Problem №24 «Oscillations in water»

George Stecenko

Team «Uranium-239»

International Young Naturalists' Tournament 2020

Problem

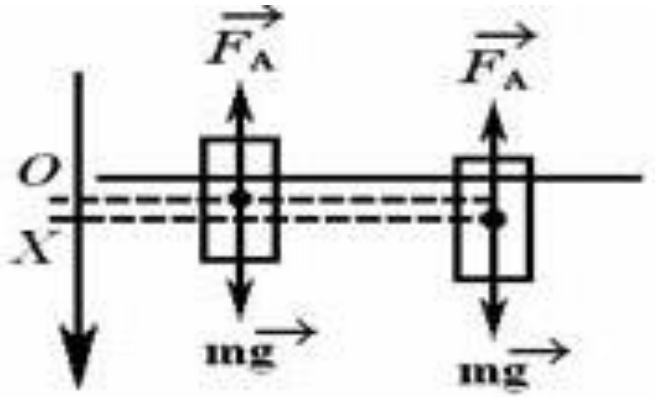
Take a vial, a tall glass, or a bottle and load it with heavy objects. Make it float vertically on the water surface. If displaced up or down, the vial will oscillate. Calculate theoretically and measure experimentally the period of its oscillations.

Work plan

- Build a theoretical model
- Make experimental setup
- Compare experimental data with theoretical
- Determine critical parameters

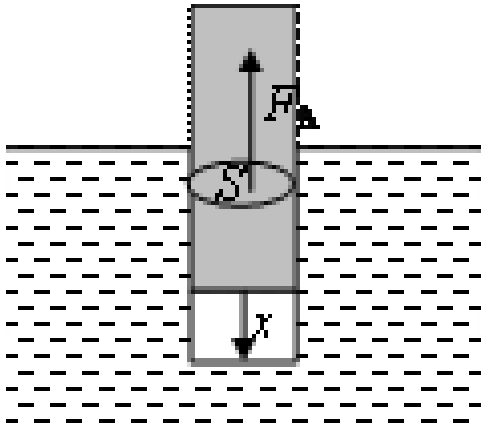
Theory

In the equilibrium position, the force of gravity is balanced by the Archimedean force. But if the float is displaced from the equilibrium position, then the vector sum F_A of the Archimedean force and gravity force mg will be non-zero and directed towards the movement of the float, i.e. when it is submerged, it is directed up, when it rises from the water – down. Therefore, this sum of forces can be written as



$$ma = -\rho gV = -\rho gSx$$

$$\frac{d^2x}{dt^2} + \frac{\rho gS}{m}x = 0$$



Theory. Period of oscillation

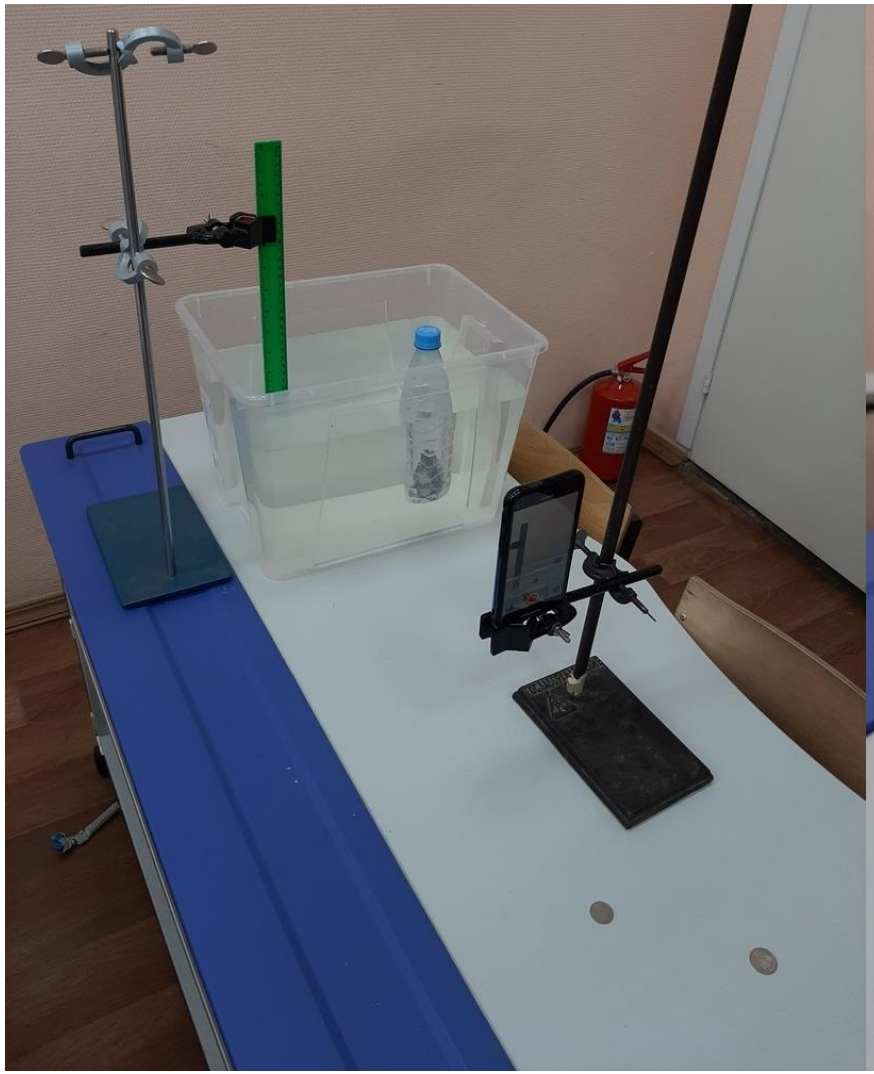
$$\omega = \sqrt{\frac{\rho g S}{m}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{\rho g S}}$$

$$\rho = 1000\ \frac{g}{cm^3} \qquad S = 28,26\ cm^2 \qquad m_1 = 339\ g$$

$$T \approx 2,859\ s$$

Experimental setup



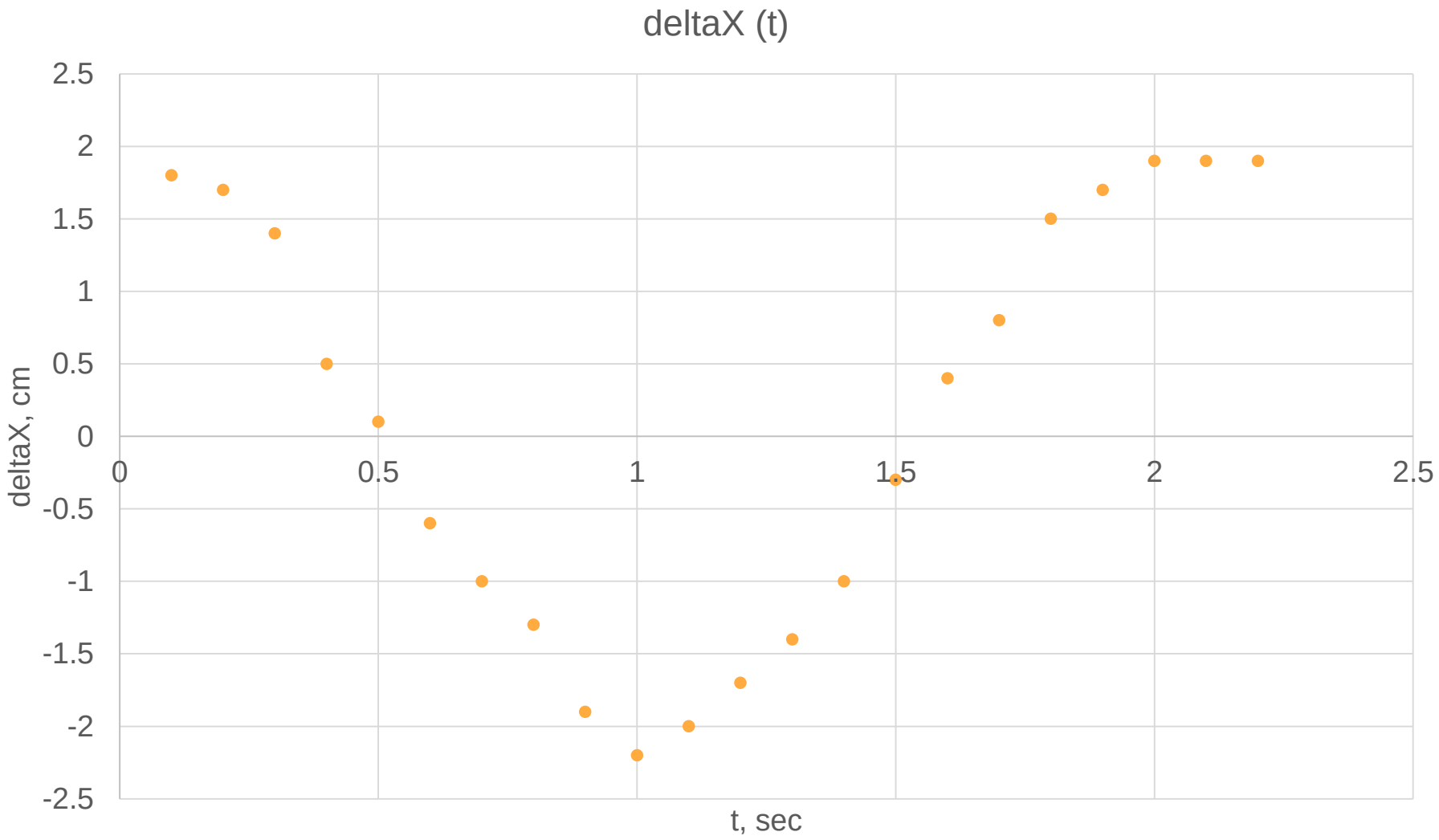
1.Ruler

2.Bottle

3.Coins

4.Camera

Experimental data



$$T \approx 2,2\ s$$

Thank you for attention!