Solution

PHYSICS

JEE main - Physics

PHYSICS (Section-A)

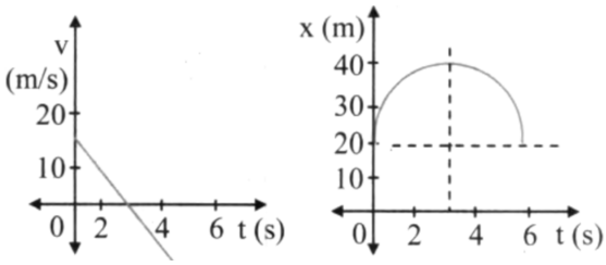
1. **(a)** $[ML^{-1}T^{-2}]$

   Explanation:

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

2.

   (c)



   Explanation:

   The particle is undergoing constant retardation. Hence, its velocity will reduce to zero and then become negative. Graphically it would mean a line with the constant slope with y-intercept at 15 m/s.

   $\Delta t = \frac{v - v_0}{a} = \frac{0-15}{5} = 3s$

   i.e., in 3 s, velocity will reduce to zero giving x-intercept at t = 3 s, then velocity will take a negative value. The corresponding plot of displacement vs time will be a parabolic curve with decreasing slope as velocity is decreasing uniformly. After time t = 3 s, when velocity will turn negative it would imply particle has reversed the direction of motion and heading back to original position.

   Both these representations are correctly depicted by graphs.

3.

   (d) 23.09 m

   Explanation:

   Components of velocities of both the particles in the vertical direction are equal. Therefore, their times of flight are equal and their relative motion is in the horizontal direction only. Thus, the maximum distance between them is equal to the difference in their horizontal ranges.

   $R_1 = \frac{(20)^2 \sin 60^\circ}{g} = \frac{400\sqrt{3}}{10 \times 2} = 34.64$ m

   $R_2 = \frac{(20/\sqrt{3})^2 \sin 120^\circ}{g}$

   $= \frac{400 \times \sqrt{3}}{10 \times 3 \times 2} = 11.55$ m

   $\therefore S_{max.} = R_1 - R_2 = 23.09$ m

4.

   (d) $T_1 > T_2$

   Explanation:

   Tension,

   $T = \frac{mv^2}{r} + mg\cos\theta$

   For $\theta = 30^o$, $T_1 = \frac{mv^2}{r} + mg\cos 30^o$

   $\theta = 60^o$, $T_2 = \frac{mv^2}{r} + mg\cos 60^o$

   $T_1 > T_2$

5. **(a)** Zero

Explanation:

For a body moving in a circular path, the centripetal force and the displacement are perpendicular to each other. So, the work done by the centripetal force is zero.

6. **(b)** -6$\hat{i}$ N m

Explanation:

The torque about any point is given as:

$\tau = \vec{r} \times \vec{F}$

Substitute the value of force and radius vector:

$\tau = 2\hat{k} \times 3\hat{j}$

$\tau = 6(-\hat{i})$

τ = -6$\hat{i}$ N m

7. **(d)** 2 cm

Explanation:

Velocity at the sides is higher when the cylindrical vessel rotates, since v = rω (ω is same)

Hence, v increases as r increases or v is proportional to r. According to Bernoulli theorem,

$P + \frac{1}{2}\rho v^2$ = constant (hρg is same here)

Hence, pressure at sides is lower than at the centre since velocity at sides is higher than at centre.

Hence, $\frac{1}{2}\rho\left(v^2_{\text{sides}} - v^2_{\text{centre}}\right) = \left(P_{\text{centre}} - P_{\text{sides}}\right) = \Delta P$

or $\frac{1}{2}\rho\left[(r\omega)^2 - (0 \times \omega)^2\right] = \Delta P$

or $\frac{1}{2}\rho r^2\omega^2 = h\rho g$

or $h = \frac{r^2\omega^2}{2g} = \frac{(0.05)^2 \times (2\pi \times 2)^2}{2 \times 9.8}$

= 0.02 m = 2 cm

8. **(c)** the distance among its atoms increases

Explanation:

With rise in temperature, the amplitude of vibration and hence energy of atoms increases. This results in an increase in the average distance between them and the rod expands.

9. **(d)** 227°C

Explanation:

227°C

10. **(a)** 5 m/s^2

Explanation:

Rate of change of speed,

$\frac{dv}{dt}$ = tangential acceleration

= $\frac{\text{tangential force}}{\text{mass}} = \frac{mg\sin 30^\circ}{m}$

= g sin 30° = 10 $\times \frac{1}{2}$ = 5 m/s^2

11. **(a)** $\frac{C_1 V}{C_1 + C_2}$

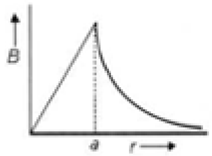
Explanation:

By taking common potential:

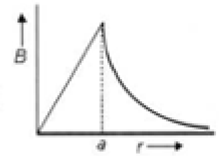
$C_1V = C_1V' + C_2V'$

$\therefore V' = \frac{C_1}{(C_1+C_2)} \times V$

12.

(d) 

Explanation:



13.

(b) zero

Explanation:

When the magnetic field is applied to a diamagnetic substance, it produces a magnetic field in the opposite directions so the net magnetic field inside the cavity of the sphere will be zero. So, the field inside the paramagnetic substance kept inside the cavity is zero.

14.

(b) becomes 4 L henry

Explanation:

$L \propto N^2$

15.

(c) 170 V

Explanation:

$E - E_b = IR$

$\therefore E_b = E - IR = 220 - 2.5 \times 20 = 170$ V

16.

(c) double of the frequency of wave

Explanation:

double of the frequency of wave

17.

(c) 1.856×10^{-6} amp

Explanation:

Let n be the number of photons falling on the surface.

Energy of n photons,

$n \frac{hc}{\lambda} = P$

$\therefore n = \frac{P\lambda}{hc}$

$= \frac{10^{-3} \times 4.56 \times 10^{-7}}{6.62 \times 10^{-34} \times 3 \times 10^8}$

$= 2.35 \times 10^{15}$

As quantum efficiency = 0.5% hence number o f electrons liberated from surface,

$n' = n \times \frac{0.5}{100} = 1.15 \times 10^{13}$

$\therefore I = n'e = 1.15 \times 10^{13} \times 1.6 \times 10^{-19}$

$= 1.84 \times 10^{-6}$ amp.

18. **(a)** $4v_0$ Hz

Explanation:

$v = Z^2RC\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$v_0 = RC\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5RC}{36}$

Further $v = (2)^2 RC\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{20RC}{36}$

$\therefore \frac{v}{v_0} = 4$ or $v = 4v_0$ Hz

19.

(c) 3 : 2

Explanation:

Let heavy nucleus breaks into two nuclei of mass m_1 and m_2 and move away with velocities V_1 and V_2 respectively.

According to question, $\frac{V_1}{V_2} = \frac{8}{27}$

$m_1V_1 = m_2V_2$ (Law of momentum conservation)

$\Rightarrow \frac{m_1}{m_2} = \frac{V_2}{V_1} = \frac{27}{8}$

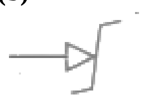
$\frac{\rho \times \frac{4}{3}\pi R_1^3}{\rho \times \frac{4}{3}\pi R_2^3}$ ($\because$ density $\rho = \frac{\text{mass}}{\text{volume}}$)

$\Rightarrow \left(\frac{R_1}{R_2}\right) = \left(\frac{27}{8}\right)^{\frac{1}{3}} = \left(\frac{3}{2}\right)^{3 \times \frac{1}{3}}$

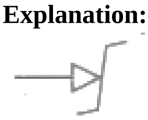
$\therefore \frac{R_1}{R_2} = \frac{3}{2}$

20.

(b)



Explanation:



PHYSICS (Section-B)

21. 0.25

Explanation:

$\frac{(-1)(+q)}{d^2} + \frac{(-1)(-1)}{4d^2} = 0$

or $\frac{-q}{d^2} + \frac{1}{4d^2} = 0$ or $q = \frac{1}{4}$ = 0.25 C

22. 0.28

Explanation:

$g = \frac{4}{3}\pi G\rho R$

$g \propto \rho R$

$\therefore \frac{g_e}{g_m} = \frac{\rho_e}{\rho_m} \times \frac{R_e}{R_m}$

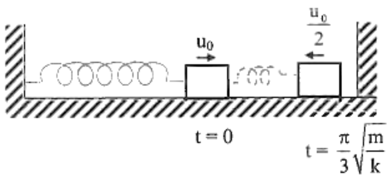
$\therefore \frac{6}{1} = \frac{5}{3} \times \frac{R_e}{R_m}$

$\therefore R_m = \frac{5}{18} R_e$

$\therefore k = \frac{5}{18} = 0.28$

23. 0.52

Explanation:



Displacement x = A sin ωt

Velocity, v = ωA cos ωt

At the time of collision,

v = 0.5 U_0

$\therefore \omega \ \cos\omega t = \frac{\omega A}{2}$

$\therefore$ cos $\omega t = \frac{1}{2}$

$\Rightarrow \omega t = \frac{\pi}{3}$

$\Rightarrow t = \frac{\pi}{3}\sqrt{\frac{m}{k}}$

The time at which the particle passes through the equilibrium position for the second-time

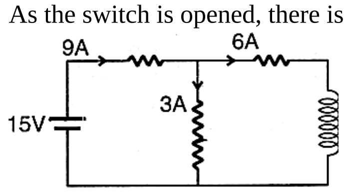
= 2 $\times$ t + $\frac{T}{2}$ = 2 $\times \frac{\pi}{3}\sqrt{\frac{m}{k}} + \frac{2\pi}{2}\sqrt{\frac{m}{k}}$

= $\frac{5\pi}{3}\sqrt{\frac{m}{k}} = \frac{5\pi}{3}\sqrt{\frac{0.1}{10}} = \frac{5\times\pi}{3\times10}$ = 0.52 s

24. 6

Explanation:

As the switch is opened, there is no change in current, hence required current is 6 A.



25. 1818

Explanation:

For an adiabatic process,

$TV^{\gamma-1}$ = constant

$\therefore T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$\Rightarrow$ T_2 = $(300) \times \left(\frac{V_1}{\frac{V_1}{16}}\right)^{1.4-1}$

$\Rightarrow$ T_2 = 300 $\times$ $(16)^{0.4}$

Ideal gas equation, PV = nRT

$\therefore$ V = $\frac{nRT}{P}$

$\Rightarrow$ V = kT (since pressure is constant for isobaric process)

So, during isobaric process

$V_2 = kT_2$ ...(i)

$2V_2 = kT_f$ ...(ii)

Dividing (i) by (ii)

$\frac{1}{2} = \frac{T_2}{T_f}$

T = $2T_2$ = 300 $\times$ 2 $\times$ $(16)^{04}$ = 1818 K