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. Match the radiations listed in column-I with their uses listed in column-II correctly.

	Column-I		Column-II
(A)	UV rays	(P)	Physiotherapy
(B)	Infra red rays	(Q)	Treatment of cancer
(C)	X-rays	(R)	Lasic eye surgery
(D)	Microwave rays	(S)	Aircraft navigation

(1) A – S, B – P, C – R, D – Q
(2) A – R, B – P, C – Q, D – S
(3) A – Q, B – P, C – S, D – R
(4) A – R, B – P, C – S, D – Q

Answer (2)

Sol. UV rays are used for lasik eye surgery.
IR is used for physiotherapy.
X-rays are used for cancer treatment.
and Microwaves are used for aircraft navigation.

2. During an adiabatic process performed on a diatomic gas 725 J of work is done on the gas. The change in internal energy of the gas is equal to
(1) 495 J (2) 725 J
(3) 225 J (4) Zero

Answer (2)

Sol. For adiabatic process $Q = 0$
$\Delta U + W = 0$
$\Delta U - 725 = 0$
$\Delta U = 725$ J

3. Two balls are projected with equal speed (40 m/s), one at an angle of 30° and other at 60° with horizontal. Find the ratio of maximum heights of both the balls.
(1) $\frac{1}{4}$ (2) $\frac{3}{1}$
(3) $\frac{1}{3}$ (4) $\frac{4}{1}$

Answer (3)

Sol. $H_{max} = \frac{v^2 \sin^2\theta}{2g}$

$\Rightarrow$ Ratio $= \frac{\sin^2 30°}{\sin^2 60°}$

$= \frac{1}{3}$

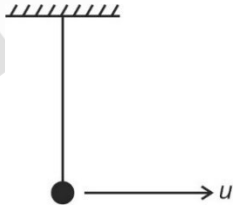
4. Find ionization energy of 2nd excited state of Li^{2+}. It is given that ionization energy of ground state of hydrogen atom is 13.6 eV.
(1) 20.4 eV (2) 27.2 eV
(3) 6.8 eV (4) 13.6 eV

Answer (4)

Sol. $E = 13.6(3)^2\left[\frac{1}{3^2} - 0\right]$

= 13.6 eV

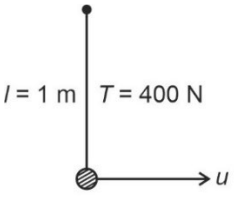
5. A ball of mass 1 kg is hanging from 1 m long inextensible string which can withstand maximum tension of 400 N. Find the maximum speed (u) that should be given to the ball.

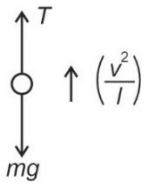


(1) $\sqrt{390}$ m/s (2) $\sqrt{410}$ m/s
(3) 20 m/s (4) 22 m/s

Answer (1)

Sol.





$T = mg + \frac{mv^2}{l}$

$400\ \text{N} = 10 + \frac{u^2}{l}$

$u = \sqrt{400 - 10} = \sqrt{390}$ m/s

6. Match the physical quantities given in column-I with the physical dimensions in column-II correctly.

	Column-I		Column-II
A.	Torque	(P)	$ML^{-1}T^{-2}$
B.	Stress	(Q)	ML^2T^{-2}
C.	Pressure gradient	(R)	$ML^{-2}T^{-2}$
D.	Angular momentum	(S)	ML^2T^{-1}

(1) A(S), B(P), C(R), D(Q)

(2) A(Q), B(P), C(R), D(S)

(3) A(P), B(S), C(R), D(Q)

(4) A(Q), B(P), C(S), D(R)

Answer (2)

Sol. $[\tau] = [r][F] = [L]\,[MLT^{-2}] = [ML^2T^{-2}]$

$$[\text{Stress}] = \frac{[F]}{[A]} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$$

$$[\text{Pressure gradient}] = \frac{[P]}{[Z]} = \frac{[ML^{-1}T^{-2}]}{[L^1]} = [ML^{-2}T^{-2}]$$

$[L] = [\tau][t] = [ML^2T^{-2}][T] = [ML^2T^{-1}]$

7. The equation of two simple harmonic motions are given by $y_1 = 10 \sin(\omega t + \pi/3)$, and $y_2 = 5\left[\sin(\omega t) + \sqrt{3}\cos\omega t\right]$. The amplitude of resultant S.H.M is

(1) 10 m (2) 20 m

(3) 5 m (4) 15 m

Answer (2)

Sol. $y_1 = 5\left[\sin(\omega t) + \sqrt{3}\cos(\omega t)\right]$

$$= 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

$$y_2 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

$$y_1 + y_2 = y_{\text{resultant}} = 10\sin\left(\omega t + \frac{\pi}{3}\right) + 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

$$y_{\text{resultant}} = 20\sin\left(\omega t + \frac{\pi}{3}\right)$$

Amplitude = 20

8. Projectile 1 is thrown at angle 60° with horizontal with speed 40 m/s. Projectile 2 is thrown with same speed for same range as projectile 1 but at different angle. Sum of the maximum heights achieved by two projectiles is equal to (Take g = 10 m/sec^2)

(1) 40 m (2) 60 m

(3) 80 m (4) 160 m

Answer (3)

Sol. If angle of projection for projectile 1 is 60° then angle of projectile 2 is 30° for same range

$$H_1 = \frac{u^2\sin^2 60^\circ}{2g},\ H_2 = \frac{u^2\sin^2 30^\circ}{2g}$$

$$H_1 + H_2 = \frac{u^2}{2g} = \frac{40^2}{2\times 10} = 80\text{ m}$$

9. A body has weight W on the surface of earth. Find the weight at a height 9 times the radius of earth.

(1) $\frac{W}{100}$ (2) $\frac{W}{81}$

(3) $\frac{W}{64}$ (4) $\frac{W}{121}$

Answer (1)

Sol. $g' = \frac{g_0}{\left(\frac{r}{R}\right)^2}$

$$= \frac{g_0}{10^2} = \frac{g_0}{100}$$

$$\Rightarrow W' = \frac{W}{100}$$

10. A wire is first coiled in n circular turns and current I is run through it. Now the same wire is again coiled in N circular turns and same current I is run through it. If B_1 and B_2 are the magnetic fields at centre of two coils respectively then $\frac{B_1}{B_2}$ is equal to

(1) $\sqrt{\frac{n}{N}}$ (2) $\left(\frac{n}{N}\right)^2$

(3) $\frac{n}{N}$ (4) $\frac{n^3}{N^3}$

Answer (2)

Sol. Let the length of wire is ℓ, thus the radius of first coil

$R_1 = \frac{\ell}{2\pi n}$ and the radius of second coil $R_2 = \frac{\ell}{2\pi N}$

So $B_1 = \frac{\mu_0 nI}{\frac{2\ell}{2\pi n}} = \frac{\mu_0\pi n^2 I}{\ell}$

And $B_2 = \frac{\mu_0 nI}{\frac{2\ell}{2\pi N}} = \frac{\mu_0\pi N^2 I}{\ell}$

So $\frac{B_1}{B_2} = \frac{n^2}{N^2}$

11. For a medium, it is given that

Young's modulus = 3.2×10^{10} N/m^2

Density = 8000 kg/m^3

Find speed of sound in this medium.

(1) 1000 m/s

(2) 2000 m/s

(3) 500 m/s

(4) 4000 m/s

Answer (2)

Sol. $v = \sqrt{\frac{Y}{\rho}}$

$= \sqrt{\frac{3.2 \times 10^{10}}{8000}}$

= 2000 m/s

12. When current of 4 amperes is made to run through a resistance of R ohms for 10 seconds, it produces heat energy of H units. Now if 16 amperes of current is made to flow through same resistance for 10 seconds than heat energy produced will be

(1) 16 H (2) 4 H

(3) 8 H (4) 2 H

Answer (1)

Sol. $H = i^2Rt = 4^2R \times 10 = 160R$

$H' = I^2Rt = 16^2R \times 10 = 2560R = 16$ H

13. Across an inductor of 5 mH an AC source with potential given as 268 sin(200 πt) Volts is used. The value of inductive reactance provided by inductor is equal to

(1) $2\pi\ \Omega$ (2) $\frac{\pi}{2}\Omega$

(3) $20\pi\ \Omega$ (4) $\pi\ \Omega$

Answer (4)

Sol. $X_L = \omega L = 200\pi \times 5 \times 10^{-3}$

$= \pi\ \Omega$

14. A lens of refractive index 1.5 and focal length 15 cm in air is submerged in water. Change in focal length of lens is $\left(r = \frac{4}{3}\right)$

(1) 45 cm (2) 60 cm

(3) 30 cm (4) 10 cm

Answer (1)

Sol. When lens is placed in air,

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{15} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ...(1)$$

When submerged in water $\left(\mu = \frac{4}{3}\right)$

$$\Rightarrow \frac{1}{f'} = \left(\frac{1.5}{\left(\frac{4}{3}\right)} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ...(2)$$

$$\frac{\text{Equation (1)}}{\text{Equation (2)}}$$

$$\frac{f'}{15} = \left(\frac{0.5}{0.5} \times 4\right)$$

f' = 60 cm

$\Delta f = f' - f = 60 - 15 = 45$ cm

15. In a moving coil galvanometer, number of turns in the coil are increased to increase the current sensitivity by 50%. Find percentage change in voltage sensitivity.

(1) –50%

(2) 50%

(3) No change

(4) 25%

Answer (3)

Sol. Current sensitivity

$$\frac{\theta}{I} = \frac{nAB}{K}$$

Voltage sensitivity $= \left(\frac{nAB}{KR}\right)$

As current sensitivity increases by 50%

So number of turns increases by 50%

Resistance also increases by 50%

Therefore, voltage sensitivity remains constant.

16.

17.

18.

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. In a series *RLC* circuit, R = 80 Ω, X_L = 100 Ω, X_C = 40 Ω. If the source voltage is 2500cos(628*t*) Volts, find peak current in the circuit (in Amperes)

Answer (25.00)

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

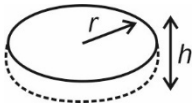
$= \sqrt{80^2 + (100-40)^2} = 100\ \Omega$

$\Rightarrow I_o = \frac{V_o}{Z} = 25$ A

22. Two discs of same mass, radii r_1 and r_2, thickness 1 mm and 0.5 mm have densities in the ratio 3 : 1. The ratio of their moment of inertia about diameter is 1 : *x*. Find *x*

Answer (06.00)

Sol.



Mass of both disc is equal

So $\Rightarrow M_1 = M_2$

$\Rightarrow (\pi r_1^2) h_1 \rho_1 = (\pi r_2^2) h_2 \rho_2$

$\Rightarrow r_1^2 \times \frac{h_1}{h_2} \times \frac{\rho_1}{\rho_2} = r_2^2$

$\Rightarrow r_1^2 \times 2 \times \frac{\rho_1}{\rho_2} = r_2^2$ $\qquad \frac{\rho_1}{\rho_2} = 3 \Rightarrow \frac{\rho_2}{\rho_1} = \frac{1}{3}$

$\Rightarrow \frac{r_1^2}{r_2^2} = \left(\frac{\rho_2}{2\rho_1}\right) = \left(\frac{1}{6}\right)$

Ratio of M.O.I = $\frac{\frac{1}{4}Mr_1^2}{\frac{1}{4}Mr_2^2} = \left(\frac{r_1^2}{r_2^2}\right) = \left(\frac{1}{6}\right)$

23. A body moving horizontally has an initial speed of 20 m/s. Due to friction, body stops after 5 seconds. If mass of body is 5 kg, co-efficient of friction is $\frac{x}{5}$. Find *x*. Take g = 10 m/s².

Answer (02.00)

Sol. $v = u + at$

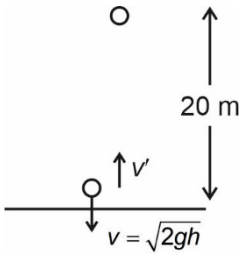
$\Rightarrow 0 = 20 + (-\mu g)(5)$

$\Rightarrow \mu = 0.4$

24. A ball was dropped from 20 m height from ground. Find the height (in m) upto which it rises after the collision. $\left(\text{use } e = \frac{1}{2}, g = 10\ \text{m/s}^2\right)$

Answer (05.00)

Sol.



$v' = ev$

$h' = \frac{(v')^2}{2g} = \frac{e^2 v^2}{2g} = e^2 h = (0.5)^2 \times 20$

$= \frac{20}{4} = 5$ m

$h' = 5$ m

25. A particle is in uniform circular motion with time period 4 s and radius $\sqrt{2}$ m. Find the magnitude of displacement (in m) in 3 s.

Answer (02.00)

Sol. $\theta = \frac{3}{4} \times 2\pi = \frac{3\pi}{2}$

$\Rightarrow |\text{Displacement}| = \sqrt{2}R$

= 2m

26. Two wavelengths λ_1 = 600 nm and λ_2 = 800 nm are used in a YDSE experiment. Their maximas coincide at certain locations on the screen. Find the minimum separation (in mm) between such a location and central maxima. It is given that d = 0.35 mm & D = 7 m

Answer (48.00)

Sol. $n_1 \frac{\lambda_1 D}{d} = n_2 \frac{\lambda_2 D}{d}$

$\Rightarrow 6n_1 = 8n_2$

$\Rightarrow$ Minimum $n_1 = 4$

& $n_2 = 3$

$\Rightarrow$ Minimum separation = $\frac{4 \times 600\ \text{nm} \times 7\ \text{m}}{0.35\ \text{mm}}$

= 48

27.

28.

29.

30.