

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 dimensions of angular impulse is equal to

- (1) $[M^1L^2T^{-1}]$ (2) $[M^1L^2T^1]$
(3) $[M^1L^2T^2]$ (4) $[M^1L^1T^{-1}]$

Answer (1)

Sol. Angular impulse = Change in angular momentum

$$[J] = [mvr]$$

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

2. A vernier caliper has 10 main scale divisions coinciding with 11 vernier scale divisions. 1 main scale division equals 5 mm. The least count of the device is

- (1) $\frac{1}{2}$ mm (2) $\frac{5}{12}$ mm
(3) $\frac{5}{11}$ mm (4) 0.3 mm

Answer (3)

Sol. $10 M = 11 V$

$$\Rightarrow 1V = \frac{10}{11} \times 5 \text{ mm}$$

$$\Rightarrow LC = |M - V|$$

$$= \frac{5}{11} \text{ mm}$$

3. On increasing temperature, the elasticity of a material

- (1) Increases
(2) Decreases
(3) Remains constant
(4) May increase or decrease

Answer (2)

Sol. $E = \frac{\text{Stress}}{\text{Strain}}$

As temperature increases, strain increases

\therefore Elasticity decreases

4. Determine the lowest energy of photon emitted in Balmer series of hydrogen atom.

- (1) 10.02 eV
(2) 1.88 eV
(3) 1.65 eV
(4) 2.02 eV

Answer (2)

Sol. For $3 \rightarrow 2$ transitions

$$\Delta E = 13.6 \left(\frac{1}{4} - \frac{1}{9} \right)$$

$$= 13.6 \times \frac{5}{36}$$

$$= 1.88 \text{ eV}$$

5. de Broglie wavelength of proton = λ and that of an α particle is 2λ . The ratio of velocity of proton to that of α particle is :

- (1) 8 (2) $\frac{1}{8}$
(3) 4 (4) $\frac{1}{4}$

Answer (1)

Sol. $\lambda = \frac{h}{p}$

$$\Rightarrow \lambda = \frac{h}{mv_p}$$

and $2\lambda = \frac{h}{4mv_\alpha}$

$$\Rightarrow \frac{1}{2} = \frac{4v_\alpha}{v_p}$$

$$\Rightarrow \frac{v_p}{v_\alpha} = 8$$

6. 2 moles of monoatomic gas and 6 moles of diatomic gas are mixed. Molar specific heat, for constant volume, of mixture shall be (R is universal gas constant)

- (1) $1.75R$ (2) $2.25R$
 (3) $2.75R$ (4) $2.50R$

Answer (2)

Sol. $(C_V)_{\text{mix}} = \left(\frac{2 \times \frac{3}{2} + 6 \times \frac{5}{2}}{2 + 6} \right) R$
 $= \frac{(3 + 15)R}{8} = \frac{9}{4}R$

7. A gas undergoes a thermodynamic process from state (P_1, V_1, T_1) to state (P_2, V_2, T_2) . For the given

process if $PV^{\frac{3}{2}} = \text{constant}$, find the work done by the gas.

- (1) $\frac{(P_2V_2 - P_1V_1)}{2}$ (2) $\frac{(P_1V_1 - P_2V_2)}{2}$
 (3) $\frac{3}{2}(P_1V_1 - P_2V_2)$ (4) $2(P_1V_1 - P_2V_2)$

Answer (4)

Sol. $W = \frac{P_1V_1 - P_2V_2}{\alpha - 1}$
 $= \frac{P_1V_1 - P_2V_2}{\left(\frac{3}{2} - 1\right)}$
 $= 2(P_1V_1 - P_2V_2)$

8. For measuring resistivity, the relation

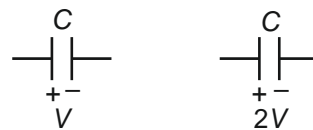
$R = \rho \frac{l}{A} = \frac{\rho l}{\pi r^2}$ is used. Percentage error in resistance (R), in length (l) and in radius (r) are given x , y and z respectively. Find percentage error in resistivity ρ .

- (1) $x + y + 2z$ (2) $x + 2y + z$
 (3) $\frac{x}{2} + y + z$ (4) $x + 2z - y$

Answer (1)

Sol. $\frac{\Delta \rho}{\rho} = \frac{\Delta R}{R} + \frac{2\Delta r}{r} + \frac{\Delta l}{l}$
 $= x + 2z + y.$

9. Two capacitors are charged as shown. When both the positive terminals and negative terminals of capacitors are connected the energy loss will be



- (1) $\frac{1}{2}CV^2$ (2) $\frac{3}{4}CV^2$
 (3) $\frac{1}{4}CV^2$ (4) $2CV^2$

Answer (3)

Sol. $V_c = \frac{CV + 2CV}{2C} = \frac{3V}{2}$

$\therefore \text{Energy loss} = \frac{1}{2}CV^2 + \frac{1}{2}C(2V)^2 - \frac{1}{2}2C\left(\frac{3V}{2}\right)^2$
 $= \frac{1}{4}CV^2$

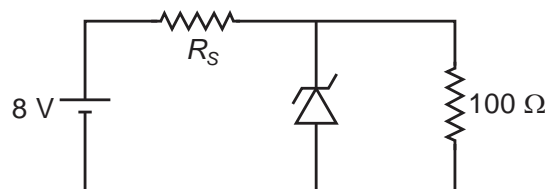
10. A moving coil galvanometer has resistance 50Ω and full deflection current is 5 mA . The resistance needed to convert this galvanometer into voltmeter of range 100 volt is

- (1) 19550Ω (2) 18500Ω
 (3) 19850Ω (4) 18760Ω

Answer (1)

Sol. $I_g(G + R) = 100 \text{ V}$
 $5 \times 10^{-3}(50 + R) = 100$
 $50 + R = 20000$
 $R = 19550 \Omega$

11. In the voltage regulator circuit shown below, the reverse breakdown voltage of zener diode is 5 V and power dissipated across it is 100 mW . Find R_s



- (1) 120Ω (2) 250Ω
 (3) 1000Ω (4) 1500Ω

Answer (1)

Sol. $i_{1000\ \Omega} = 5\ \text{mA}$

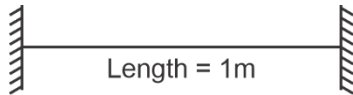
$$i_z = \frac{P}{V_z} = 20\ \text{mA}$$

$$\therefore i_R = 25\ \text{mA}$$

$$V_R = 3\ \text{V}$$

$$\therefore R = \frac{3}{25} \times 10^3 = 120\ \Omega$$

12. Two strings are identical and fixed at both ends with tension 6 N each. If the tension in one string fixed at both end is changed from 6 N to 52 N, then find beats frequency.



Linear mass density = 1 kg/m

- (1) 2.38 Hz (2) 3.25 Hz
(3) 2.75 Hz (4) 5.25 Hz

Answer (1)

Sol. $f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$

$$f_1 = \frac{1}{2L} \sqrt{\frac{T_1}{\mu}}$$

$$f_2 = \frac{1}{2L} \sqrt{\frac{T_2}{\mu}}$$

$$\text{Beats frequency} = \Delta f = f_2 - f_1 = \frac{1}{2L} \left(\sqrt{\frac{52}{\mu}} - \sqrt{\frac{6}{\mu}} \right)$$

$$= \frac{1}{2} (\sqrt{52} - \sqrt{6})$$

$$= \frac{1}{2} (7.21 - 2.45)$$

$$= 2.38\ \text{Hz}$$

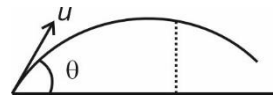
13. A particle is moving in a circle of radius R in time period of T . This moving particle is projected at angle θ with horizontal & attains a maximum height of $4R$. Angle θ can be given as (g is acceleration due to gravity)

(1) $\sin^{-1} \left(\frac{T}{2\pi} \sqrt{\frac{2g}{R}} \right)$ (2) $\sin^{-1} \left(\frac{T}{\pi} \sqrt{\frac{g}{R}} \right)$

(3) $\sin^{-1} \left(\frac{T}{\pi} \sqrt{\frac{2g}{R}} \right)$ (4) $\sin^{-1} \left(T \sqrt{\frac{2g}{R}} \right)$

Answer (3)

Sol. $\frac{2\pi R}{T} = u$

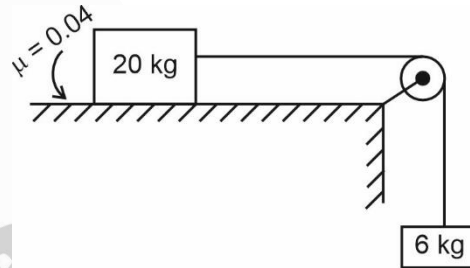


$$\frac{u^2 \sin^2 \theta}{2g} = 4R$$

$$\frac{4\pi^2 R^2}{T^2 2g} \sin^2 \theta = 4R$$

$$\sin^2 \theta = \frac{2gT^2}{\pi^2 R} = \left(\frac{T}{\pi} \sqrt{\frac{2g}{R}} \right)^2$$

14. A block of mass 20 kg is placed on rough surface having co-efficient of friction 0.04 as shown in figure. Find acceleration of system when it released.



- (1) 3 m/s
(2) 2 m/s
(3) 1 m/s
(4) 4 m/s

Answer (2)

Sol. Maximum friction (F_{max}) = $0.04 \times 20 \times 10 = 8\ \text{N}$

Pulley force (F) = 60 N

$$\text{Acceleration (a)} = \frac{60 - 8}{26} = 2\ \text{m/s}^2$$

15. In single slit diffraction with slit width 0.1 mm, light of wavelength $6000\ \text{\AA}$ is used. A convex lens of focal length 20 cm is used to focus the diffracted ray. Find width of central maxima.
- (1) 24 mm
(2) 2.4 mm
(3) 12 mm
(4) 1.2 mm

Answer (2)

Sol. Angular width = $\frac{2\lambda}{a}$

Linear width = $\frac{2\lambda}{a} f$

$$= \frac{2 \times 6000 \times 10^{-10} \times 20 \times 10^{-2}}{0.1 \times 10^{-3}}$$

$$= 2 \times 6 \times 2 \times 10^{-4}$$

$$= 24 \times 10^{-4}$$

$$= 2.4 \text{ mm}$$

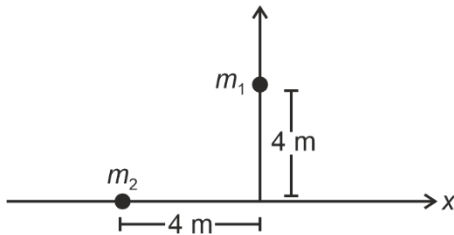
- 16.
- 17.
- 18.
- 19.
- 20.

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. Two particles each of mass 2 kg are placed as shown in xy plane. If the distance of centre of mass from origin is $\frac{4\sqrt{2}}{x}$, find x

from origin is $\frac{4\sqrt{2}}{x}$, find x



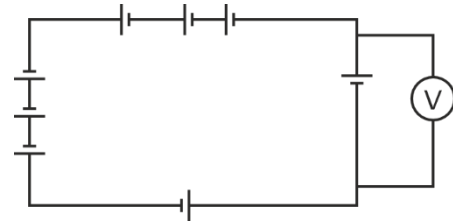
Answer (2)

Sol. $\vec{r}_{cm} = -2\hat{i} + 2\hat{j}$

$\therefore r = 2\sqrt{2}$

$x = 2$

22. Eight identical batteries (5 V, 1 Ω) are connected as shown :



The reading of the ideal voltmeter is _____ volts.

Answer (0)

Sol. $\epsilon = 8 \times 5 = 40 \text{ V}$

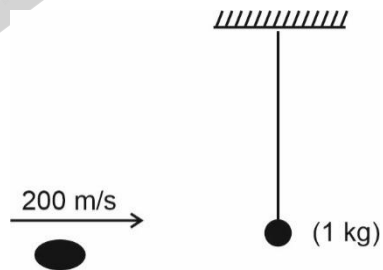
$r = 8 \times 1 = 8 \Omega$

$\Rightarrow i = 5 \text{ A}$

\Rightarrow Voltmeter reads

$= 5 - ir = 0 \text{ volts}$

23. A bullet, of mass 10^{-2} kg and velocity 200 m/s gets embedded inside the bob (mass 1 kg) of a simple pendulum as shown. The maximum height the system rises by is _____ cm.



Answer (20)

Sol. Momentum conservation :

$10^{-2} \times 200 = 1 \times v \quad \dots(1)$

Energy conservation :

$v = \sqrt{2gh} \quad \dots(2)$

$\Rightarrow h = \frac{v^2}{2g} = \frac{4}{20} \text{ m} = 20 \text{ cm}$

24. The length of a seconds pendulum if it is placed at height $2R$ (R : radius of earth) is $\frac{10}{x\pi^2}$ metres. Find x .

Answer (9)

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

$$\Rightarrow 2 = 2\pi\sqrt{\frac{l}{g_0/9}}$$

$$\Rightarrow 2 = 2\pi \times 3\sqrt{\frac{l}{10}}$$

$$\Rightarrow \frac{l}{10} = \frac{1}{9\pi^2}$$

$$\Rightarrow l = \frac{10}{9\pi^2} \text{ m}$$

25. Nuclear mass and size of nucleus of an element A are 64 and 4.8 femtometer. If size of nucleus of element B is 4 femtometer then its nuclear mass will be $\frac{1000}{x}$ then

Answer (27)

Sol. $R^3 = \alpha A$

$$\frac{(4.8^3)}{4^3} = \frac{64}{M}$$

$$M = \frac{16 \times 4 \times 16 \times 4}{48 \times 48 \times 48} \times 10^3$$

26. In a series LCR circuit connected to an AC source, value of the elements are L_0 , C_0 & R_0 such that circuit is in resonance mode. If now capacity of capacitor is made $4C_0$, the new value of inductance, for circuit to still remain in resonance, is $\frac{L_0}{n}$. Find n .

Answer (4)

Sol. $\frac{1}{\sqrt{LC}} = \text{fixed}$

$$\Rightarrow LC = \text{fixed}$$

$$\Rightarrow L = \frac{L_0}{4}$$

27. The current through a conductor varying with time as $i = 3t^2 + 4t^3$.

Find amount of charge (in C) passes through cross section of conductor in interval $t = 1$ sec to $t = 2$ sec.

Answer (22)

Sol. $Q = \int i \cdot dt$

$$= \int_1^2 (3t^2 + 4t^3) \cdot dt = (t^3 + t^4)_1^2$$

$$= (8 + 16) - (2)$$

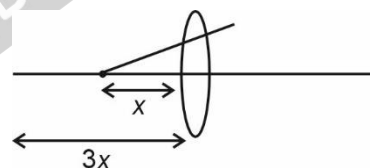
$$= 22 \text{ C}$$

28. Distance between virtual magnified image, (size three times of object) of an object placed in front of convex lens and object is 20 cm. The focal length of lens is x cm, then x is _____

Answer (15)

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ $\frac{v}{u} = 3$

$$v = 3u$$



$$3x - x = 20$$

$$x = 20$$

$$\frac{1}{-30} - \frac{1}{-10} = \frac{1}{f}$$

$$\frac{1}{10} - \frac{1}{30} = \frac{1}{f}$$

$$\frac{2}{30} = \frac{1}{f} \Rightarrow f = 15$$

29.
30.