Answer on Question #59261-Physics-Mechanics-Relativity

A uniform rod of wood floats vertically in water with $h = 14\ cm = 0.14\ m$ of its length immersed in water. If it is depressed slightly and released find its period of oscillation.

Solution

At the equilibrium the weight of the rod is equal to Archimedes force:

$$mg = \rho_{wood} gAh.$$

When it depressed the net force on rod:

$$F_{net} = mg - \rho_{wood} gA(h + y) = -\rho_{wood} gAy.$$

The second Newton's law:

$$ma = m\ddot{y} = F_{net} = -\rho_{wood} gAy.$$

$$\ddot{y} + \frac{\rho_{wood} gA}{m} y = 0$$

This is equation for harmonic oscillations with angular frequency

$$\omega = \sqrt{\frac{\rho_{wood} gA}{m}}.$$

But using the equilibrium equation:

$$\frac{\rho_{wood} gA}{m} = \frac{g}{h}$$

$$\omega = \sqrt{\frac{g}{h}}$$

The period of oscillation is given by the formula:

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{h}{g}} = 2\pi\sqrt{\frac{0.14}{9.8}} = 0.75\ s.$$

Answer: $0.75\ s$.