



JEE (Main)

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2021

COMPUTER BASED TEST (CBT)

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Date: 27 August, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

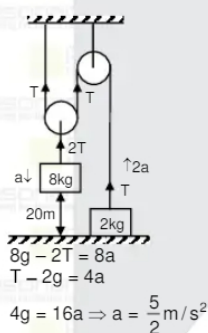
1. In the given arrangement, find the time taken by 8 kg block to reach ground, if initially system is at rest?



(1) 4s (2) 3s (3) 2s (4) 6s

Ans. (1)

Sol.



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

$$t = 4\text{s}$$

2. Equation of two SHM and $y_1 = 10 \sin\left(3\pi t + \frac{\pi}{3}\right)$, $y_2 = 5[\sin 3\pi t + \sqrt{3} \cos \pi t]$. Find ratio of amplitude $\frac{A_2}{A_1}$.

(1) 3 (2) 2 (3) 4 (4) 1

Ans. (4)

Sol.

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

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

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

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

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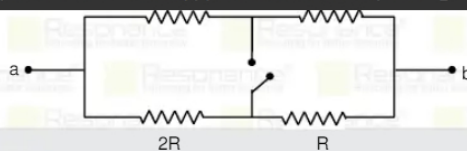
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3. The ratio of equivalent resistance of the combined Resistances when the switch is closed to switch is



(1) 9 (2) 4 (3) 5 (4) 2

Ans. (1)

Sol.

When switch is closed

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

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

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

second drop when first drop about to touches the ground : ($g = 9.8 \text{ m/s}^2$)



Ans. (2)
Sol.

For first drop.

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

For 2nd drop

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

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

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

so height of 2nd drop

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

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5. Find relation between current gain α and β in transistor :

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

$$(2) \beta = \frac{\alpha}{1+\alpha}$$

$$(3) \beta = \frac{1+\alpha}{\alpha}$$

$$(4) \beta = \frac{1}{\alpha}$$

Ans. (1)

Sol. $i_e = i_b + i_c$

$$\frac{i_e}{i_c} = \frac{i_b}{i_c} + 1$$

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

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

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6. Assuming force (F), length (L) and time (T) as a fundamental units. Find dimensional formula for density.

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

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

$$(3) [F L^{-3} T]$$

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

Ans. (1)

Sol. $d \propto F^a L^b T^c$

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

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

comparing :

$$a = 1 \quad \dots (i)$$

$$a + b = -3 \quad \dots (ii)$$

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

$$c = 2 \quad ; \quad b = -4 \quad ; \quad \therefore [d] = [F L^{-4} T^2] \quad \text{Ans.}$$

7. A player hits a ball at an angle 45° from horizontal with velocity 25 m/s. Find maximum height and time

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$$(1) \frac{125}{8} \text{ m}, \frac{5}{2\sqrt{2}} \text{ s}$$

$$(2) \frac{125}{3} \text{ m}, \frac{5}{2} \text{ s}$$

$$(3) \frac{125}{4} \text{ m}, \frac{5}{\sqrt{2}} \text{ s}$$

$$(4) \frac{125}{8} \text{ m}, \frac{5}{2\sqrt{2}} \text{ s}$$

Ans. (1)

Sol. $\theta = 45^\circ$

$$H = \frac{u^2 \sin^2 \theta}{2g} = \frac{(25)^2 \times \left(\frac{1}{2}\right)^2}{2 \times 10} = \frac{125}{8} \text{ m}$$

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

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

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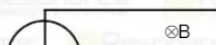
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8. In the given arrangement, magnetic field is $B = 1\text{ T}$ and radius of circular loop is 1 m . Find EMF induced in 1 sec :



$$x=0 \\ t=0$$

(1) $\frac{\pi}{2} \text{ V}$

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

(3) $\pi \text{ V}$

(4) $2\pi \text{ V}$

Ans. (1)

Sol.

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

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

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

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or fringes is zero, what will be the maximum intensity?

(1) $8I_1$

(2) $4I_1$

(3) $2I_1$

(4) $\sqrt{2} I_1$

Ans. (2)

Sol.

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

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

$$\Rightarrow I_1 = I_2$$

$$I_{\text{max}} = (\sqrt{I_1} + \sqrt{I_2})^2 = 4I_1$$

10. In a sample of H like atoms highest quantum state is $n = 6$. Find total number of spectral lines in emission spectrum :

(1) 6

(2) 15

(3) 20

(4) 5

Ans. (2)

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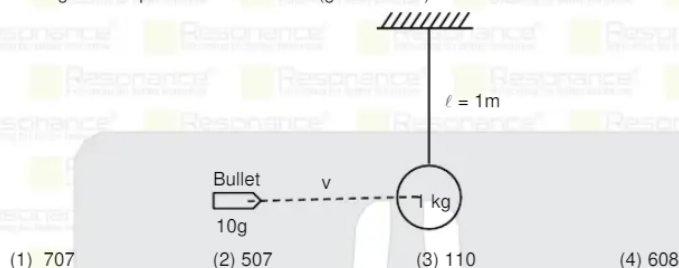
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11. A bullet of mass 10g travelling with velocity 'v' collides with pendulum-mass system of mass 1kg and length 1m and embedded in it as shown in figure. Find minimum value of v, so that pendulum mass undergoes complete circular motion. ($g = 9.8 \text{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



Ans. (1)

- (1) 707 (2) 507 (3) 110 (4) 608

Now $(m + M) \sqrt{5gR} = m \times v$

thus $v = \frac{(1 + 0.01) \times \sqrt{5 \times 9.8 \times 1}}{0.01}$

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

12. Water fall from height 63 meter. Find the temperature difference of water between top and bottom position. ($g = 9.8 \text{ m/s}^2$)

- (1) 20°C (2) 40°C (3) 0.147°C (4) 100°C

Ans. (3)

Sol. $mgh = ms\Delta\theta$

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

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

gravitation potential at a distance 25 m from center.

- (1) $-\frac{5G}{8}$ (2) $-\frac{8G}{5}$ (3) $-\frac{3G}{4}$ (4) $-\frac{2G}{5}$

Ans. (2)

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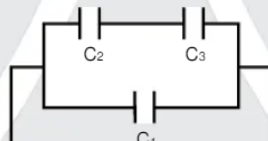
Sol.



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

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

14. In the given circuit, if $C_1 = 2F$, $C_2 = 6F$ & $C_3 = 12F$. Find the ratio of charge in capacitor C_1 and C_2 at steady state?



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

(2) 2

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

(4) 4

Ans. (1)

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

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

then

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

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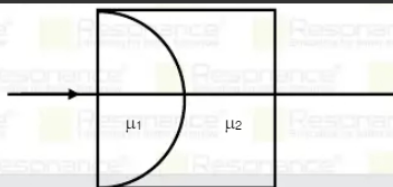
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(1) $\mu_2 - \mu_1$

(2) $\mu_1 - \mu_2$

(3) $\frac{\mu_1 - \mu_2}{2}$

(4) $2(\mu_1 - \mu_2)$

Ans. (2)

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

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

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

$$\frac{R}{f_{eq}} = \mu_1 - \mu_2 \quad \text{Ans.}$$

16. Initially in an AC circuit $X_L = 3R$ and resistance is R . Now a capacitor of reactance $2R$ is connected in series. Find ratio of new power factor to old power factor.
- (1) $\sqrt{5}$ (2) $\sqrt{3}$ (3) $\sqrt{2}$ (4) $\sqrt{6}$
- Ans. (1)
- Sol. $PF_{\text{initial}} = \frac{R}{\sqrt{9R^2 + R^2}} = \frac{1}{\sqrt{10}}$
- $PF_{\text{final}} = \frac{R}{\sqrt{(3-2)^2 R^2 + R^2}} = \frac{1}{\sqrt{2}}$
- $\frac{PF_{\text{final}}}{PF_{\text{initial}}} = \sqrt{5}$

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17. What should be the length of smallest closed organ pipe which will resonate with the tuning fork of frequency 250 Hz?
- (1) 33 cm (2) 25 cm (3) 38 cm (4) 28 cm
- Ans. (1)

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Sol. For closed organ pipe

$$F_0 = (2n + 1) \frac{v}{4\ell}$$

for minimum length, $n = 0$

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

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

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

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18. Two disc are rotating with angular velocity ω_1 and ω_2 in opposite direction and their moment of inertial is I_1 and I_2 respectively. Now one disc is placed on another disc. Find loss in kinetic energy of system

(1) $\frac{2I_1 I_2 (\omega_1 - \omega_2)^2}{(I_1 + I_2)}$ (2) $\frac{I_1 I_2 (\omega_1 - \omega_2)^2}{4(I_1 + I_2)}$ (3) $\frac{I_1 I_2 (\omega_1 - \omega_2)^2}{2(I_1 + I_2)}$ (4) $\frac{I_1 I_2 (\omega_1 - \omega_2)^2}{2(I_1 - I_2)}$

Ans. (3)

Sol. Angular momentum conservation

$$I_1 \omega_1 - I_2 \omega_2 = (I_1 + I_2) \omega$$

$$\omega = \frac{I_1 \omega_1 - I_2 \omega_2}{I_1 + I_2}$$

$$\text{Loss} = \frac{1}{2} I_1 \omega_1^2 + \frac{1}{2} I_2 \omega_2^2 - \frac{1}{2} (I_1 + I_2) \omega^2$$

$$= \frac{1}{2} I_1 \omega_1^2 + \frac{1}{2} I_2 \omega_2^2 - \frac{1}{2} (I_1 + I_2) \left(\frac{I_1 \omega_1 - I_2 \omega_2}{I_1 + I_2} \right)^2$$

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$$E_i - E_f = \frac{I_1 I_2 (\omega_1 - \omega_2)^2}{2(I_1 + I_2)}$$

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

(1) 8 (2) 6 (3) 4 (4) 2

Sol. C.S. = $\frac{\theta}{I}$

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

Potential difference = 50 mV

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

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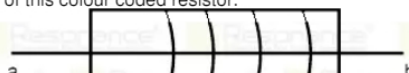
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20. Calculate the value of this colour coded resistor.



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- (1) $57 \times 10^4 \pm 5\%$ (2) $57 \times 10^4 \pm 10\%$ (3) $75 \times 10^4 \pm 5\%$ (4) $75 \times 10^4 \pm 10\%$

Ans. (1)
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	Multiplier	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		
White	W	9	10^9		

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

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- 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.
- 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 $\pm 20\%$

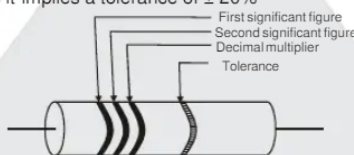
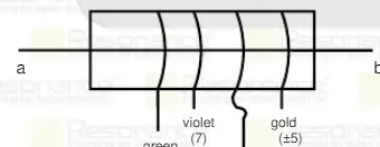


Figure. Meanings of four bands.



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

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21. Find the ratio of RMS velocity of O_2 molecule to H_2 molecule at same temperature.

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

Ans. (1)

Sol. $V_{rms} \propto \frac{1}{\sqrt{M}}$

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

22. A coaxial cable having an 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. ($b > 2a$)

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

Ans. (4)

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

$$\begin{aligned} B_2 \times 2\pi\left(\frac{3a}{2}\right) &= i - i \frac{(b^2 - a^2)}{(b^2 - a^2)} \\ &= i \left[1 - \frac{5a^2}{4(b^2 - a^2)} \right] \\ &= i \frac{(4b^2 - 9a^2)}{4(b^2 - a^2)} \end{aligned}$$

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

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

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23. 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 ?

- (1) 1.12 eV (2) 1.18 eV (3) 1.16 eV (4) 1.10 eV

Ans. (3)

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

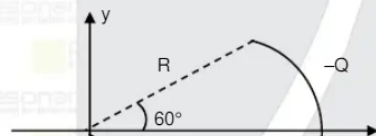
$$v' = \frac{hc}{\lambda'} = \frac{hc}{\lambda} + V$$

$$V' = \frac{hc}{\lambda'} - \frac{hc}{\lambda} + V$$

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

$$= 1.16 \text{ eV}$$

24. An arc is having total charge $(-Q)$ distributed uniformly. Find the electric field at center.



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$$(1) \frac{3\sqrt{3}}{4\pi} \frac{kQ}{R^2} \hat{i}$$

$$(2) \frac{3\sqrt{3}}{8\pi} \frac{kQ}{R^2} \hat{i}$$

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

$$(4) \frac{7\sqrt{3}}{4\pi} \frac{kQ}{R^2} \hat{i}$$

Ans. (3)

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

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

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

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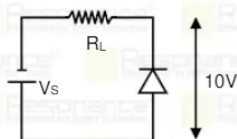
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25. In the given arrangement, source voltage is 14V. What will be resistance R_L if power losses in diode is $2 \times 10^{-3} \text{ W}$ and potential drop across diode is 10V.



$$(1) 20\text{m}\Omega$$

$$(2) 40\text{m}\Omega$$

$$(3) 60\text{m}\Omega$$

$$(4) 80\text{m}\Omega$$

Ans. (1)

Sol. For diode

$$P = V_i$$

$$i = \frac{P}{V} = \frac{2}{10} = 0.2\text{mA}$$

Now for $V_s = 14\text{V}$

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

$$R_L = \frac{4}{0.2 \times 10^{-3}} = 20\text{m}\Omega$$

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26. In a region, if electric field is 6V/m, then magnetic field will be ?

$$(1) 2 \times 10^{-8} \text{ T}$$

$$(2) 4 \times 10^{-8} \text{ T}$$

$$(3) 2 \times 10^{-4} \text{ T}$$

$$(4) 5 \times 10^{-8} \text{ T}$$

Ans. (1)

Sol. $B = \frac{E}{C} = \frac{6}{3 \times 10^8} = 2 \times 10^{-8} \text{ T}$

27. Match the following

Column (A)

- (a) Gas constant (R)
(b) Planck constant (h)

Column (B)

- (p) ML^2T^{-1}
(q) $\text{ML}^{-1}\text{T}^{-1}$

- (d) Permeability of free space (μ_0) (s) $\text{ML}^{-1}\text{T}^{-1}$
(1) a - r, b - p, c - s, d - q (2) a - p, b - r, c - s, d - q
(3) a - r, b - p, c - q, d - s (4) a - r, b - q, c - s, d - p

Ans. (1)

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

- (1) 450 k (2) 460 k (3) 480 k (4) 500 k

Ans. (2)

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

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29. Two blocks of masses 2 kg and 4 kg are attached with a spring of spring constant 100 N/m. If time period of their SHM is $2\pi\sqrt{\frac{1}{n}}$, find n :



Ans. 75

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

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