Determining the density of air

Objects of the experiments

- Measuring the mass of the open glass sphere filled with air.
- Measuring the mass of the evacuated glass sphere.
- Determining the density of air from the mass difference and the volume of the glass sphere.

Principles

Depending on the state of aggregation of a homogeneous substance, different methods are applied to determine its density

$$\rho = \frac{m}{V} \quad \text{(I).}$$

m: mass, V: volume

In most cases, the mass and the volume are measured separately.

In this experiment, the density of air in a glass sphere of known volume V is determined. The mass m of the air enclosed in the sphere is determined from the mass difference between the total mass m_1 of the sphere filled with air and the mass m_2 of the empty (evacuated) sphere:

$$m = m_1 - m_2 \quad \text{(II)}$$

Apparatus

1 sphere with 2 cocks	379 07
1 school and lab. balance 311, 311 g . . .	315 05
1 hand vacuum and pressure pump	375 58
1 support ring for round-bottom flasks, 250 ml	667 072

Setup and carrying out the experiment

The experimental setup is illustrated in Fig. 1.

– Put the sphere with 2 cocks on the scale pan, open one cock **(a)**, and determine the total mass m_1 (see Fig. 1 left).

– Connect the hand vacuum and pressure pump, and evacuate the sphere with 2 cocks as far as possible (see Fig. 1 middle, the hand vacuum and pressure pump displays the differential pressure Δp relative to the outside air pressure).

– Close the open cock **(a)**, and remove the hand vacuum and pressure pump.

– Put the sphere with 2 cocks on the scale pan again, and determine the mass m_2 of the empty sphere (see Fig. 1 right).

Measuring example

Total mass: m_1 = 253.94 g
Mass of the empty sphere *: m_2 = 252.83 g
*: measured at p = 1000 mbar – Δp = 50 mbar

Evaluation

Mass of the enclosed air: m = 1.11 g

Volume of the enclosed air: V = 1000 ml = 1000 cm^3

From Eq. (I) we obtain $\rho = 0.0011 \frac{g}{cm^3} = 1.1 \frac{kg}{m^3}$

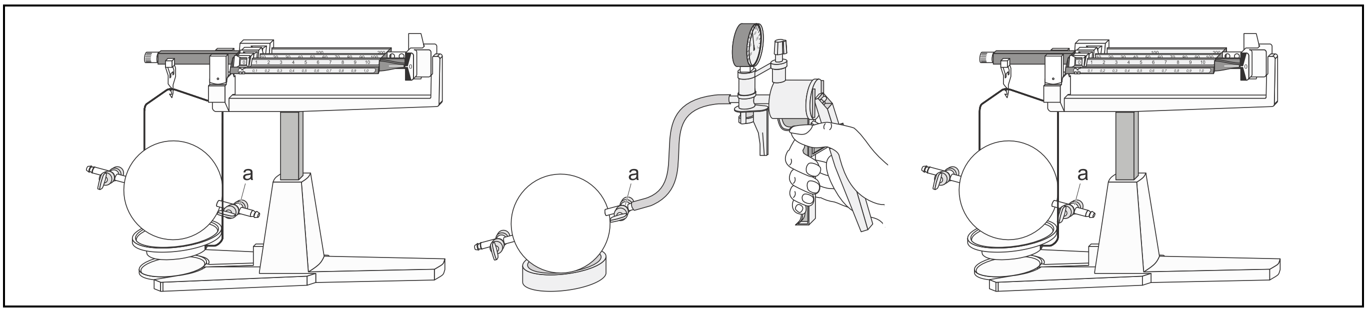
Value quoted in the literature:

$\rho = 1.29 \frac{kg}{m^3}$ (density of dry air under normal conditions)

Results

Air, too, has a density. Under normal conditions it is approximately one thousandth the density of water.

Fig. 1 Experimental setup for determining the density of air



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