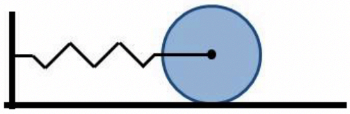
2) A spring with a spring constant of 448 J/m^2 is attached to a uniformly dense solid sphere with a mass of 7 kg that rolls without slipping along a horizontal surface as shown in the figure. What is the effective mass (in kg) of this system for its oscillation?

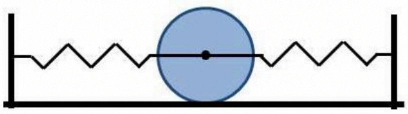


1. $m_{effective} = \frac{I}{R^2} + m$

$I = \frac{2}{5} m R^2 \Rightarrow$

$m_{effective} = \frac{2}{5} m + m = 9.8\,kg$

Two identical springs, each with a spring constant of 567 J/m^2, are attached to a uniformly dense solid sphere with a mass of 10 kg that rolls without slipping along a horizontal surface as shown in the figure. What is the period (in s) of simple harmonic oscillations of this system about its equilibrium position?



2. (1) $m_{eff} = \frac{I}{R^2} + m$, $I = \frac{2}{5} m R^2$

$\Rightarrow m_{eff} = \frac{2}{5} m + m = \frac{7}{5} m = 14\,kg$

(2) $k_{eff} = 567\,J/m^2 + 567\,J/m^2 = 2.567\,J/m^2$

(3) $\omega = \sqrt{\frac{k_{eff}}{m_{eff}}} = \sqrt{\frac{2.567}{7/5\, m}}$

(4) $T = \frac{2\pi}{\omega}$ $\quad(\omega = 2\pi f,\ f = \frac{1}{T})$

$\therefore T = \frac{2\pi}{\sqrt{\frac{2.567}{14}}} = \frac{2\pi}{9}\,s$

I

~~15.~~ Your car collides with this car at a right angle and the two vehicles then slide together for 3 m before crashing into several cars parked in the nearby parking lot and exploding in a massive fireball. Your car has a mass of 2000 kg and the other car has a mass of 2750 kg. Assuming that your car was moving at 35 m/s and the other car was moving at 15 m/s when the collision occurred, what was the total kinetic energy (in MJ) of the two cars before the collision?

3

$$K_{total} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

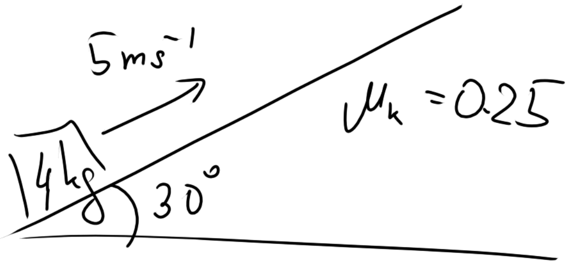
$$= \frac{1}{2}(2000) \cdot 35^2 + \frac{1}{2}(2750) \cdot 15^2$$

$$= 1.5 \text{ MJ}$$

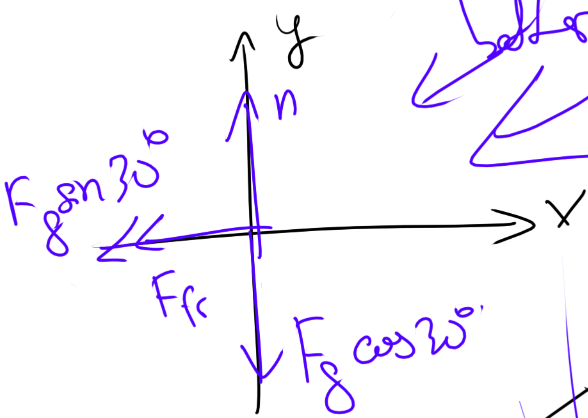
II

(4) Question:

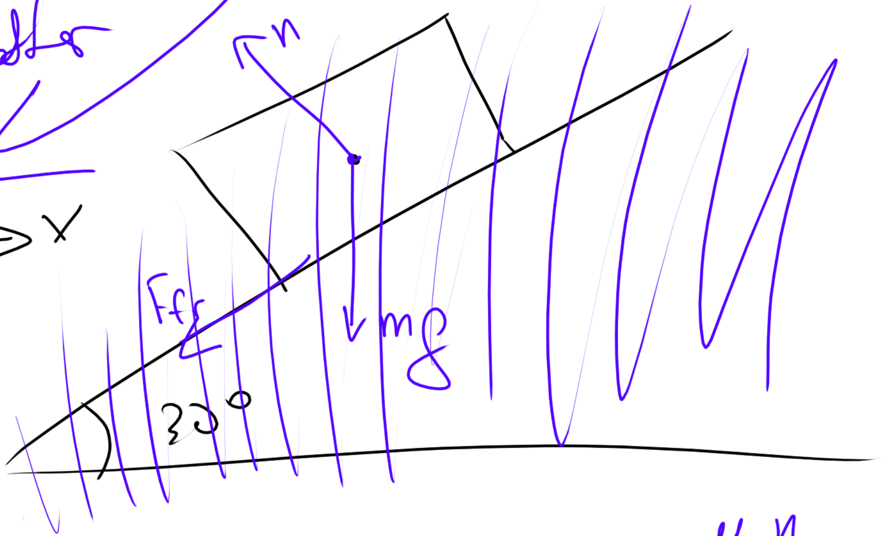
What is the instantaneous power (in W) supplied by the force of kinetic friction 0.5 s after the block is launched.



Solution



better perspective



$$\begin{cases} (F_{net})_x = ma_x = -F_g \sin 30^\circ - F_{fr} \quad (F_{fr} = \mu_k n) \\ (F_{net})_y = ma_y = n - F_g \cos 30^\circ = 0 \end{cases}$$

$$\Rightarrow \begin{cases} n = F_g \cos 30^\circ \\ ma_x = -mg \sin 30^\circ - \mu_k mg \cos 30^\circ \end{cases}$$

III

Then

$$a_x = -g\sin 30^\circ - \mu_k g\cos 30^\circ$$

$$= -7.02\ \mathrm{ms^{-2}}$$ ← constant!!!

What's the next step?

$$\Delta V_x = a_x \Delta t$$

$$\Rightarrow V_f - 5 = -7.02 \cdot 0.5$$

$$\Rightarrow V_f = 1.49\ \mathrm{ms^{-1}}$$

Now do the power!

$$P = \vec{F}\cdot\underset{\uparrow\ \langle 1.49, 0\rangle}{\vec{v}} = -\mu_k v m g \cos 30^\circ$$

$$\Rightarrow P = -0.25 \cdot 1.49 \cdot 4 \cdot 9.8 \cdot \frac{\sqrt{3}}{2}$$

$$= -12.65\ \mathrm{W}$$

↑ Answer

$\boxed{\text{IV}}$