, 1 are the extremes and $x = \frac{1}{2}$ is the mean position.

10. There is a line solid cylinder carrying current along the axis with uniform current density. Variation of magnetic field (B) with radial distance from axis of cylinder (r) is best denoted by

(1) 

(2) 

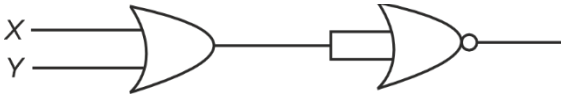
(3) 

(4) 

Answer (3)

Sol. $B = \frac{\mu_0 jr}{2}$ inside and $B = \frac{\mu_0 I}{2\pi r}$ for outside

11. For which of the following input, output of the circuit is zero



(A) $x = 0, y = 0$
(B) $x = 0, y = 1$
(C) $x = 1, y = 0$
(D) $x = 1, y = 1$

(1) A only
(2) A, B, C only
(3) B, C D only
(4) A and C

Answer (3)

Sol. Combination of OR gate and NOT gate.

$\Rightarrow$ Equivalent to NOR gate

12. There is a conical pendulum of mass m and length l making 60° with vertical. Then tension in thread is

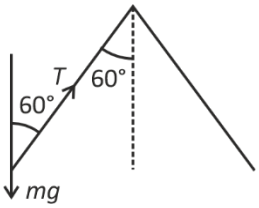
(1) mg (2) $\frac{mg}{2}$

(3) $2mg$ (4) $3mg$

Answer (3)

Sol. $T\cos 60° = mg$

$T = 2mg$



13. There are two identical conducting spheres placed at certain distance l. On of them is carrying charge of 4×10^{-8} C and the other is neutral. Now both are connected using a conducting wire and force between them is found to be 9×10^{-3} N, then distance l is

(1) 4 cm

(2) 4 m

(3) 2 cm

(4) 1 cm

Answer (3)

Sol. $\frac{\theta^0}{4\pi\varepsilon_0 l^2} = F$

$$\frac{\left(2\times10^{-8}\right)^2 \times 9\times10^9}{l^2} = 9\times10^{-3}$$

$l = 2 \times 10^{-2}$ m

14.

15.

16.

17.

18.

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. If the acceleration due to gravity on the surface of earth is 'g', then acceleration due to gravity on a planet whose diameter is $\frac{1}{3}$ of that of earth and same mass as that of earth is $g' = ng$ where n is _____ .

Answer (9)

Sol. Diameter = $2R = d$

$$g = \frac{GM}{R^2} = \frac{4GM}{d^2}$$

$$g' = \frac{4GM}{(d/3)^2} = 9g$$

22. The excess pressure required to decrease the volume of water sample by 0.2% is $P \times 10^5$ Pa. If the bulk modulus of water is 1.25×10^9 Pa, then the value of P is _____ .

Answer (25)

Sol. Given $\frac{\Delta v}{v} \times 100 = -0.2$

$$B = -\frac{\Delta P}{(\Delta P / v)} \text{ or } \Delta p = -B\left(\frac{\Delta v}{v}\right)$$

$$\Rightarrow \quad \Delta p = -(1.25\times10^9)\left(-\frac{0.2}{100}\right) \text{Pa}$$

$= 25 \times 10^5$ Pa

23.

24.

25.