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. The ratio of intensities of two coherent sources is 1 : 9. The ratio of the maximum to the minimum intensities is

(1) 9 : 1

(2) 16 : 1

(3) 8 : 1

(4) 4 : 1

Answer (4)

Sol. $\frac{I_{max}}{I_{min}}=\left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2=\left(\frac{\sqrt{9}+\sqrt{1}}{\sqrt{9}-\sqrt{1}}\right)^2$

$\frac{I_{max}}{I_{min}}=\left(\frac{3+1}{3-1}\right)^2=4$

2. Excess pressure inside bubble A is half of that of bubble B. Find ratio of volume of bubble A to bubble B

(1) 8

(2) 4

(3) 27

(4) 16

Answer (1)

Sol. $\frac{4T}{R_A}=\frac{1}{2}\cdot\frac{4T}{R_B}$

$\frac{R_A}{R_B}=2$

$\frac{V_A}{V_B}=2^3=8$

3. In a resonance tube experiment at one end, resonance is obtained at two consecutive lengths l_1 = 100 cm and l_2 = 140 cm. If the frequency of the sound is 400 Hz, the velocity of sound is

(1) 320 m/s

(2) 340 m/s

(3) 380 m/s

(4) 300 m/s

Answer (1)

Sol. $\Delta l=\frac{\lambda}{2}$

$\lambda = 2 \times 40 = 80$ cm

$v=f\lambda=\frac{400\times80}{100}=320\,m/s$

4. Physical quantity S is given as $S=\frac{pq}{r^3\sqrt{t}}$. Find to percentage change in S if percentage change in p, q, r and t are 1, 1, 3 and 2 respectively.

(1) 7%

(2) 9%

(3) 5%

(4) 12%

Answer (4)

Sol. $\%S=\%p+\%q+3\%r+\frac{1}{2}\%t$

$=1+1+3\times3+\frac{1}{2}(2)$

$=12\%$

5. In a medium of refractive index 2, the frequency of light is 5×10^{14} Hz, the wavelength of the light in the medium is

(1) 200 nm

(2) 300 nm

(3) 500 nm

(4) 600 nm

Answer (2)

Sol. $v = \frac{3}{2} \times 10^8$ m/s

$$\lambda = \frac{v}{f} = \frac{3}{2} \times \frac{10^8}{5 \times 10^{14}} = 3 \times 10^{-7}$$

$$= 300 \text{ nm}$$

6. A capacitor $C_1 = 100$ pF is connected to a 60 V cell and then disconnected. C_1 is now connected to an uncharged capacitor C_2 such that the final potential across C_1 becomes 20 V. Find C_2.

(1) 200 pF (2) 100 pF

(3) 600 pF (4) 50 pF

Answer (1)

Sol. $V_{final} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$$20V = \frac{(100pF)(60V) + C_2(0V)}{100pF + C_2}$$

On Solving

$C_2 = 200$ pF

7. A bulb rated 100 W, 220 V connected to an ac supply of 220 V. Find peak current in the bulb.

(1) 8 A

(2) 0.64 A

(3) 3.2 A

(4) 2 A

Answer (2)

Sol. $P = V_{rms} I_{rms}$

$100 = 220\, I_{rms}$

$$I_{rms} = \frac{10}{22}$$

$$I = \frac{10}{22}\sqrt{2}$$

$I = 0.64$ A

8. **Statement-I :** O^{2-} and H^+ are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of O^{2-} will be less than H^+.

Statement-II : e^- and p^+ are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of e^- will be more the proton.

(1) Statement-I is correct, statement-II is incorrect

(2) Both statement-I and statement-II are correct

(3) Both statement-I and statement-II are incorrect

(4) Statement-I is incorrect, statement-II is correct

Answer (3)

Sol. $r = \frac{Vm}{Bq}$

$r_{O^{2-}} > r_{H^+}$

$r_{p^+} > r_{e^-}$

9. The pressure of an ideal gas is increased by 0.4% keeping the volume constant. Find the initial temperature of the gas if there is a 1°C rise in temperature.

(1) 250 K

(2) 250°C

(3) 2500 K

(4) 2500°C

Answer (1)

Sol. $P \propto T$ (T is measured in K)

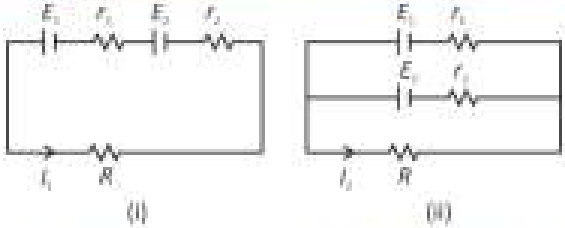
$\Rightarrow$ % change in P = % change in T

i.e. 0.4% change in $T_i = 1$°C

$$\frac{0.4}{100} \times T_i = 1°C = 1\,K$$

$$T_i = \frac{100}{0.4} K$$

$= 250$ K

10. 

In two situations given in figures (i) and (ii) current through R is I_1 and I_2 respectively. If $E_1 = 2$ V, $r_1 = 1\ \Omega$, $E_2 = 1$ V, $r_2 = 2\ \Omega$, $R = 6\ \Omega$ then find $\frac{I_1}{I_2}$.

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

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

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

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

Answer (2)

Sol. $I_1 = \frac{E_{eq}}{r_1 + r_2 + R} = \frac{1}{3}$ $\quad I_2 = \frac{E_{eq}}{r_{eq} + R}$ $\quad E_{eq} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{5}{3}$

$I_2 = \frac{1}{4}$

$\frac{I_1}{I_2} = \frac{4}{3}$

11. A block of mass 10 kg is moving with speed 3 m/s collides with a spring connected to another block of mass 5 kg initially at rest. Find the compression in spring when both move with same speed

(1) 0.1 m (2) 0.2 m

(3) 1 m (4) 2 m

Answer (1)

Sol. $v_f = \frac{10 \times 3}{15} = 2$ m/s

$\frac{1}{2}kx^2 = \frac{1}{2} \times 10 \times 9 - \frac{1}{2} \times 15 \times 4$

$x^2 = \frac{30}{3000} = \frac{1}{100}$

$x = \frac{1}{10}$ m

12. The torque experienced by a magnetic dipole in a uniform magnetic field is $80\sqrt{3}$ N-m. If the angle between the magnetic moment and the magnetic field is 60°, the potential energy of the dipole is

(1) -80 J

(2) -60 J

(3) $\frac{80}{3}$ J

(4) -40 J

Answer (1)

Sol. Torque = $MB\sin\theta$

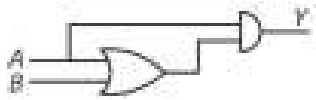
Potential Energy = $-MB\cos\theta$

$\Rightarrow$ Potential Energy = $-$(Torque) $\cot\theta$

i.e., = $-(80\sqrt{3})\cot 60°$ J

$= -80$ J

13. The truth-table of the circuit shown is



(1)

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

(2)

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

(3)

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

(4)

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

Answer (D)

Sol. $Y = (A + B)A$

$= A + AB$

$= A(1 + B)$

$= A$

14. Match the following:

(i)	Boltzmann's constant	(a)	ML^2T^{-1}
(ii)	Coefficient of viscosity	(b)	$ML^2T^{-2}K^{-1}$
(iii)	Thermal conductivity	(c)	$ML^{-1}T^{-1}$
(iv)	Planck's constant	(d)	$MLT^{-3}K^{-1}$

(1) (i)-(c), (ii)-(b), (iii)-(a), (iv)-(d)

(2) (i)-(b), (ii)-(c), (iii)-(d), (iv)-(a)

(3) (i)-(b), (ii)-(d), (iii)-(a), (iv)-(c)

(4) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)

Answer (2)

15. Find the distance of the object from the left surface, if the distance of the final image from the left surface is 200 cm

(1) 100 cm (2) 50 cm

(3) 200 cm (4) 75 cm

Answer (1)

Sol. Final image is at a distance + 100 cm from right surface

$$\Rightarrow \frac{1}{+100\text{ cm}} - \frac{1.5}{u'} = \frac{1-1.5}{-50\text{ cm}}$$

or $u' = \infty$

i.e., the rays become parallel after refraction from left surface

or $$\frac{1.5}{\infty} - \frac{1}{u} = \frac{1.5-1}{+50\text{ cm}}$$

$$-\frac{1}{u} = \frac{1}{100\text{ cm}}$$

$u = -100$ cm

16. The displacement of a particle is given as $x = C_0(t^2 - z) + C(t - z)^2$, where t is time in seconds and C_0 and C are constants the acceleration of the particle is

(1) C_0 (2) $2(C_0 + C)$

(3) Ct^2 (4) $2(C_0 - 2C)$

Answer (2)

Sol. $x = C_0(t^2 - z) + C(t - z)^2$

$$\frac{dx}{dt} = 2C_0t + 2C(t - z)$$

$$a = \frac{d^2x}{dt^2} = 2C_0 + 2C = 2(C_0 + C)$$

17.

18. A solid ball of diameter 3.6 mm and having density 7825 kg/m^3. This ball has terminal velocity 2.56×10^{-1} m/s in a liquid of density 925 kg/m^3 find coefficient (in pascal sec) of viscosity.

(1) 190 (2) 1.9

(3) 256×10^{-3} (4) 38×10^{-3}

Answer (2)

Sol. $$V_T = \frac{2r^2(\rho - \rho_s)g}{9\eta}$$

$\eta = 1.89$

$\eta \simeq 1.9$

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. A block of mass 1 kg moves from $x = 0.1$ m to $x = 1.9$ m. The speed of block at $x = 0.1$ is 10 m/s. A resistive force $F = -10x$ acts on the block. Find speed of block (in m/s) when it is at $x = 1.9$ m.

Answer (8)

Sol. $$\text{Work} = -\int_{0.1}^{1.9} 10x\,dx$$

$$= -5(1.9^2 - 0.1^2)$$

$$= -5 \times 2 \times 1.8$$

$$= -18\ J$$

$$\frac{1}{2}1.v^2 = \frac{1}{2}1.(10)^2 - 18$$

$v^2 = 64$

$v = 8$ m/s

22. A projectile is fired with an initial velocity u, such that range of the projectile is 3 times the maximum height. If the range of the projectile is $\frac{Nu^2}{25g}$, Find value of N

Answer (24)

Sol. $$\frac{2u^2\sin\theta\cos\theta}{g} = \frac{3u^2\sin^2\theta}{2g}$$

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

$$R = \frac{24u^2}{24g}$$

23. In a Hydrogen atom, an electron makes a transition from n^{th} orbit to 4th excited state. Energy released in this transition 0.33 eV find the value of n.

Answer (8)

Sol. $$\Delta E = -13.6\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$0.33 = -13.6\left(\frac{1}{n^2} - \frac{1}{5^2}\right]$$

$n = 8$

24.

25.