ARCHIMEDES' PRINCIPLE BY EXPERIMENT AND CALCULATION

As a science teacher, it always a delight to approach a problem from two very different directions that lead to the same solution. Archimedes’ Principle, the principle of buoyancy, is one such problem. After we have studied density and fluid pressure in the classroom, students can then determine Archimedes’ Principle by experiment. They conclude that a body submerged in or floating on a fluid is buoyed up by a force equal to the weight (not mass) of the displaced fluid (Figure 1).

Note: for simplicity, water's density is assumed to be 10 N / 1,000 cm$^3$ (N = Newtons). Although this equation represents weight-density, a non-standard unit (normally, mass-density is used), I am using it here to simplify the process, and because we are measuring the force of gravity, or weight.

Figure 1. Buoyancy by experiment.

Apparent Weight Loss = Weight of Displaced Fluid
27,000 N - 17,000 N = 10,000 N
The students are then asked to calculate the downward force on top of a submerged block of granite submerged in water, the upward force against the bottom of that block, and the net upward force on the block (Figure 2).

*Figure 2. Buoyancy by calculation.*

* The values used here were used for ease in calculation. The depth to which the block is submerged can be any value, as can the dimensions of the block.

Force at A = Pressure x Area
    = Density x Depth x Area
    = 10 N / 1,000 cm³ x 100 cm x 10,000 cm²
    = 10,000 N

Force at B = Density x Depth x Area
    = 10 N / 1,000 cm³ x 200 cm x 10,000 cm²
    = 20,000 N

Therefore,
Net Upward Force = 20,000 N − 10,000 N
    = 10,000 N
Once these two experiments are concluded, after having approached the problem from different directions, it becomes apparent that the same solution can be obtained through these two different methods.

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