JEE-Main-24-06-2022-Shift-1 (Memory Based)

Physics

Question: At what height from the surface of earth the weight of the body is 1/3rd of its weight at the surface?

Options:

(a) 5000 km

(b) 5562.5 km

(c) 4684.8 km

(d) 3600 km

Answer: (c)

Solution:

We know

$$gh = \frac{g}{\left(1+\frac{h}{R}\right)^2} \quad ....(1)$$

So, Q

For weight to be 1/3rd of the weight on the earth surface g_h should be 1/3rd of g. So from eq.

(1) $\frac{g}{3} = \frac{g}{\left(1+\frac{h}{\text{Re}}\right)^2}$

$$\left(1+\frac{h}{\text{Re}}\right)^2 = 3$$

$$\left(1+\frac{h}{\text{Re}}\right) = \sqrt{3}$$

$$\frac{h}{\text{Re}} = 1.732 - 1$$

$$h = 0.732 \times \text{Re} \quad (\text{Re} = 6400 km)$$

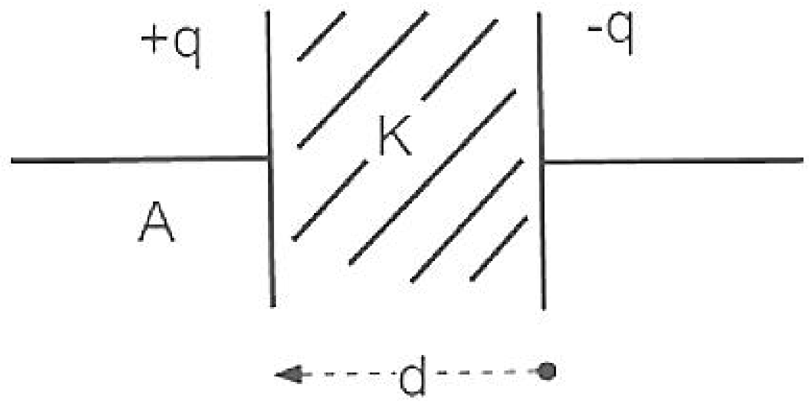
$$h = 0.732 \times 6400 km$$

$$h = 4684.8 km$$

Question: Electric Field Strength = E

Max charge = q

Find K = ?



Options:

(a) $\boxed{K = \dfrac{q}{\varepsilon_0 EA}}$

(b) $\boxed{K = \dfrac{qd}{\varepsilon_0 EA}}$

(c) $\boxed{K = \dfrac{qA}{\varepsilon_0 E}}$

(d) None of these

Answer: (a)

Solution:

$$E = \frac{v}{d} = \frac{q}{c \cdot d} \Rightarrow c = \frac{q}{E \cdot d}$$

$$c = \frac{\varepsilon_0 AK}{d}$$

Therefore, $\dfrac{q}{E \cdot d} = \dfrac{\varepsilon_0 AK}{d}$

Therefore, $\boxed{K = \dfrac{q}{\varepsilon_0 EA}}$

Question: If one end of vertical spring is connected to the ground and other end is connected to horizontal platform at rest. If a ball of mass m is dropped on it from height h above platform compresses spring by h/2. If h = 10 cm find k.

Options:

(a) 120 mg

(b) 200 mg

(c) 180 mg

(d) 130 mg

Answer: (a)

Solution:

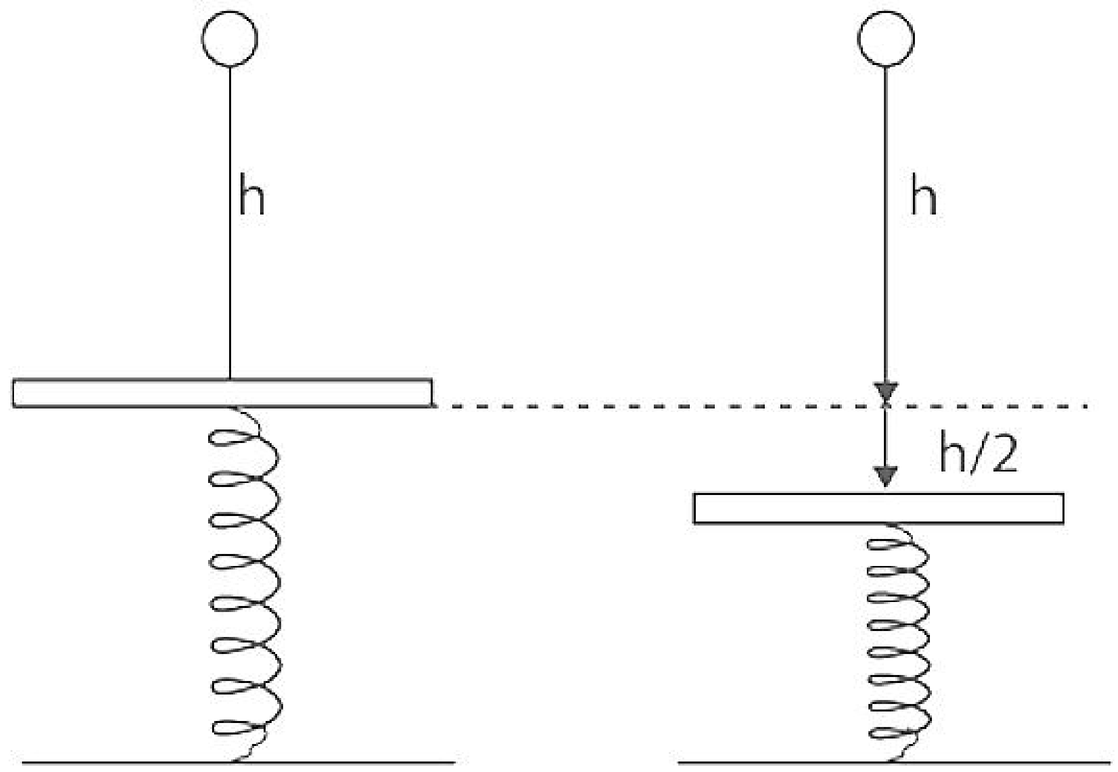
Loss in PE of ball = gain in S.P.E.

$$mg\left(h + \frac{h}{2}\right) = \frac{1}{2}K\left(\frac{h}{2}\right)^2$$

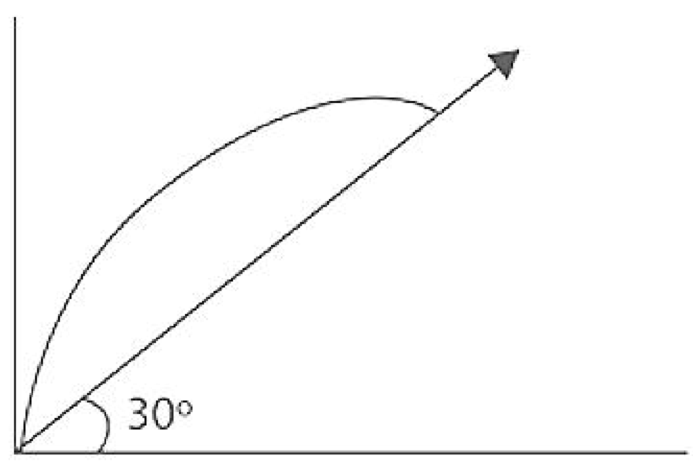
$$mg\left(\frac{3h}{2}\right) = \frac{1}{2}K\frac{h^2}{4}$$

$$\frac{12mg}{h} = K$$

$$K = \frac{12mg}{10\times10^{-2}}$$
$$K = \frac{1200mg}{10}$$
$$K = 120mg$$



Question: The body is projected 10 m/sec. The angle of projection at $30°$. Find range



Options:

(a) 10/3

(b) 20/3

(c) 10

(d) 40/3

Answer: (b)

Solution:

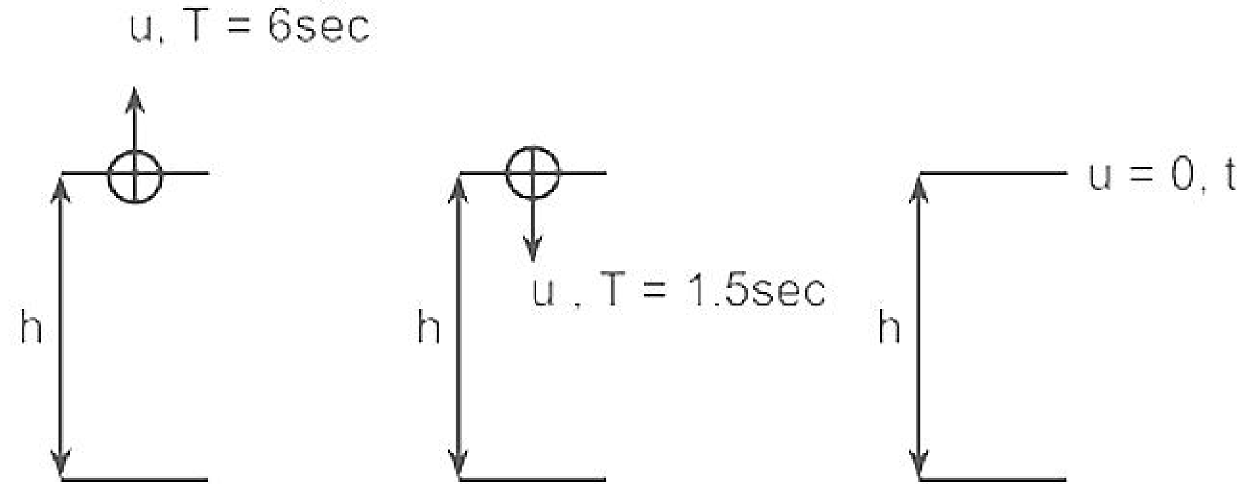
$$R = U_x \times T + \frac{1}{2}a_x T^2$$
$$R = U\cos 30° \times \frac{2U\sin 30°}{g\cos 30°} - \frac{1}{2}g\sin 30°\left(\frac{2U\sin 30}{g\cos 30°}\right)^2$$
$$R = \frac{2U^2\cos 30°\tan 30°}{g} - \frac{1}{2}g\sin 30°\left(\frac{2U\tan 30°}{g}\right)^2$$
$$R = \frac{2\times100\times\sqrt{3}}{2\times10}\times\frac{1}{\sqrt{3}} - \frac{1}{2}\times10\times\frac{1}{2}\times\frac{4\times100}{100}\times\frac{1}{3}$$

$R = \frac{100}{10} - \frac{1000}{3\times100}$

$R = 10 - \frac{10}{3}$

$R = \frac{20}{3} m$

Question: A ball when thrown up from a tower of height h takes 6 seconds to reach ground and when thrown downward with same velocity, it took 1.5 seconds. How much time it will take if ball is dropped from the tower?



Options:
(a) 3 sec
(b) 5 sec
(c) 2 sec
(d) 4 sec
Answer: (a)
Solution:
Ist Condition

$-h = 64 - \frac{1}{2}\times g\times36$

$h = -6u + 10h$

$h = 10g - 6u$

$6u = 10g - h$

$u = \frac{18g - h}{6}$ ....(1)

IInd Condition

$-h = -u\times1.5 - \frac{1}{2}\times g\times2.25$

$h = 1.5u + \frac{1}{2}g\times2.25$

$h = 1.5\left(\frac{18g - h}{6}\right) + \frac{1}{2}g\times2.25$

$h = \frac{18\times1.5g}{6} - \frac{1.5h}{6} + \frac{1}{2}g\times2.25$

$\left(h + \frac{1.5h}{6}\right) = \frac{180\times1.5}{6} + 5\times2.25$

$1.25h = 45 + 11.25$

$h = 45m$

IIIrd Condition

$$h = 0 + \frac{1}{2} \times 10 \times t^2$$

$$\frac{45 \times 2}{10} = t^2$$

$$t^2 = 9$$

$$t = 3\sec$$

Question: Find change in kinetic energy if a block is displaced from (1,2) to (2,3) on applying a force of $\vec{F} = 4x^2\hat{i} + 3y^3\hat{j}$.

Options:

(a) 58.08 J

(b)45.08 J

(c) 55.56 J

(d) 32.3 J

Answer:(a)

Solution:

$$WD = \Delta KE = \int F_x dx + \int F_y dy$$

$$= \int_1^2 4x^2 dx + \int_2^3 3y^3 dy$$

$$= \left.\frac{4x^3}{3}\right|_1^2 + \left.\frac{3y^4}{4}\right|_2^3$$

$$\Delta KE = \frac{4}{3}\left(2^3 - 1\right) + \frac{3}{4}\left(3^4 - 2^4\right)$$

$$= \frac{4}{3} \times 7 + \frac{3}{4} \times 65$$

$$= \frac{697}{12}$$

$$= 58.08J$$

Question: The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is ___ × 10^3 kg m/s^2. [Given cos 30° = 0.87, μs = 0.2]

Options:

(a) 8.8

(b)5.8

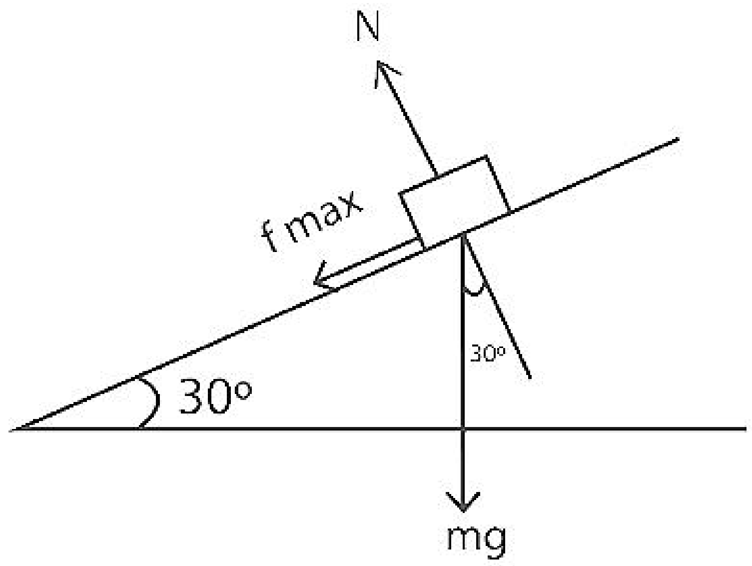
(c) 10.4

(d) 3.2

Answer:(c)

Solution:

At maximum possible speed friction will be limiting



Balancing force invertical

$N\cos 30^{\circ} - mg - \mu N\cos 60^{\circ} = 0$

$N\left(\cos 30^{\circ} - \mu\cos 60^{\circ}\right) = mg$

$\Rightarrow N = \dfrac{mg}{(0.87 - 0.2 \times 0.5)} = \dfrac{8000}{0.77} = 10.4 \times 10^{3}\ \text{N}$

Question: Stopping potential for e- for wavelength 491 nm is 0.410 V incidence wavelength is changed to new value then stopping potential is 1.02 V. New wavelength is

Options:
(a) 234.62 nm
(b)582.65 nm
(c) 104.32 nm
(d) 645.83 nm
Answer:(d)
Solution:
We know that,

$\dfrac{hc}{\lambda} = \phi + KE$

$\dfrac{hc}{\lambda_1} = \phi + kE_1$

$\dfrac{hc}{491nm} = \phi + 0.4100V...(i)$

$\dfrac{hc}{\lambda_2} = \phi + 1.02eV...(ii)$

(ii) -(i)

$\dfrac{hc}{491nm} - \dfrac{hc}{\lambda_2} = (1.02 - 0.410)e\text{V}$

$\dfrac{1240\text{eV}\cdot\text{nm}}{491\text{nm}} - 0.61\text{eV} = \dfrac{1240\text{eV}\cdot\text{nm}}{\lambda_2}$

$(2.53 - 0.61)\text{eV} = \dfrac{1240}{\lambda_2}$

$\lambda_2 = \dfrac{1240}{1.92} = 645.83\text{nm}$

Question: If at the centre of circular current carrying coil, magnetic field is B_0 then the magnetic field at distance r/2 on the axis of a coil from centre is (r is the radius)

Options:

(a) $\frac{4}{5\sqrt{5}}B_0$

(b) $\frac{8}{5\sqrt{5}}B_0$

(c) $\frac{4}{5}B_0$

(d) $\frac{8}{\sqrt{5}}B_0$

Answer: (b)

Solution:

We know that magnetic field at center of current carrying coil is $\frac{\mu_0 I}{2r}$

So,

$$B_0 = \frac{\mu_0 I}{2r} \ldots(i)$$

Magnetic field at a point on the axis of current carrying coil

$$B = \frac{\mu_0 I r^2}{2\left(x^2 + r^2\right)^{3/2}}$$

At $x = \frac{r}{2}$

$$B = \frac{\mu_0 I r^2}{2\left(\frac{r^2}{4} + r^2\right)^{3/2}}$$

$$\Rightarrow B = \frac{\mu_0 I r^2}{2\left(\frac{5}{4}\right)^{3/2} r^3}$$

$$\Rightarrow B = \left(\frac{\mu_0 I}{2r}\right)\frac{8}{5\sqrt{5}}$$

$$\Rightarrow B = \frac{8}{5\sqrt{5}}B_0$$

Question: If B = 10^9 Nm^{-2} & fractional change in volume is 2% find the volumetric stress required

Options:

(a) $1\times10^7\ pa$

(b) $2\times10^7\ pa$

(c) $3\times10^7\ pa$

(d) $5\times10^7\ pa$

Answer: (b)

Solution:

Given $N = 10^9$

Also, $N = \frac{dp}{(dv/v)}$

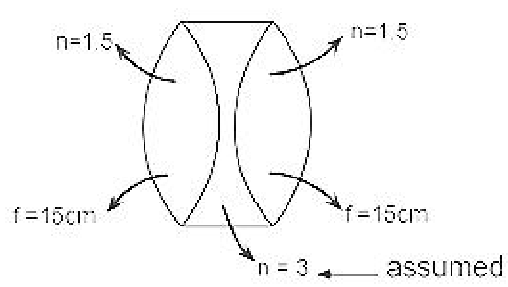
Fractional change = 2%

$\Rightarrow \frac{dv}{v} = 0.02$

$\therefore dp = B\left(\frac{dv}{v}\right) = 0.02 \times 10^9$

$= 2 \times 10^7\ pa$

Question: Find effective focal length



Options:

(a) -7.5 cm

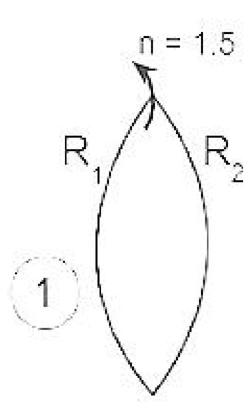
(b) -5.7 cm

(c) -7.4 cm

(d) -6.7 cm

Answer: (a)

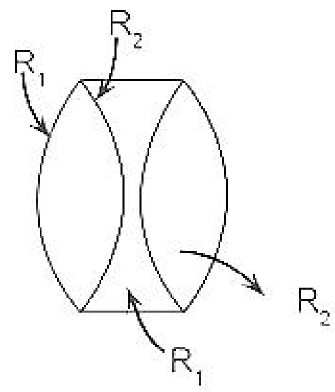
Solution:

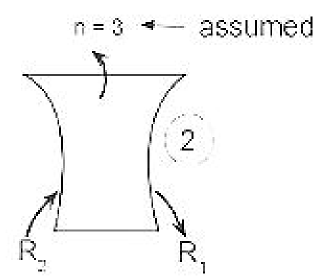


$$\frac{1}{15} = \frac{1}{f_1} = (1.5-1)\left(\frac{1}{R_1} - \frac{1}{-R_2}\right)$$

$$\frac{1}{15} = \frac{1}{2}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{2}{15}$$





$$\frac{1}{f_2} = (3-1)\left(\frac{1}{R_2} - \frac{1}{R_1}\right)$$

$$= -2\left(\frac{1}{R_2} + \frac{1}{R_1}\right)$$

$$= -2 \times \frac{2}{15}$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

$$= \frac{1}{15} - \frac{4}{15} + \frac{1}{15}$$

$$\frac{1}{f_{eq}} = -\frac{2}{15}$$

$$f_{eq} = -7.5\,cm$$

Question: Efficiency of carnot engine was 25% at 27° C what will be the temperature to increase its efficiency by 100% more.

Options:

(a) $T_2 = 400K$

(b) $T_2 = 200K$

(c) $T_2 = 100K$

(d) $T_2 = 300K$

Answer: (b)

Solution:

At $27°C = 300K$,

$$\eta_1 = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{T_1}$$

$$\frac{25}{100} = 1 - \frac{300}{T_1}$$

$$-\frac{75}{100} = -\frac{300}{T_1}$$

$T_1 = 400K$

To increase η by 100% more

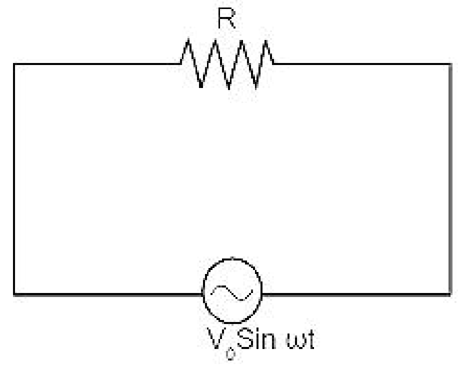
i.e. make the η 50%

$$\frac{50}{100} = 1 - \frac{T_2}{400}$$

$$-\frac{1}{2} = -\frac{T_2}{400}$$

$T_2 = 200K$

Question: In a given AC circuit which has maximum voltage V_0 and frequency 50 Hz. Find the time instant where the current in the circuit will be equal to RMS value of circuit



Options:
(a) 1.5 m/s
(b) 2.5 m/s
(c) 4.5 m/s
(d) 3.5 m/s
Answer: (b)
Solution:

In the circuit $i = \frac{V_0 \sin \omega t}{R}$, also $i_{rms} = \frac{i_0}{\sqrt{2}}, \omega = 2\pi f$

Hence at $t = t \Rightarrow \frac{i_0}{\sqrt{2}} = \frac{V_0}{R} \sin \omega t \; = 100\pi$

$$\frac{1}{\sqrt{2}} = \sin \omega t$$

$$\sin \frac{\pi}{4} = \sin \omega t$$

$$\Rightarrow t = \frac{\pi}{4\omega} = \frac{\pi}{4 \times 100\pi} = \frac{1}{400} \;\&= \frac{1000}{400} ms$$

$$\boxed{t = 2.5\,ms}$$