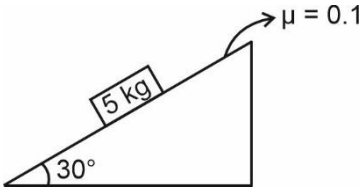
PHYSICS

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. For the block shown, F_1 is the minimum force required to move block upwards and F_2 is the minimum force required to prevent it from slipping, find $\left|\vec{F}_1 - \vec{F}_2\right|$



(1) $50\sqrt{3}$ N

(2) $5\sqrt{3}$ N

(3) $25\sqrt{3}$ N

(4) $\frac{5\sqrt{3}}{2}$ N

Answer (2)

Sol. $f_K = \mu mg\cos\theta$

$= 0.1 \times \frac{50\times\sqrt{3}}{2}$

$= 2.5\sqrt{3}$ N

$F_1 = mg\sin\theta + f_K$

$= 25 + 2.5\sqrt{3}$

$F_2 = mg\sin\theta - f_K$

$= 25 - 2.5\sqrt{3}$

$\therefore \quad F_1 - F_2 = 5\sqrt{3}$ N

2. Force on a particle moving in straight line is given by $\vec{F} = 6t^2\hat{i} - 3t\hat{j}$ and velocity is $\vec{v} = 3t^2\hat{i} + 6t\hat{j}$. Find power at $t = 2$.

(1) 216 W

(2) 108 W

(3) 0 W

(4) 54 W

Answer (1)

Sol. $P = \vec{F}\cdot\vec{v}$

$= 18t^4 - 18t^2$

$\Rightarrow \quad P(t=2) = 18[16-4] = 216$ W

3. If $E = \frac{A - x^2}{Bt}$ where E is energy, x is displacement and t is time. Find dimensions of AB

(1) $[M^{-1}L^2T]$

(2) $[ML^2T^{-1}]$

(3) $[M^{-1}L^2T^{-2}]$

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

Answer (1)

Sol. $[A] = L^2$

$B = \frac{x^2}{tE} \equiv \frac{L^2}{TML^2T^{-2}} = \frac{1}{MT^{-1}}$

$[B] = M^{-1}T$

$[AB] = [M^{-1}L^2T]$

4. Unpolarised light incident on transparent glass at incident angle 60°. If reflected ray is completely polarised, then angle of refraction is

(1) 45°

(2) 60°

(3) 30°

(4) 37°

Answer (3)

Sol. By Brewsters law

$\mu = \tan i$

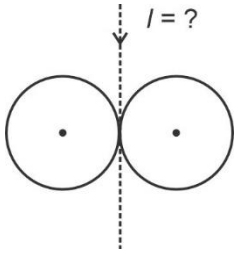
$\mu = \sqrt{3}$

$\therefore \quad 1\times\frac{\sqrt{3}}{2} = \sqrt{3}\times\sin r$

$\sin r = \frac{1}{2}$

$r = 30°$

5. Two solid spheres each of mass 2 kg and radius 75 cm are arranged as shown. Find MOI of the system about the given axis.



(1) 3.15 kg m^2

(2) 31.5 kg m^2

(3) 0.9 kg m^2

(4) 9 kg m^2

Answer (1)

Sol. $I = \left(\frac{2}{5}MR^2 + MR^2\right) \times 2$

$= \frac{14}{5} \times 2 \times \frac{9}{16}$

$= \frac{63}{20}$

= 3.15 kg m^2

6. If the current through an incandescent lamp decreases by 20%, how much change will be there in its illumination?

(1) 36% (2) 64%

(3) 20% (4) 40%

Answer (1)

Sol. $p = i^2R$

$p' = 0.64\ i^2R$

7. Find the speed of sound in oxygen gas at STP.

(1) 300 m/s

(2) 350 m/s

(3) 330 m/s

(4) 400 m/s

Answer (3)

Sol. $v = \sqrt{\frac{\gamma RT}{M}} = 330$ m/s

8. Find average power in electric circuit if source voltage (V) = 20sin(100ωt) and current in the circuit $(I) = 2\sin(100\omega t + \frac{\pi}{3})$

(1) 10 W (2) 20 W

(3) 5 W (4) 15.5 W

Answer (1)

Sol. $\langle P \rangle = IV\cos\phi$

$= \frac{20}{\sqrt{2}} \times \frac{2}{\sqrt{2}} \times \cos 60°$

= 10 W

9. In a photoelectric experiment, frequency $f = 1.5f_0$ (f_0: threshold frequency). If the frequency of light is changed to $f/2$, then photocurrent becomes (intensity of light has doubled)

(1) Zero

(2) Doubled

(3) Same

(4) Thrice

Answer (1)

Sol. Since $\frac{f}{2} < f_0$

$\Rightarrow$ current = 0

10. Radius of curvature of equiconvex lens is 20 cm. Material of lens is having refractive index of 1.5. Find image distance from lens if an object is placed 10 cm away from the lens.

(1) 20 cm

(2) 10 cm

(3) 40 cm

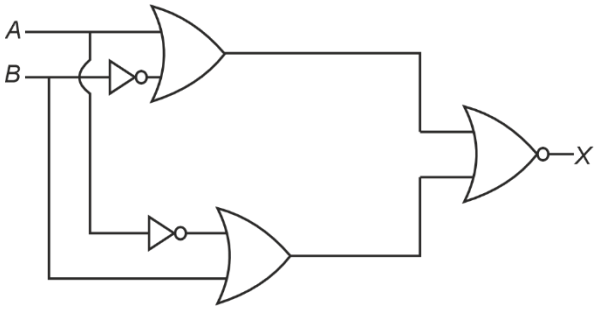
(4) 5 cm

Answer (1)

Sol. $\frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$ $f = 20$ cm

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{10} = \frac{1}{20}$

11. 

Draw truth table of given gate circuit.

(1)

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

(2)

A	B	X
0	0	0
0	1	0
1	0	0
1	1	0

(3)

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(4)

A	B	X
0	0	1
0	1	0
1	0	0
1	1	1

Answer (2)

Sol. $X = \overline{(A+\bar{B})+(\bar{A}+B)}$

$\overline{(A+\bar{B})}\cdot\overline{(\bar{A}+B)}$

$(\bar{A}\cdot\bar{\bar{B}})\cdot(\bar{\bar{A}}\cdot\bar{B})$

$(\bar{A}\cdot B)\cdot(A\cdot\bar{B}) = \bar{A}\cdot B\cdot A\cdot\bar{B} = 0$

12. The magnetic flux through a loop varies with time as $\phi = 5t^2 - 3t + 5$. If the resistance of loop is 8 Ω, find the current through it at t = 2 s

(1) $\frac{15}{8}$ A

(2) $\frac{5}{8}$ A

(3) $\frac{17}{8}$ A

(4) $\frac{13}{8}$ A

Answer (3)

Sol. $\frac{d\phi}{dt} = 10t - 3$

at t = 2, V = 17

$i = \frac{V}{R} = \frac{17}{8}$ A

13. 8 moles of oxygen and 4 moles of nitrogen are at same temperature T and are mixed. The total internal energy is

(1) 60RT

(2) 15RT

(3) 30RT

(4) 90RT

Answer (3)

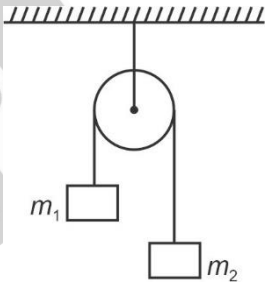
Sol. $U = nC_vT$

$\Rightarrow U = n_1C_{v_1}T + n_2C_{v_2}T$

$\Rightarrow 8\times\frac{5R}{2}\times T + 4\times\frac{5R}{2}\times T$

$= 30RT$

14. In the system shown below, the pulley 4 string are ideal. If the acceleration of blocks is $\frac{g}{8}$, find $\frac{m_1}{m_2}$



(1) $\frac{9}{7}$

(2) $\frac{8}{7}$

(3) $\frac{5}{7}$

(4) $\frac{9}{8}$

Answer (1)

Sol. $a = \frac{(m_1 - m_2)g}{(m_1 + m_2)} = \frac{g}{8}$

$8m_1 - 8m_2 = m_1 + m_2$

$7m_1 = 9m_2$

$\frac{m_1}{m_2} = \frac{9}{7}$

15. The force between two charged particle placed in air at separation x is F_0. Both the charged particle immerged in a medium of dielectric constant K without changing separation between two charge, then net force on one of the particle is now

(1) $\frac{F_0}{K}$

(2) $\frac{F_0}{2K}$

(3) $\frac{2F_0}{K}$

(4) F_0

Answer (1)

Sol. In air $F = \frac{1}{4\pi \in_0}\frac{q_1 q_2}{r_2}$

In medium $F' = \frac{1}{4\pi(k \in_0)}\frac{q_1 q_2}{r^2}$

$F' = \frac{F_0}{K}$

16. Two vector each of magnitude A are inclined at angle θ with each other, then magnitude of resultant vector is

(1) $A\cos^2\frac{\theta}{2}$

(2) $2A\cos\frac{\theta}{2}$

(3) $2A\cos\theta$

(4) $A\cos\frac{\theta}{2}$

Answer (2)

Sol. The magnitude of resultant vector (R) $= \sqrt{a^2 + b^2 + 2ab\cos\theta}$

here $a = b = A$

then $R = \sqrt{A^2 + A^2 + 2A^2\cos\theta}$

$= A\sqrt{2}\sqrt{1+\cos\theta}$

$= \sqrt{2}A\sqrt{2\cos^2\frac{\theta}{2}}$

$= 2A\cos\frac{\theta}{2}$

17. **Statement 1 :** Electric and magnetic energy density in electromagnetic waves are equal.

Statement 2 : Electromagnetic waves exert pressure on a surface.

(1) Statement 1 is true & Statement 2 is true and is correct explanation of Statement 1

(2) Statement 1 is true & Statement 2 is true but is not correct explanation of Statement 1

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

(4) Statement 1 is false but Statement 2 is true

Answer (2)

Sol. $\frac{1}{2}\varepsilon_0 E^2 = \frac{B^2}{2\mu_0}$

$\because E = CB$ and $C = \frac{1}{\mu_0\varepsilon_0}$

18. A pendulum completes 50 oscillations in 40 seconds. If the length of pendulum is (20 $\pm$ 0.2) cm and resolution of watch is 1 second, find the percentage error in calculation of g.

(1) 7%

(2) 3%

(3) 6%

(4) 4%

Answer (3)

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

$g = \frac{4\pi^2 l}{T^2}$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$

$= \frac{0.2}{20} + 2\left(\frac{1}{40}\right)$

$= 6\%$

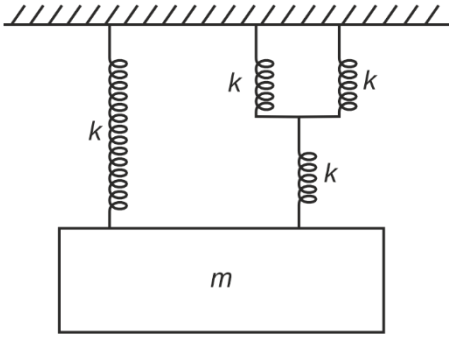
19.

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. The period of oscillation of system shown below is $\pi\sqrt{\frac{\alpha m}{5k}}$ then α is _____



Answer (12)

Sol. $k_{eq} = \frac{2k \cdot k}{3k} + k = \frac{5k}{3}$

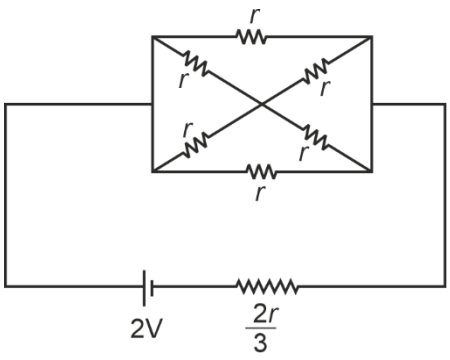
Angular frequency of oscillation (ω) = $\sqrt{\frac{k_{eq}}{m}}$

$\omega = \sqrt{\frac{5k}{3m}}$

Period of oscillation (τ) = $\frac{2\pi}{\omega} = 2\pi\sqrt{\frac{3m}{5k}}$

$= \pi\sqrt{\frac{12m}{5k}}$

22. In the given circuit, $r = 2\ \Omega$. The power dissipated in the circuit is _____W.



Answer (2)

Sol. $R_{eq} = r$

$\therefore \quad P = \frac{V^2}{r} = \frac{4}{2} = 2\ \text{W}$

23. A body of mass m is projected with speed u at angle 45° with horizontal. The angular momentum of body, about point of projection when body is at highest point, is $\frac{\sqrt{2}\, m\, u^3}{xg}$ find x,

Answer (8)

Sol. $L = mu\cos\theta\frac{u^2\sin^2\theta}{2g}$

$= mu^3\frac{1}{4\sqrt{2}\,g} \Rightarrow x = 8$

24. Mass of moon is $\frac{1}{81}$ times the mass of a planet and radius is $\frac{1}{9}$ times the radius of the planet. The ratio of escape speed from planet to escape speed from moon is _____.

Answer (3)

Sol. $v_{esc} = \sqrt{\frac{2GM}{R}}$

$\Rightarrow$ Ratio $= \sqrt{\frac{81}{9}} = 3$

25. Find the mass number of an atom whose radius is half of that of a given atom of mass number 192.

Answer (24)

Sol. $r = R_0(192)^{\frac{1}{3}}$

$\frac{r}{2} = R_0(m)^{\frac{1}{3}}$

$m = \frac{192}{8} = 24$

26.

27.

28.

29.

30.