

Answer on Question #57258-Physics-Mechanics-Relativity

Take a hollow plastic ball (dia 3cm to 5cm) 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 (5mm 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

The result of our manipulations is a physical pendulum. The period of oscillation of the resulting system can be determined by using

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

where m is the mass of the ball with filling; g is the gravitational acceleration; L is the distance from the point of suspension to the center of mass of ball; $J = \frac{2}{5}mr^2 + mL^2$ is the moment of inertia (from to the parallel axis theorem).

$$T = 2\pi \sqrt{\frac{\frac{2}{5}mr^2 + mL^2}{mgL}} = 2\pi \sqrt{\frac{\frac{2}{20}d^2 + L^2}{gL}} = 2\pi \sqrt{\frac{\frac{2}{20} \cdot 0.03^2 + 0.51^2}{9.81 \cdot 0.51}} \approx 1.43 \text{ s.}$$

where $d = 0.03 \text{ m}$ is the diameter of the ball; $L \approx \frac{(1.05m-d)}{2} = \frac{(1.05m-0.03 \text{ m})}{2} = 0.51m$ (considering that $r \ll L$).

Answer: The period of oscillation depends on the diameter of the ball and the length of the suspension and does not depend on the ball filling (filling homogeneous). For these sizes period is 1.43 seconds.