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

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

$\Rightarrow LC = |M - V|$

$= \frac{5}{11}$ 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 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. $(C_V)_{mix} = \left(\frac{2\times\frac{3}{2}+6\times\frac{5}{2}}{2+6}\right)R$

$= \frac{(3+15)R}{8} = \frac{9}{4}R$

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 $PV^{\frac{3}{2}} =$ 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) $x + 2y + z$

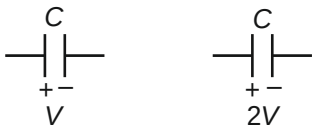
(3) $\frac{x}{2} + y + z$ (4) $x + 2z - y$

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

$\therefore$ 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 50 Ω and full deflection current is 5 mA. The resistance needed to convert this galvanometer into voltmeter of range 100 volt is

(1) 19550 Ω (2) 18500 Ω

(3) 19850 Ω (4) 18760 Ω

Answer (1)

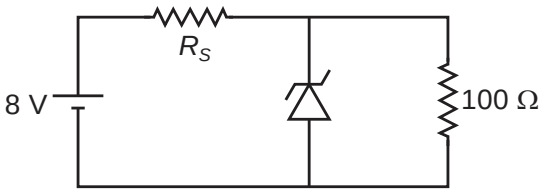
Sol. $I_g(G + R) = 100$ V

~~5~~ × $10^{-3}(50 + R) = ~~100~~^{20}$

$50 + R = 20000$

$R = 19550\ \Omega$

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) 120 Ω (2) 250 Ω

(3) 1000 Ω (4) 1500 Ω

Answer (1)

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

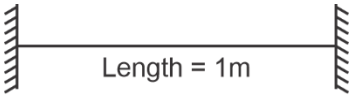
$$i_z = \frac{P}{V_z} = 20 \text{ mA}$$

$\therefore \quad i_R = 25$ mA

$V_R = 3$ V

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

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

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

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

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

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

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

= 2.38 Hz

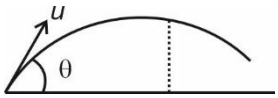
13. A particle is moving in a circle of radius R in time period of T. This moving particle is projected at angle θ with horizontal & attains a maximum height of $4R$. Angle θ can be given as (g is acceleration due to gravity)

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

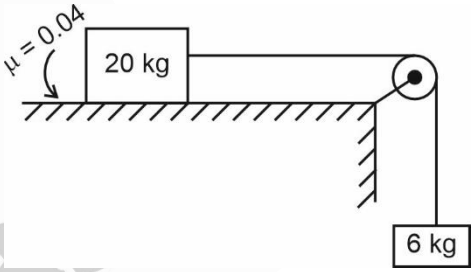


$$\frac{u^2 \sin^2\theta}{2g} = 4R$$

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

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

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 × 20 × 10 = 8N

Pulley force (F) = 60 N

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

15. In single slit diffraction with slit width 0.1 mm, light of wavelength 6000 Å 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 $= \frac{2\lambda}{a} f$

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

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

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

$= 2.4$ mm

16.

17.

18.

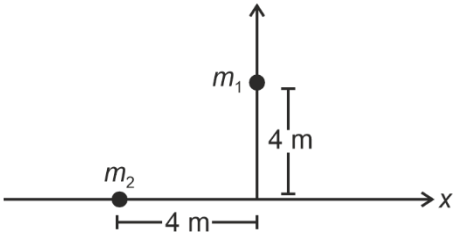
19.

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



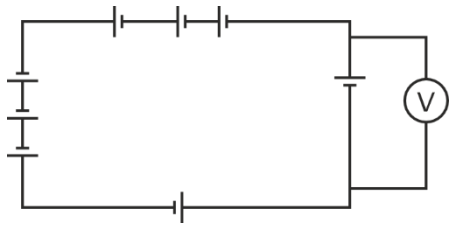
Answer (2)

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

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

$\boxed{x = 2}$

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



The reading of the ideal voltmeter is _____ volts.

Answer (0)

Sol. $\varepsilon = 8 \times 5 = 40$ V

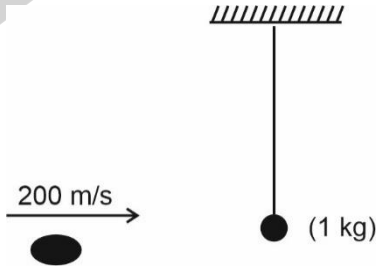
$r = 8 \times 1 = 8\ \Omega$

$\Rightarrow \quad i = 5$ A

$\Rightarrow$ Voltmeter reads

$= 5 - ir = 0$ 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 :

$10^{-2} \times 200 \simeq 1 \times v \qquad \ldots(1)$

Energy conservation :

$v = \sqrt{2gh} \qquad \ldots(2)$

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

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

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

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

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

$\Rightarrow \quad l = \frac{10}{9\pi^2}$ 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. $R^3 = \alpha A$

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

$M = \frac{16\times4\times16\times4}{48\times48\times48}\times10^3$

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

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

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

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 internal t = 1 sec to t = 2 sec.

Answer (22)

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

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

= (8 + 16) – (2)

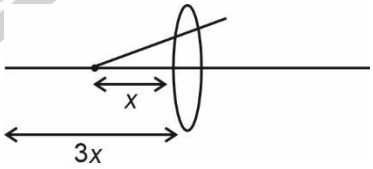
= 22 C

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

$v = 3u$



$3x - x = 20$

$x = 20$

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

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

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

29.

30.