

Density, pressure, buoyancy and moving fluids

AP Physics 1 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

How does the buoyant force depend on the volume of an object that is fully under water? In this lab you weigh aluminium cylinders in air and in water, plot the force against volume, and use the gradient to measure the density of water and aluminium.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 8

Aim

To measure the buoyant force on aluminium cylinders of different volumes and use the results to find the density of water.

Equipment

- Newton meter (0 to 2 N, resolution 0.01 N)
- Five aluminium cylinders of volume 10, 20, 30, 40 and 50 cm³ with a hook
- Beaker of fresh water, large enough to submerge the largest cylinder
- Thread, retort stand and clamp
- Paper towel

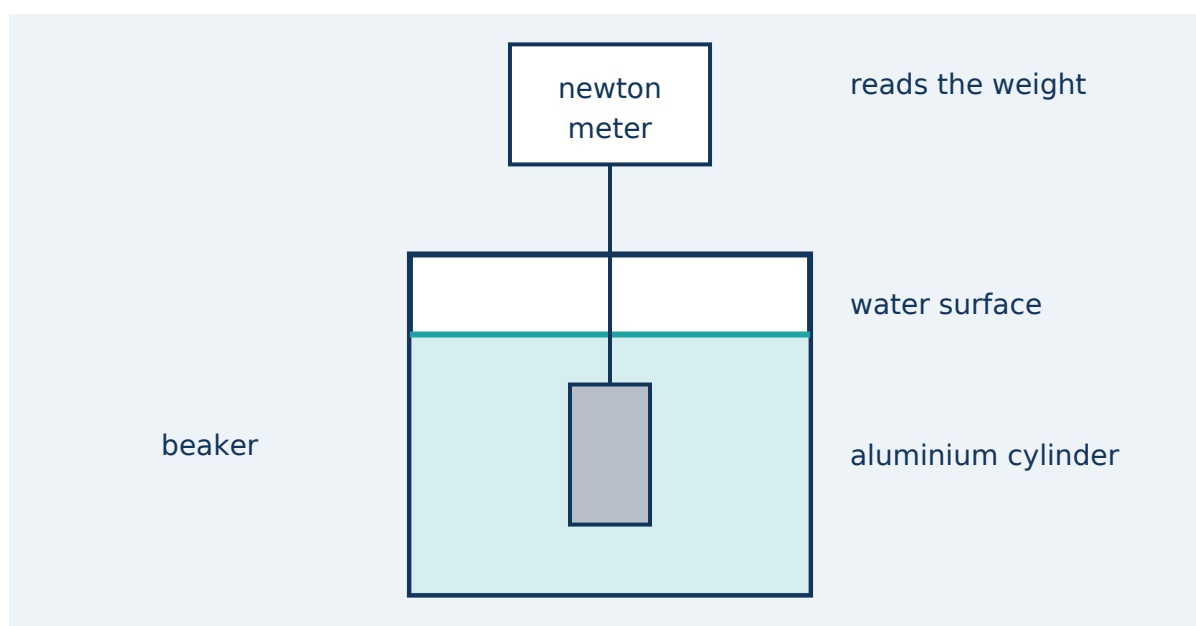
Safety

Safety

Wipe up spills at once because a wet floor is slippery. Keep the beaker away from the table edge and support the newton meter on the stand so that a falling cylinder cannot hit your foot or the glass.

Method

1. Hang the first cylinder from the newton meter and record its weight in air, W_{air} .
2. Lower the cylinder until it is fully under water, not touching the sides or the bottom. Remove any bubbles with a finger.
3. Wait until the reading is steady and record the weight in water, W_{water} .
4. Repeat for the other four cylinders.
5. Calculate the buoyant force $B = W_{\text{air}} - W_{\text{water}}$ for each cylinder.



The cylinder hangs from the newton meter and is lowered until it is fully under water, without touching the glass.

Results

Sample readings from Mei's class in Singapore are shown.

Volume V (cm ³)	W in air (N)	W in water (N)	B (N)
10	0.27	0.17	0.10
20	0.53	0.33	0.20
30	0.80	0.50	0.30
40	1.06	0.67	0.39
50	1.32	0.83	0.49

Analysis questions

Question 1 Plot and describe

Plot B (vertical) against V (horizontal) and describe the pattern.

Question 2 Gradient

Calculate the gradient of the line using the data for 50 cm³ and convert it to N/m³.

Question 3 Density of water

Use the gradient to find the density of the water and compare it with 1000 kg/m³.

Question 4 Density of aluminium

Use the readings for the 50 cm³ cylinder to find the density of aluminium.

Question 5 Uncertainty

Each newton meter reading has an uncertainty of ± 0.01 N. Find the percentage uncertainty in B for the 10 cm³ and the 50 cm³ cylinders.

Question 6 Effect of bubbles

A student leaves air bubbles on the cylinder. Explain how this changes B and the calculated density of water.

Question 7 Salt water prediction

Predict B for the 50 cm³ cylinder in salt water of density 1100 kg/m³.