JEE Main 2021 August 27 Shift 2 Physics

1. A mass of 15kg is kept at the center of spherical shell of mass 50 kg and radius 50 m. Find the value of gravitation potential at a distance 25 m from center.

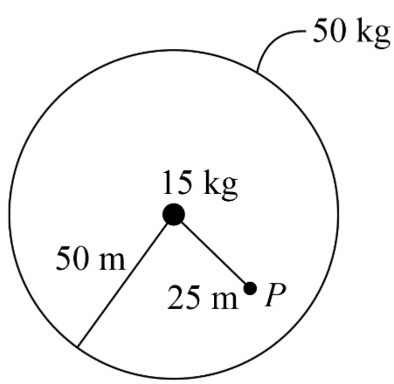
(A) $-\frac{3G}{8}$

(B) $-\frac{8G}{5}$

(C) $-\frac{6G}{4}$

(D) $-\frac{7G}{5}$

Ans. (B)



Sol.

Since potential is a scalar quantity so,

$$V_P = V_{50\ kg} + V_{15\ kg}$$

$$V_P = -\frac{G(50)}{50} - \frac{G(15)}{25}$$

$$V_P = -\frac{80G}{50} = -\frac{8G}{5}$$

2. Drops are falling from 9.8 m height. When first drop touches the ground, third drop leave. Find height of second drop when first drop about to touches the ground: $(g = 9.8 m/s^2)$

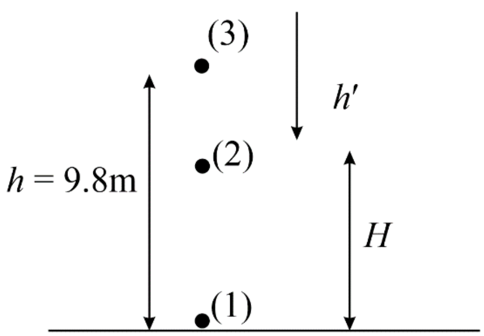
(A) 7.35m

(B) 8.35m

(C) 6.35m

(D) 9.35m

Ans. (A)



Sol.

For first drop.

$h=\frac{1}{2} g(2 n)^2$

For 2^{nd} drop

$h'=\frac{1}{2} g(n)^2$

$\frac{\mathrm{h}}{\mathrm{h}'}=\frac{4}{1}$

$\mathrm{h}'=\frac{\mathrm{h}}{4}=\frac{9.8}{4}$

so height of 2^{nd} drop

$H=h-h'=9.8-\frac{9.8}{4}=\frac{3}{4} \times 9.8=7.35 \mathrm{~m}$

3. A player hits a ball at an angle 45° from horizontal with velocity $25 \mathrm{m/s}$. Find time taken to reach maximum height and maximum height $(\mathrm{g}=10 \mathrm{m/s}^2)$

(A) $\frac{7}{2 \sqrt{2}} s, \frac{125}{8} m$

(B) $\frac{5}{2} s, \frac{135}{3} m$

(C) $\frac{5}{\sqrt{2}} s, \frac{125}{4} m$

(D) $\frac{5}{2 \sqrt{2}} s, \frac{125}{8} m,$

Ans. (D)

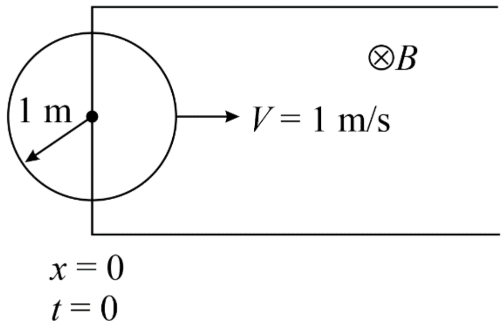
Sol. $\theta=45^{\circ}$

$H=\frac{u^2\sin^2 0}{2g}=\frac{(25)^2\times\left(\frac{1}{2}\right)}{2\times10}=\frac{125}{8}m$

and time $t=\frac{T}{2}$

$=\frac{u\sin\theta}{g}=\frac{25\left(\frac{1}{\sqrt{2}}\right)}{10}=\frac{25}{10\sqrt{2}}=\frac{5}{2\sqrt{2}}$ s

4. In the given arrangement, Find EMF induced in 1second if magnetic field is $B=1T$ and radius of circular loop is 1m.



(A) $\frac{2}{\pi}$ V

(B) $\frac{1}{\pi}$ V

(C) $\frac{\pi}{2}$ V

(D) 2πV

Ans. (C)

Sol. According to Lenz's Law,

$\varepsilon=-\frac{d\phi}{dt}$

$\varepsilon=-B\frac{dA}{dt}=-B\frac{\Delta A}{\Delta t}$

$\varepsilon=\frac{-1\times\left(\frac{\pi R^2}{2}-0\right)}{1}; |\varepsilon|=\frac{\pi}{2}$V

5. In YDSE experiment, there are two light waves of intensity I_1 and I_2 forms interference pattern on screen. If minimum intensity of fringes is zero, what will be the maximum intensity?

(A) $3I_1$

(B) $4I_1$

(C) $2I_1$

(D) $\sqrt{8}I_1$

Ans. (B)

Sol. Given,

$I_{\text{minimum}} = 0$

$\left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = 0$

It means,

$\Rightarrow \mathrm{I}_1 = \mathrm{I}_2$

Now as we know that-

$\mathrm{I}_{max} = \left(\sqrt{\mathrm{I}_1} + \sqrt{\mathrm{I}_2}\right)^2$

So,

$\mathrm{I}_{max} = 4\mathrm{I}_1$

6. Find total number of spectral lines in emission spectrum of a sample of H like atoms highest quantum state is $\mathrm{n} = 6$.

(A) 6

(B) 5

(C) 15

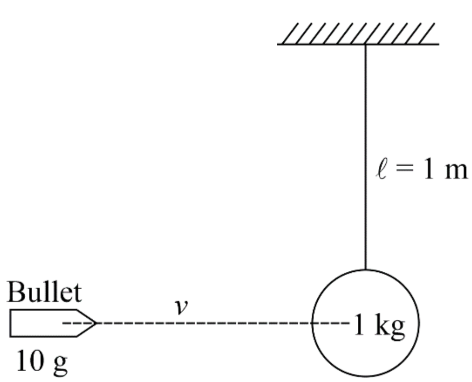
(D) 20

Ans. (C)

Sol. Total number of spectral lines in emission spectrum

$6C_2 = 15$

7. A bullet of mass 10g travelling with velocity 'v' collides with pendulum-mass system of mass 1kg and length 1m and embedded in it as shown in figure. Find minimum value of V, so that pendulum mass undergoes complete circular motion. $(g = 9.8 \mathrm{m/s^2})$



(A) 207

(B) 307

(C) 407

(D) 707

Ans. (D)

Sol. As we know that to complete the just vertical circular motion velocity at bottom should be $\sqrt{5gl}$

So,

Final velocity of system (bullet + mass) $= \sqrt{5gl}$

Now according to momentum conservation,

$(\mathrm{m}+\mathrm{M})\sqrt{5gl} = \mathrm{m} \times \mathrm{v}$

Thus,

$\mathrm{v} = \frac{(1+0.01)\times\sqrt{5\times9.8\times1}}{0.01}$

$\mathrm{v} = 707\ \mathrm{m/s}$

8. If water fall from height 63 meter. Then find the temperature difference of water between top and bottom position. $(\mathrm{g} = 9.8\mathrm{m/s^2})$

(A) $30^\circ\mathrm{C}$

(B) $40^\circ\mathrm{C}$

(C) $50^\circ\mathrm{C}$

(D) $0.147^\circ\mathrm{C}$

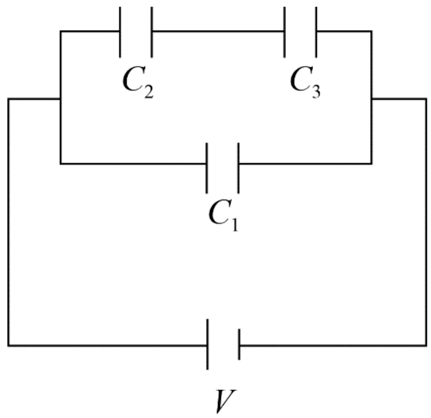
Ans. (D)

Sol. $mgh = ms\Delta\theta$

$\mathrm{g} \times 63 = \Delta\theta \times 4.2 \times 10^3$

$\Delta\theta = 0.147^\circ\mathrm{C}$

9. In the given circuit, if $\mathrm{C_1} = 2\mathrm{F}, \mathrm{C_2} = 6\mathrm{F}$ & $\mathrm{C_3} = 12\mathrm{F}$. Find the ratio of charge on capacitor $\mathrm{C_1}$ and $\mathrm{C_2}$ at steady state?



(A) $\frac{1}{2}$

(B) 5

(C) $\frac{1}{7}$

(D) 10

Ans. (A)

Sol. C_2 & C_3 are in series with each other and their series combination is in parallel with C_1

So,

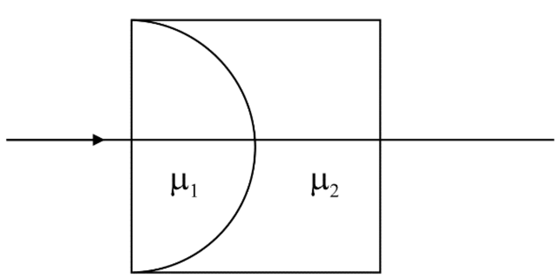
$$C_{eq} = C_1 + \frac{C_2 C_3}{C_2 + C_3}$$

$$C_{eq} = 2 + \frac{6\times12}{6+12} = 6F$$

Then,

$$\frac{Q_{C_1}}{Q_{C_2}} = \frac{C_1 V}{\frac{C_2 C_3}{C_2 + C_3} V} = \frac{2\times(6+12)}{6\times12} = \frac{1}{2}$$

10. For given arrangement as shown in figure. what will be the ratio of radius of curvature to equivalent focal length for given arrangement as shown in figure.



(A) $\mu_1 - \mu_2$

(B) $\mu_2 - \mu_1$

(C) $\frac{\mu_1-\mu_2}{4}$

(D) $2(\mu_1)$

Ans. (A)

Sol. $\frac{1}{f_1} = (\mu_1 - 1)\left[\frac{1}{R}\right]$

$\frac{1}{f_2} = (\mu_2 - 1)\left[\frac{1}{-R}\right]$

$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{(\mu_1-1)}{R} - \frac{(\mu_2-1)}{R}$

$\frac{1}{f_{eq}} = \frac{(\mu_1-\mu_2)}{R}$

$\frac{\mathrm{R}}{f_{eq}} = \mu_1 - \mu_2$

So the (A) option is the correct option.

11. Initially in an AC circuit $\mathrm{X_L} = 3\mathrm{R}$ and resistance is R. Now if a capacitor of reactance 2R is connected in series then Find ratio of new power factor to old power factor.

(A) $\sqrt{8}$

(B) $\sqrt{7}$

(C) $\sqrt{6}$

(D) $\sqrt{5}$

Ans. (D)

Sol. initial power factor $= \frac{R}{\sqrt{9R^2+R^2}} = \frac{1}{\sqrt{10}}$

final power factor $= \frac{\mathrm{R}}{\sqrt{(3-2)^2\mathrm{R}^2+\mathrm{R}^2}} = \frac{1}{\sqrt{2}}$

$\frac{PF_{\text{final}}}{PF_{\text{intitial}}} = \sqrt{5}$

So the (D) option is the correct option.

12. If fundamental frequency of close organ pipe is in resonance with the turning fork of frequency 250 Hz .What should be the length of pipe ?

(A) 23 cm

(B) 43 cm

(C) 33 cm

(D) 30 cm

Ans. (C)

Sol. For closed organ pipe

$\mathrm{f} = (2n+1)\frac{v}{4\ell}$

for fundamental frequency, n = 0

$f_0 = \frac{V}{4\ell}$

$\Rightarrow \ell = \frac{v}{4f_0}$

$= \frac{330}{4\times 250} = 33$ cm

13. A galvanometer of 50 division having sensitivity is 2 div/mA. Potential difference across galvanometer is 50 mV. Find resistance of galvanometer is :

(A) 8

(B) 6

(C) 4

(D) 2

Sol. $\mathrm{C.S.} = \frac{\theta}{\mathrm{I_g}}$

$\mathrm{I_g} = \frac{\theta}{\mathrm{C.S.}} = \frac{50\mathrm{div}}{2\mathrm{div/mA}} = 25\mathrm{mA}$

Potential difference $= 50\mathrm{mV}$

Resistance $= \frac{\mathrm{V}}{\mathrm{I}} = \frac{50\mathrm{mV}}{25\mathrm{mA}} = 2\Omega$

14. If we consider force (F), length (L) and time (T) as a fundamental quantities then Find dimensional formula for density.

(A) $[\mathrm{FL^{-1}T^2}]$

(B) $[\mathrm{F^3L^{-4}T}]$

(C) $[\mathrm{F^2L^{-4}T}]$

(D) $[\mathrm{FL^{-3}T^{-2}}]$

Ans. (C)

Sol. $\mathrm{d} \propto \mathrm{F^aL^bT^c}$

$[ML^{-3}] = [MLT^{-2}]^a[L^b][T^c]$

$= [M^a L^{a+b} T^{-2a+c}]$

comparing :

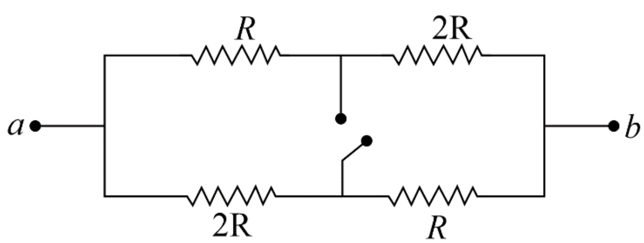
$a = 1 \ldots\ldots (i)$

$a + b = -3 \ldots\ldots (ii)$

$-2a + c = 0 \ \ldots\ldots (iii)$

$c = 2; \quad b = -4; \quad \therefore [d] = [FL^{-4}T^2]$

15. Find the value of x. If the ratio of equivalent resistance across A and B when the switch is close and switch is open is $[8 : x]$



(A) 2

(B) 8

(C) 9

(D) 1

Ans. (C)

Sol. When switch is closed

$R_1 = \frac{2R}{3} + \frac{2R}{3} = \frac{4R}{3}$

When open $R_2 = \frac{3R \cdot 3R}{3R + 3R} = \frac{3R}{2}$

$\frac{R_1}{R_2} = \frac{4R}{3} \times \frac{2}{3R} = \frac{8}{9}$

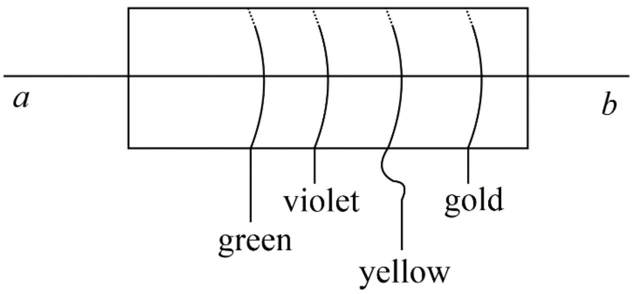
Now according to question

$$\frac{R_1}{R_2} = \frac{8}{x}$$

$$\frac{8}{9}=\frac{8}{x}$$

x= 9

16. Using the colour code scheme of resistors calculate the value of given colour coded resistor.



(A) $47 \times 10^{4} \pm 5\%$

(B) $57 \times 10^{-4} \pm 10\%$

(C) $64 \times 10^{-4} \pm 5\%$

(D) $57 \times 10^{4} \pm 10\%$

Ans. (D)

Sol. A colour code is used to indicate the resistance value of a carbon resistor and its percentage accuracy.

Colour	Letter as an aid to memory	Number	Miltiplier	Colour	Tolerance
Black	B	0	10^{0}	Gold	5%
Brown	B	1	10^{1}	Silver	10%
Red	R	2	10^{2}	No fourth band	20%
Orange	O	3	10^{3}		
Yellow	Y	4	10^{4}		
Green	G	5	10^{5}		
Blue	B	6	10^{6}		
Violet	V	7	10^{7}		
Grey	G	8	10^{8}		
While	W	9	10^{9}		

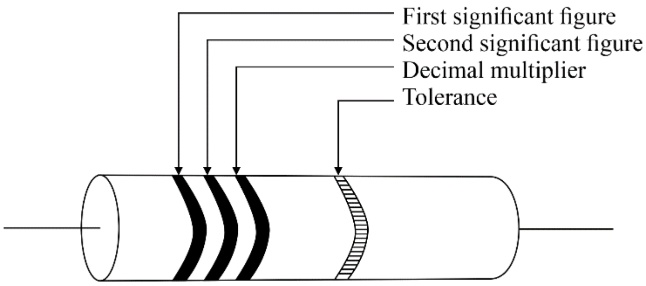
A set of coloured co-axial rings or bands is printed on the resistor which reveals the following facts :

1. The first band indicates the first significant figure.

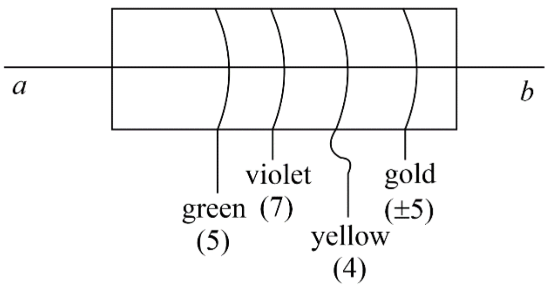
2. The second band indicates the second significant figure.

3. The third band indicates the power of ten with which the above two significant figures must be multiplied to get the resistance value in ohms.

4. The fourth band indicates the tolerance or possible variation in percent of the indicated value. If the fourth band is absent, it implies a tolerance of 20%



Meanings of four bands.



$R = 57 \times 10^4 \pm 5\%$

17. For the given value of temperature find the ratio of RMS velocity of O_2 molecule to H_2 molecule.

(A) $\frac{1}{6}$

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

(C) 6

(D) 4

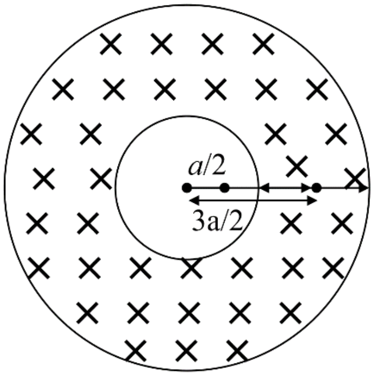
Ans. (B)

Sol. $V_{\text{rms}} = \sqrt{\frac{3RT}{M}}$

$V_{\text{rms}} \propto \frac{1}{\sqrt{M}}$

$\frac{(V_{rms})O_2}{(V_{rms})H_2} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} = \sqrt{\frac{2}{32}} = \frac{1}{4}$

18. A coaxial cable having a inner core of radius ' a ' and carrying current 'i' covered by a shell whose inner radius is a and outer radius 'b' also carrying a current 'i' but in opposite direction then find the ratio of magnetic field at a distance $'a/2'$ inside and outside from surface of inner core. $(b > 2a)$



(A) $\frac{B_1}{B_2} = \frac{3(b^2-a^2)}{4b^2-9a^2}$

(B) $\frac{B_1}{B_2} = \frac{2(b^2-a^2)}{4b^2-9a^2}$

(C) $\frac{B_1}{B_2} = \frac{4(b^2-a^2)}{4b^2-9a^2}$

(D) $\frac{B_1}{B_2} = \frac{3(b^3-a^3)}{4b^3-9a^3}$

Ans. (A)

Sol. $B_1 \times 2\pi\left(\frac{a}{2}\right) = \frac{\mu_0 I\left(\frac{a}{2}\right)^2}{a^2}$

$B_2 \times 2\pi\left(\frac{3a}{2}\right) = I - I\frac{\left[\left(\frac{3a}{2}\right)^2 - a^2\right]}{(b^2-a^2}$

$= I\left[1 - \frac{5a^2}{4(b^2-a^2)}\right]$

$= \frac{(4b^2-9a^2)}{4(b^2-a^2)}$

$\frac{B_1}{3B_2} = \frac{b^2-a^2}{4a^2-9a^2}$

$\frac{B_1}{B_2} = \frac{3(b^2-a^2)}{4b^2-9a^2}$

19. In a photoelectric experiment, when wavelength of light is 642.4 nm falls on metal surface, stopping potential of photo electrons is 0.48eV. What will be the stopping potential when wavelength of light used is 474 nm?

(A) 1.10 eV

(B) 1.16 eV

(C) 1.25eV

(D) 1.30eV

Ans. (B)

Sol. According to Einstein's equation,

$$eV = \frac{hc}{\lambda} - \phi$$

Write the two equations for 2 different cases and take difference of both case

$$e(V' - V) = hc\left(\frac{1}{\lambda'} - \frac{1}{\lambda}\right)$$

$$V' = \frac{hc}{e}\left(\frac{1}{\lambda'} - \frac{1}{\lambda}\right) + V$$

$$= 1240\left(\frac{1}{474} - \frac{1}{642.4}\right) + 0.48$$

$$= 1.16 \text{ eV}$$

20. What is the relation between current gain α and β in transistor ?

(A) $\beta = \frac{\alpha}{1+\alpha}$

(B) $\beta = \frac{\alpha}{1-\alpha}$

(C) $\beta = \frac{1+\alpha}{\alpha}$

(D) $\beta = \alpha$

Ans. (B)

As we know

$$i_E = i_B + i_C$$

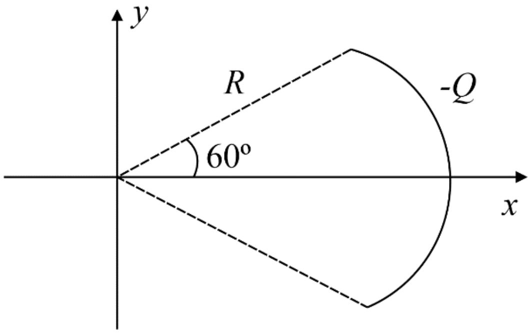
Devide by i_C in both side

$$\frac{i_E}{i_C} = \frac{i_B}{i_C} + 1$$

$$\frac{1}{\alpha} = \frac{1}{\beta} + 1$$

$$\Rightarrow \beta = \frac{\alpha}{1-\alpha}$$

21. As shown in fig. Find the electric field at center of uniformly charged an arc having total charge (-Q).



(A) $\frac{3\sqrt{3}}{4\pi}\frac{kQ}{R^2}\hat{i}$

(B) $\frac{3\sqrt{3}}{2\pi}\frac{kQ}{R^2}\hat{i}$

(C) $\frac{3\sqrt{2}}{2\pi}\frac{kQ}{R^2}\hat{i}$

(D) $\frac{\sqrt{3}}{4\pi}\frac{kQ}{R^2}\hat{i}$

Ans. (B)

Sol. $E = \frac{2k\lambda}{R}\sin\frac{\theta}{2}\hat{i}$

$= \frac{2k}{R}\left(\frac{Q}{2R\frac{\pi}{3}}\right)\sin 60°\hat{i}$

$= \frac{3kQ}{\pi R^2}\frac{\sqrt{3}}{2}\hat{i}$

$= \frac{3\sqrt{3}}{2\pi}\frac{kQ}{R^2}\hat{i}$

22. Two SHM equations are represented by $y_1 = 10\sin\left(3\pi t + \frac{\pi}{3}\right)$ *and* $y_2 = 5\left[\sin 3\pi t + \sqrt{3}\cos \pi t\right]$. Then what will be the ratio of amplitude $\frac{A_1}{A_2}$?

(A) 1

(B) 2

(C) 3

(D) 4

Ans. (A)

Sol. $y_1 = 10\sin\left(3\pi t + \frac{\pi}{3}\right)$ …….(1)

$y_2 = 5[\sin 3\pi t + \sqrt{3}\cos \pi t]$

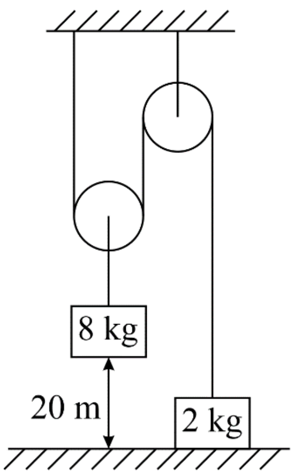
After rearranging the second wave equation of SHM

$y_2 = 10\sin\left(3\pi t + \frac{\pi}{3}\right)$ ....(2)

Now,

$\frac{A_1}{A_2} = \frac{10}{10} = 1$

23. In the given arrangement, if initially system is at rest then what will be the time taken by 8 kg block to reach ground ?



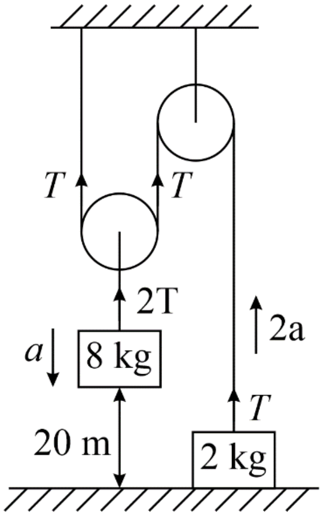
(A) $2s$

(B) $10s$

(C) $8s$

(D) $4s$

Ans. (D)



Sol.

According to constraint relation if acceleration of block 2 kg is a then acceleration of 8 kg block will be 2a

$8g - 2T = 8a$ …… (1)

$T - 2g = 4a$ ………(2)

Multiply equation (2) by 2 and add with equation (1)

$4g = 16a \Rightarrow a = \frac{5}{2} m/s^2$

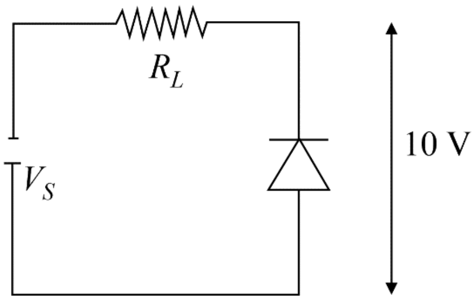
Thus

$s = ut + \frac{1}{2}at^2$

$20 = 0 + \frac{1}{2} \times \frac{5}{2} \times t^2$

$t = 4s$

24. In the given circuit, A diode and a load resistance are connected with source voltage of 14V. What will be load resistance R_L if power loses in diode is 2×10^{-3} W and potential drop across diode is 10V.



(A) 50 mΩ

(B) 30 $m\Omega$

(C) 10 mΩ

(D) 20 mΩ

Ans. (D)

Sol. For diode

$P = \mathrm{VI}$

$\mathrm{I} = \frac{\mathrm{P}}{\mathrm{V}} = \frac{2}{10} = 0.2$ mA

Now for, V_S =14V

Voltage drop across $R_L = 14 - 10 = 4\mathrm{V}$

Thus, $\mathrm{V} = \mathrm{IR_L}$

$\mathrm{R_L} = \frac{4}{0.2\times10^{-3}} = 20\ \mathrm{m}\Omega$

25. If electric field of $6\mathrm{V/m}$ is present in a region, then magnetic field will be?

(A) $4 \times 10^{-8}\mathrm{T}$

(B) $6 \times 10^{-8}\mathrm{T}$

(C) $2 \times 10^{-8}\mathrm{T}$

(D) $8 \times 10^{-8}\mathrm{T}$

Ans. (C)

Sol. As we know that ; $B = \frac{E}{C}$

$$B = \frac{E}{C} = \frac{6}{3\times10^8} = 2 \times 10^{-8}\ \mathrm{T}$$

26. Metallic rod is connected between hot liquid (Temperature $\mathrm{T_1}$) and cold liquid (Temperature $400\mathrm{K}$) rate of heat supplied from hot to cold liquid from rod is $60\mathrm{J/sec}$.. Then find temperature T_1 (given $\mathrm{K} = 0.1\ \mathrm{W/m} - \ {}^\circ\mathrm{C}, \mathrm{L} = 10\mathrm{cm}$ and $\mathrm{A} = 1\mathrm{m}^2$)

(A) 450k

(B) 460k

(C) 480k

(D) 500k

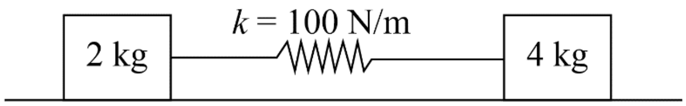
Ans. (B)

Sol. $Q = \frac{kA}{L}(T_1 - T_2)$

$\Rightarrow 60 = 1(T_1 - 400)$

$\Rightarrow T_1 = 460k$

27. In the given arrangement of two blocks of masses 2kg and 4kg are attached with a spring of spring constant 100 N/m. If time period of their SHM is $2\pi\sqrt{\frac{1}{n}}$ then find:



Sol. $\mu = \frac{m_1 m_2}{m_1 + m_2} = \frac{2\times 4}{6} = \frac{4}{3}$

$$T = 2\pi\sqrt{\frac{\mu}{k}} = 2\pi\sqrt{\frac{\frac{4}{3}}{100}} = 2\pi\sqrt{\frac{1}{75}}$$

Thus $n = 75$