PRAYAS

JEE 2025

Lecture - 06

Physics

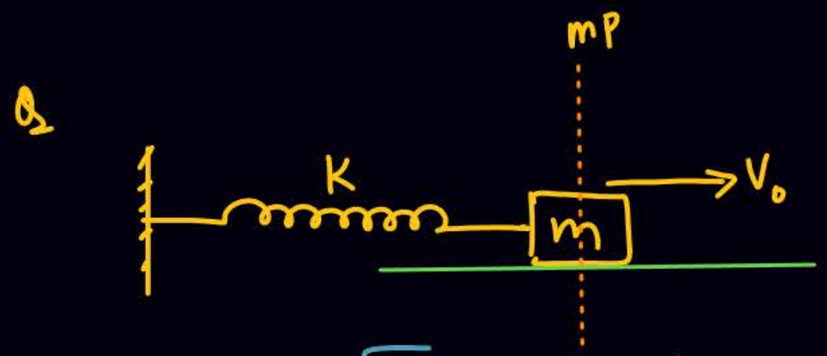
Oscillations

By- Saleem Ahmed Sir

Topics to be covered

1. Ques Practice
2.
3.
4.

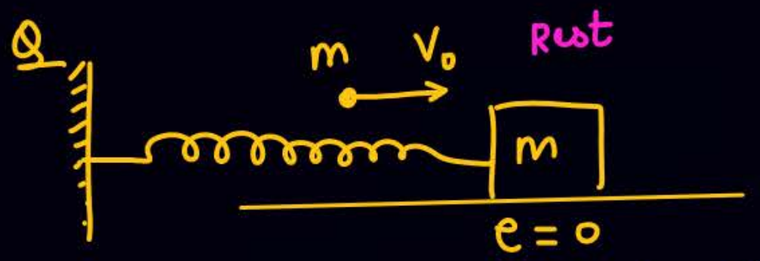
ATDB.uno

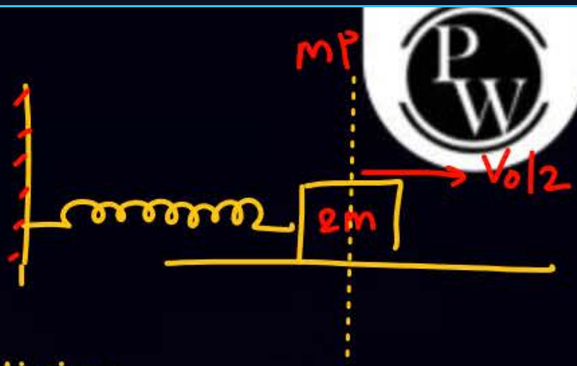


$$T = 2\pi\sqrt{\frac{m}{K}} \qquad A = \frac{V_0}{\omega}$$

$$\omega = \sqrt{\frac{K}{m}}$$

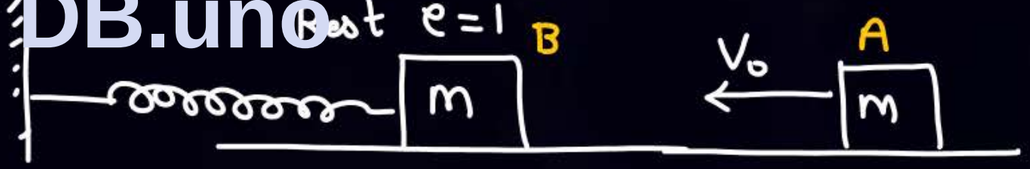
$$V_0 = A\omega$$



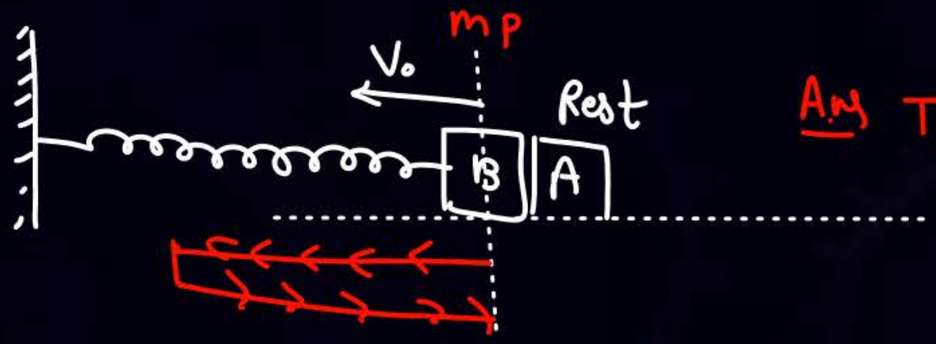


find everything just after collision.

$$T = 2\pi\sqrt{\frac{2m}{K}}, \quad \omega = \sqrt{\frac{K}{2m}}, \quad A = \frac{V_0/2}{\omega}$$



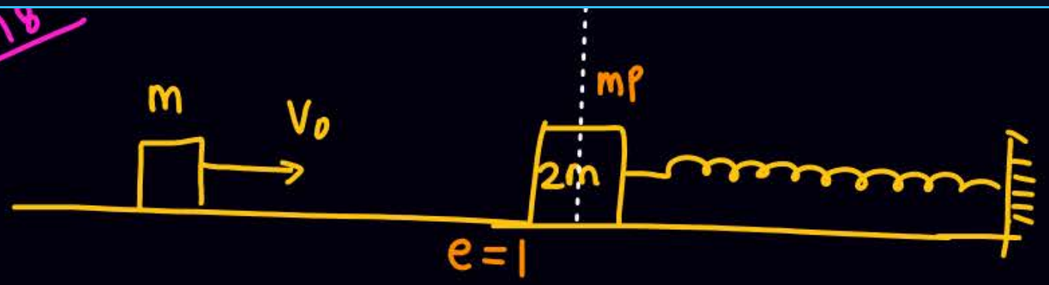
If 1^{st} collisim occur at $t = 0$. find when second collisim occurs.



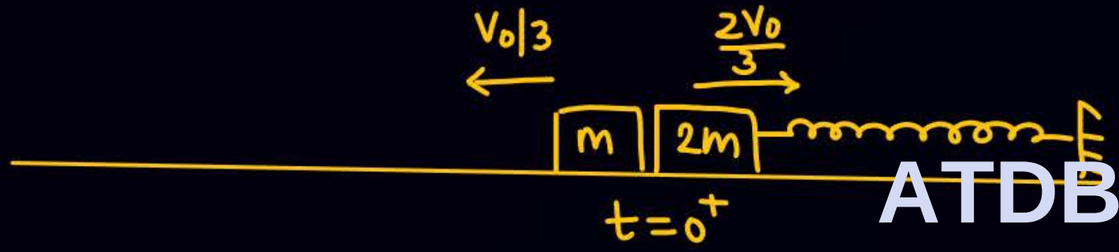
Ans $T/2 = \dfrac{2\pi\sqrt{m/k}}{2}$

JA 2018

Q

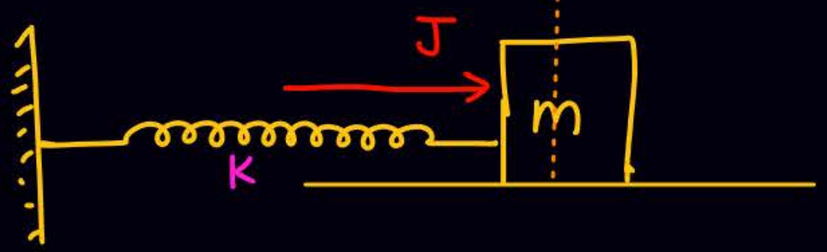


If collision occurs at $t=0$, find the separation b/w block when $2m$ mass block comes to its initial position.



Soln $\quad \frac{T}{2}\frac{V_0}{3} = \frac{TV_0}{G} \qquad T = 2\pi\sqrt{\frac{2m}{k}}$

Q



$J = \Delta P = P_f - P_i$

$J = mV_0 - 0$

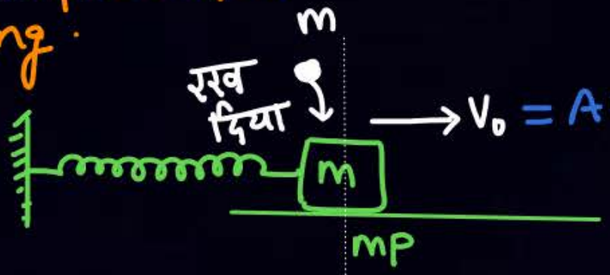
$V_0 = Aw$

$w = \sqrt{\frac{k}{m}}$

$x = A\sin(wt)$

Q A spring block system performing SHM (m, K, A, w, T). when block is at mp & moving away from mp another point mass of same mass is gentally धीरे से placed on the block s.t. chipkachipki occurs $e=0$ find everything.

Soln



$T_{नया} = 2\pi\sqrt{\frac{2m}{K}}$

$T_{नया} \longrightarrow \sqrt{2}\,T_{old}$

$w_{नया} \longrightarrow \frac{w}{\sqrt{2}}$

$w_{नया} = \sqrt{\frac{k}{2m}}$

Just after collision

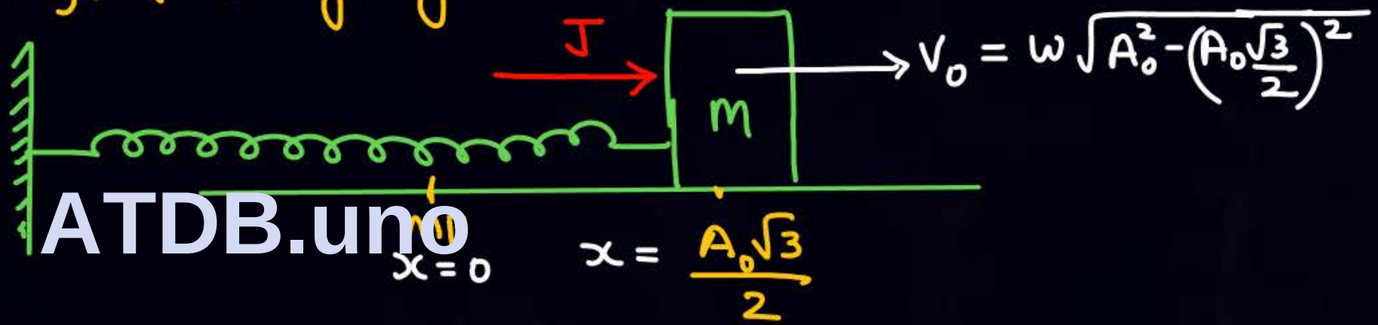
$\frac{V_0}{2} = A_{नया}\ w_{नया}$

$\frac{Aw}{2} = A_{नया} \cdot \frac{w}{\sqrt{2}}$

$A_{नया} = A/\sqrt{2}$

Q A particle is performing SHM $(A_0, T_0, \omega_0, m, K)$. When block is at a distance of $\frac{A_0\sqrt{3}}{2}$ from mp & moving away from M.P

A sharp impulse is given to the block in the dirⁿ of velocity such that its speed become double. find everything abt new SHM



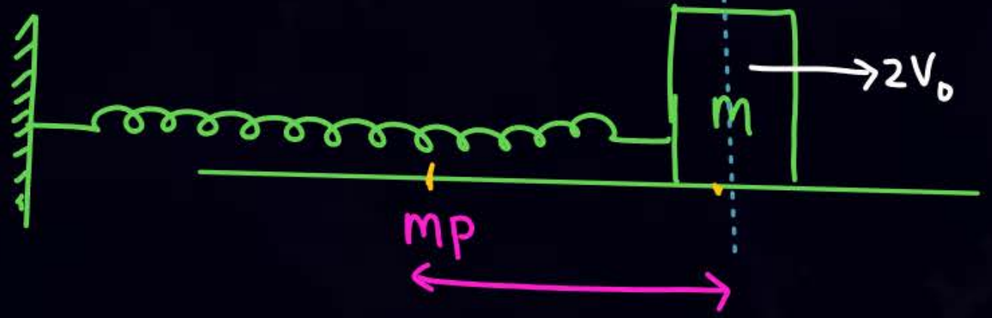
Soln just Before $V_0 = \frac{A_0\omega}{2}$

just after Impulse $= V_f = 2V_0$

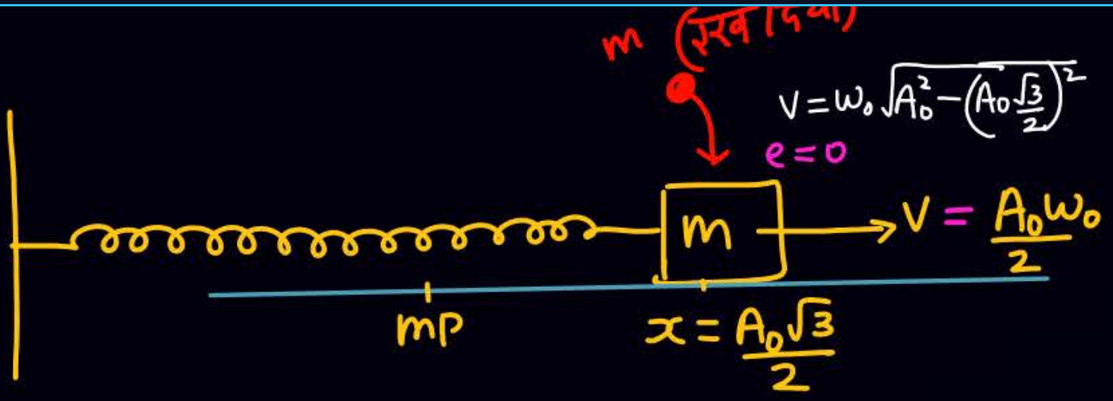
$V_f = A_0\omega$

$V_f = \omega\sqrt{A_{\text{नया}}^2 - \left(A_0\frac{\sqrt{3}}{2}\right)^2} = A_0\omega$

$$A_{\text{नया}} = \sqrt{\frac{7}{4}}A_0$$



Q



Soln

$T_{\text{नया}} = 2\pi\sqrt{\frac{2m}{K}}$

$\omega_{\text{नया}} = \sqrt{\frac{K}{2m}} = \frac{\omega_0}{\sqrt{2}}$

A spring block system (m, K) is performing SHM (A_0, T_0, ω_0) when block is at $x = \frac{A_0\sqrt{3}}{2}$ a particle is holle से placed

e = 0

$(P_i)_{\text{just before}} = (P_f)_{\text{just after}}$

$0 + mV = 2mV_f$

$V_f = \frac{V}{2}$

$V_{\text{नया}} = \omega_{\text{नया}}\sqrt{A_{\text{नया}}^2 - x^2}$

$\frac{V}{2} = \frac{\omega_0}{\sqrt{2}}\sqrt{A_{\text{नया}}^2 - \left(\frac{A_0\sqrt{3}}{2}\right)^2}$

$\frac{A_0\omega_0/2}{2} = \frac{\omega_0}{\sqrt{2}}\sqrt{A_{\text{नया}}^2 - \left(\frac{A_0\sqrt{3}}{2}\right)^2}$

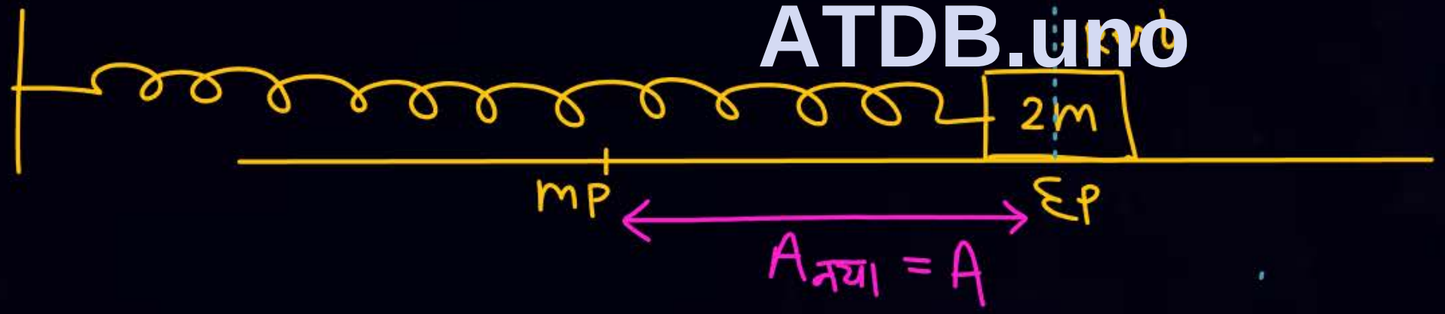
$A_{\text{नया}} = \sqrt{\frac{7}{8}}A_0$ ∴

Q

रेखा खण्ड
e=0

Spring Block is performing SHM (A, ω, T). When it is at Extreme position $x = +A$ another particle of same mass is gently placed

Sol^n

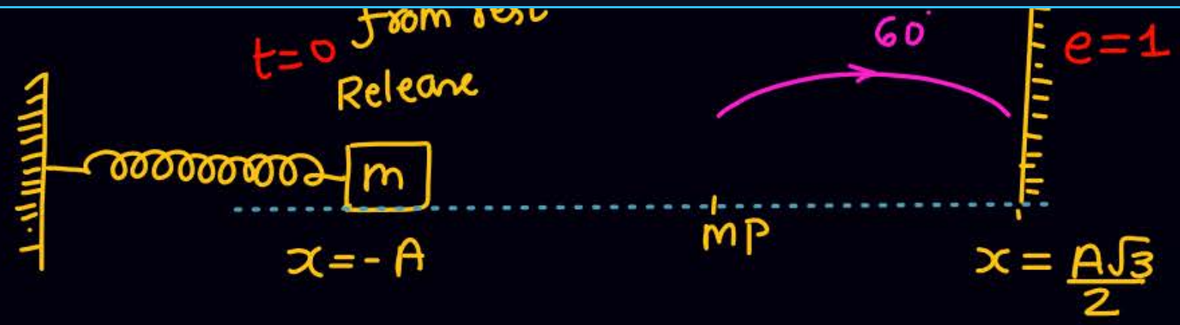


T ⟶ change $T\sqrt{2}$

ω ⟶ " $\omega/\sqrt{2}$

A ⟶ Same रहेगा

Q

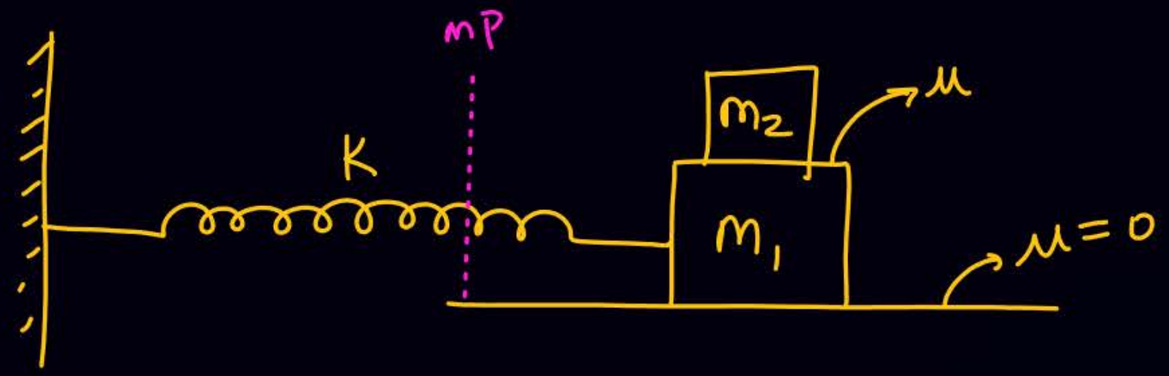


Time period = $\frac{T}{4} + \frac{T}{6} + \frac{T}{6} + \frac{T}{4}$

$T = 2\pi\sqrt{\frac{m}{k}}$

$\frac{T}{360} \times 300$

Q



Both perform Shm w/o any Slipping b/w them.

① $T = 2\pi\sqrt{\frac{m_1+m_2}{k}}$

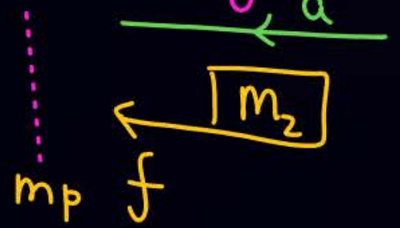
② $\omega = \sqrt{\frac{k}{m_1+m_2}}$

③ when blocks are at a distance 'x' from mP. find Value of friction

$f = m_2 a$

$f = m_2 x \omega^2$

$f = m_2 \cdot x \cdot \frac{k}{(m_1+m_2)}$



④ find max amplitude so that both perform Shm together w/o slipping.

$a_{max} \longrightarrow f_{max}$

$m_2 A\omega^2 = f$

max max

$m_2 A\omega^2 = \mu m_2 g$

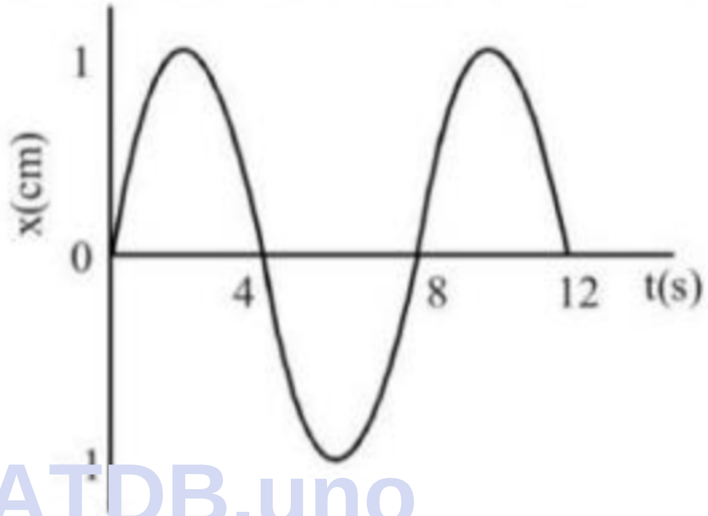
$A_{max} = \mu g/A$

$(a_{\text{झपट}})_{max} = \mu g$

$A\omega^2_{max} = \mu g$

the particle at $t = 4/3$ s is **[IIT JEE 2009]**

सरल आवर्त गति कर रहे एक कण का x-t ग्राफ दर्शाया गया है। $t = 4/3$ सैकण्ड पर कण का त्वरण होगा



(A) $\frac{\sqrt{3}}{32}\pi^2$ cm/s^2 (B) $\frac{-\pi^2}{32}$ cm/s^2 (C) $\frac{\pi^2}{32}$ cm/s^2 (D) $-\frac{\sqrt{3}}{32}\pi^2$ cm/s^2

ns. (D)

moves without friction on a horizontal surface. The block oscillates with small amplitude A about an equilibrium position x_0. Consider two cases : (i) when the block is at x_0; and (ii) when the block is at $x = x_0 + A$. In both the cases, a particle with mass m (<M) is softly placed on the block after which they stick to each other. Which of the following statement(s) is(are) true about the motion after the mass m is placed on the mass M? **[JEE-Advanced-2016]**

(A) The amplitude of oscillation in the first case changes by a factor of $\sqrt{\frac{M}{m+M}}$, whereas in the second case it remains unchanged

(B) The final time period of oscillation in both the cases is same

(C) The total energy decreases in both the cases

(D) The instantaneous speed at x_0 of the combined masses decreases in both the cases.

ABD

A particle of mass m is attached to one end of a mass-less spring of force constant k, lying on a frictionless horizontal plane. The other end of the spring is fixed. The particle starts moving horizontally from its equilibrium position at time t = 0 with an initial velocity u_0. When the speed of the particle is $0.5\ u_0$, it collides elastically with a rigid wall. After this collision :- **[JEE-Advanced-2013]**

(A) the speed of the particle when it returns to its equilibrium position is u_0

(B) the time at which the particle passes through the equilibrium position for the first time is $t = \pi\sqrt{\frac{m}{k}}$

(C) the time at which the maximum compression of the spring occurs is $t = \frac{4\pi}{3}\sqrt{\frac{m}{k}}$

(D) the time at which the particle passes through the equilibrium position for the second time is $t = \frac{5\pi}{3}\sqrt{\frac{m}{k}}$

$\ell_0 = 0.1$ m. The spring constant is $k_1 = 0.009\ \text{Nm}^{-1}$ when the length of the spring $\ell > \ell_0$ and is $k_2 = 0.016\ \text{Nm}^{-1}$ when $\ell < \ell_0$. Initially the bob is released from $\ell = 0.15$ m. Assume that Hooke's law remains valid throughout the motion. If the time period of the full oscillation is $T = (n\pi)$ s, then the integer closest to n is _____.

एक घर्षणरहित (frictionless) क्षैतिज समतल पर एक गोला (bob), जिसका द्रव्यमान $m = 0.1$ kg है, एक स्प्रिंग, जिसकी प्राकृतिक लम्बाई $\ell_0 = 0.1$ m है, से जुड़ा है। स्प्रिंग का नियतांक $k_1 = 0.009\ \text{Nm}^{-1}$ है जब स्प्रिंग की लम्बाई $\ell > \ell_0$ है, तथा $k_2 = 0.016\ \text{Nm}^{-1}$ है जब $\ell < \ell_0$ है। प्रारंभ में गोले को $\ell = 0.15$ m से छोड़ा जाता है। मान लें कि हुक का नियम (Hooke's law) पूरी गति के दौरान मान्य (valid) है। यदि एक पूरे दोलन का आवर्तकाल $T = (n\pi)$ s है, तो n का निकटतम पूर्णांक (nearest integer) _____ है।

[JEE-Advanced-2022]

Ans. 6

3. Function $x = A\sin^2\omega t + B\cos^2\omega t + C\sin\omega t\cos\omega t$ represents SHM :- **[IIT JEE 2006]**

(A) for any value of A, B and C (except $C = 0$) (B) if $A = -B$; $C = 2B$, amplitude = $\left|B\sqrt{2}\right|$

(C) if $A = B$; $C = 0$ (D) if $A = B$; $C = 2B$, amplitude = $|B|$

फलन : $x = A\sin^2\omega t + B\cos^2\omega t + C\sin\omega t\cos\omega t$ सरल आवर्त गति को निरूपित करता है :-

(A) A, B तथा C के किसी भी मान के लिये (C = 0 के अतिरिक्त)

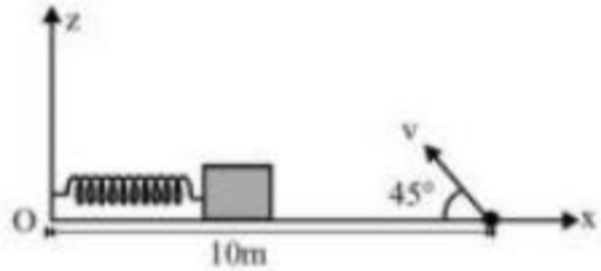
(B) यदि A = –B, C = 2B, आयाम = $\left|B\sqrt{2}\right|$

(C) यदि A = B; C = 0

(D) यदि A = B; C = 2B, आयाम = |B|

Ans. (A,B,D)

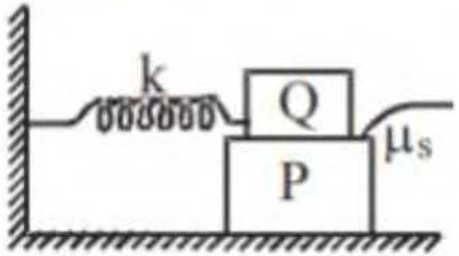
end of the spring (see the figure) is fixed. They system lies on a horizontal frictionless surface. The block is stretched by 0.2 m and released from rest at t = 0. It then executes simple harmonic motion with angular frequency $\omega = \frac{\pi}{3}$ rad/s. Simultaneously at t = 0, a small pebble is projected with speed v from point P at an angle of 45° as shown in the figure. Point P is at a horizontal distance of 10m from O. If the pebble hits the block at t = 1s, the value of v is:- (take g = 10 m/s^2) **[IIT-JEE 2012]**



(A) $\sqrt{50}$ m/s (B) $\sqrt{51}$ m/s (C) $\sqrt{52}$ m/s (D) $\sqrt{53}$ m/s

Ans. (A)

plane. A second block of same mass m is placed on it and is connected to a spring of spring constant k, the two blocks are pulled by distance A. Block Q oscillates without slipping. What is the maximum value of frictional force between the two blocks. **[2004S]**

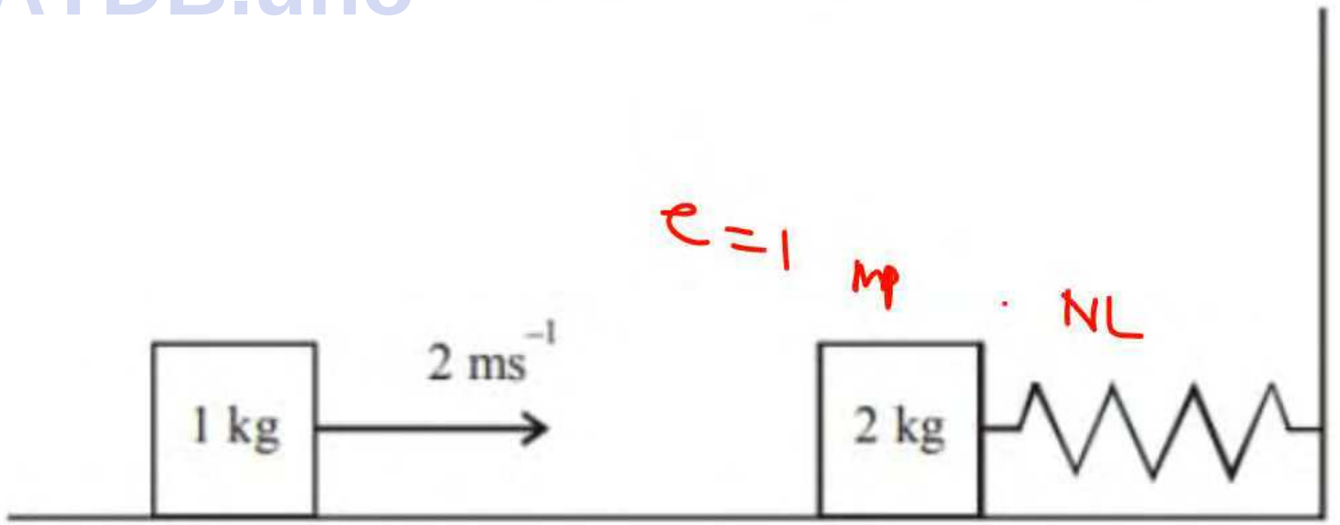


(a) $kA/2$ (b) kA

(c) $\mu_s mg$ (d) zero

23 (a)

shown in the figure. The spring constant is $2.0\ Nm^{-1}$ and the mass of the block is 2.0 kg. Ignore the mass of the spring. Initially the spring is in an unstretched condition. Another block of mass 1.0 kg moving with a speed of $2.0\ ms^{-1}$ collides elastically with the first block. The collision is such that the 2.0 kg block does not hit the wall. The distance, in metres, between the two blocks when the spring returns to its unstretched position for the first time after the collision is _____. **[Adv. 2018]**



30. (2.09)

Home Work

- DPP-05
- Revise all ques today class
- module → Prabal → (1-13), (17-20),
  Panikshit (JTA) → (1-13)