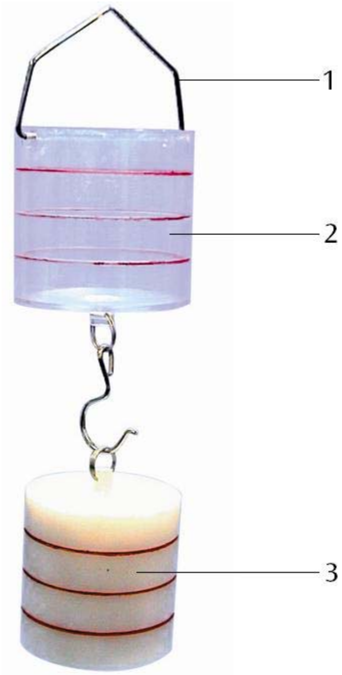
3B SCIENTIFIC® PHYSICS

...going one step further

Device for Archimedes' Principle U40875

Operating instructions

04/08 ALF



1 Handle
2 Bucket
3 Cylinder

1. Description

The device for Archimedes' Principle is used to demonstrate Archimedes' Principle of buoyancy in liquids. It can also be used to determine the density of an unknown fluid.

It consists of a bucket with a handle and a hook, as well as a precisely fitted solid cylinder with a ring. There are division marks on both the cylinder and the bucket which allow the user to perform experiments with different volumes. Each division mark represents one quarter of the total volume.

2. Basic principles

According to Archimedes' Principle, if an object is immersed in a fluid, the force F_B exerted on the object by the fluid is equal to the weight of the fluid F_W displaced by the object, $F_B = F_W$.

Archimedes' Principle is valid in fluids as well as in gases.

Since the volume of fluid V_F displaced by the object is just equal to the volume of the object V_K the mass of fluid m_F displaced is the volume of the object V_K multiplied by the density of the fluid ρ.

$$m_F = \rho\, V_K \qquad (1)$$

The weight of the displaced fluid F_W is this mass m_F multiplied by the acceleration due to gravity g.

$$F_W = g \cdot m_F \qquad (2)$$

Therefore the buoyant force F_B is given by the following formula

$$F_B = \rho\, g\, V_K \qquad (3)$$

The density ρ of an unknown fluid can therefore be calculated by the formula:

$$\rho = \frac{F_B}{V} \qquad (4)$$

3. Technical data

Volume of cylinder:	approx. 100 cm^3
Mass of cylinder:	approx. 120 g
Volume of bucket:	approx. 100 ml
Dimensions:	approx. 55x55x 55 mm^3
Net weight:	approx. 150 g

4. Operation

4.1 Verification of Archimedes' Principle

Additionally required:

1	Dynamometer 250 g / 2,5 N	U40810
1	Vessel with overflow	U8411310
1	Beaker	from U14210
1	Stand base	U8611160
1	Steel rod, 750 mm	U15003
1	Clamp with hook	U13252

4.1.1 Experiment 1

- Set up the stand and suspend the dynamometer from the hook.
- Insert the cylinder in the bucket to verify that the volume of the cylinder is equal to the volume of the cylindrical cavity of the bucket.
- Attach the cylinder to the bucket and suspend both from the dynamometer.
- Read and write down the weight.
- Fill the beaker with water and place it under the cylinder.
- Lower the dynamometer until the cylinder is immersed in the water up to the first division mark.
- Read the new value for the weight.
- Fill the bucket with water to the first division mark.

The dynamometer shows the initial value.

- In further steps lower the cylinder up to the second division mark, than third and finally until it is completely immersed in the water. With each step pour the corresponding amount of water into the bucket

Thus Archimedes' Principle is confirmed.

4.1.2 Experiment 2

- Set up the stand and suspend the dynamometer from the hook.
- Attach the cylinder to the bucket and suspend both from the dynamometer.
- Read and write down the weight.
- Fill the vessel with overflow to such an extent with water that it just stops to overflow.
- Place the beaker next to the vessel with overflow so that the overflowing water can be collected.
- Lower the dynamometer until the cylinder is completely immersed in the water. Collect the overflowing water in the beaker.
- Read the new value on the dynamometer.

The difference between the two readings is the buoyant force F_B on the cylinder.

- Carefully pour the water from the beaker into the bucket. Make sure no water is left in the beaker.

The dynamometer displays the initial value. Thus Archimedes' Principle is confirmed.

4.2 Determination of the density of an unknown fluid

Additionally required:

1 Ruler

- Use the ruler to measure the diameter *d* and height *h* of the cylinder and calculate its volume ($V = ¼ \pi d^2 h$).
- Determine the buoyant force F_A (ref. to point 4.1.2) with the unknown fluid in place of water.
- Use formula 4 to determine the density of the unknown fluid.

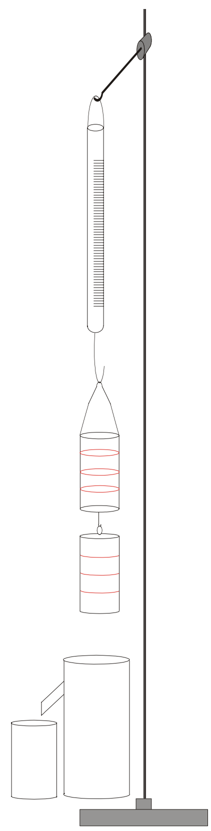


Fig. 1 Experimental set-up