Answer on Question #53684, Physics / Mechanics | Kinematics | Dynamics

Take a hollow plastic ball (dia 3 cm to 5 cm) using a needle. Pass a thread of about 105 cm along a diameter of the ball. Tie a knot at one end. Hang the ball from a rigid support so that the ball is free to oscillate. Make a small hole (5 mm dia) in the ball near the top. Fill it with sand and find its time period of oscillation. Empty the ball and fill it with steel balls/iron filings and repeat the experiment. Similarly carry out the experiment with common salt. Compare the time periods obtained in the above three cases. What do you find? Explain your finding.

Solution

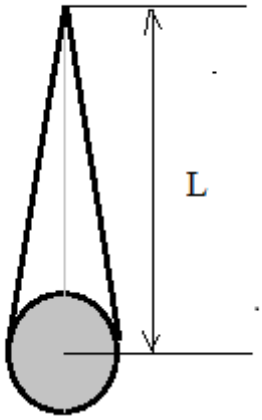

Fig.1

As a result of the manipulation we have a physical pendulum. We assume that the thread is weightless. So, the period of oscillation is given by Eq.(1)

$$T = 2\pi\sqrt{\frac{J}{mgL}} \tag{1}$$

where m is the mass of the ball with filling (mass of the plastic shell of the ball is much smaller than the mass of the filling); L is the distance from the point of

suspension to the center of mass; $J = \frac{2}{5}mr^2 + mL^2$ is the moment of inertia of the ball relative to the point of suspension (we use parallel axis theorem); $g = 9.81 m/s^2$ is the gravitational acceleration

In this case

$$T = 2\pi\sqrt{\frac{\frac{2}{5}mr^2 + mL^2}{mgL}} = 2\pi\sqrt{\frac{\frac{2}{5}r^2 + L^2}{gL}} = 2\pi\sqrt{\frac{\frac{2}{5}\cdot\left(2.5\cdot 10^{-2}\right)^2 + 0.5^2}{9.81\cdot 0.5}} \approx 1.42s$$

where $r = 2.5\cdot 10^{-2} m$; $L \approx \left(1.05m - 2r\right)/2 = \left(1.05m - 0.05m\right)/2 = 0.5m$ (considering that $r << L$).

Answer:

As it was shown above the oscillation period is independent of the filling ball and it is 1.42s.