Measurement of Density

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1. Goal

The goal of this lab experiment was to measure the density of an object of unknown material.

2. Theory and experimental setting

The density of an object is defined as

$$\rho = \frac{m}{V} \text{ kg/m}^3$$

In order to determine the density of an object, therefore, it is necessary to measure the mass of that object and its linear dimensions. Four differently shaped objects were investigated. For each of them, the linear dimensions were measured and their volume was calculated as follows:

a) **cube, rectangular plate**

The three sides, $a_1, a_2, a_3,$ were measured and the volume was calculated as

$$V = a_1 a_2 a_3$$

b) **cylinder**

The diameter, d, and the height of the cylinder, h, were measured and the volume was calculated as:

$$V = \left(\pi \frac{d^2}{4}\right) h$$

c) **sphere**

The diameter of the sphere was measured, d, and the volume was calculated as:

$$V = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3$$

Mass scale was used to measure to mass of the objects. The linear dimensions were measured by calipers except for the diameters of the cylinder and the sphere, for which a micrometer was used.

3. Experimental Data

a) Cube, rectangular plate

object	mass (g)	a_1(cm)	a_2(cm)	a_3(cm)	V(cm^3)	$\rho\ \left(\frac{\text{g}}{\text{cm}^3}\right)$			
cube	4.76	1.20	1.19	1.20	1.7136	2.778			
rectang.	34.03	0.55	2.97	7.67	12.5289	2.716			

b) Cylinder

object	mass (g)	d (cm)	h (cm)	V (cm^3)	$\rho\left(\frac{\text{g}}{\text{cm}^3}\right)$	
cylinder	36.25	1.34	4.53	6.3885	5.671	

c) Sphere

object	mass (g)	d(cm)	V (cm)	$\rho\ \left(\frac{\text{g}}{\text{cm}^3}\right)$
sphere	11.48	1.55	1.4624	7,850

4. Results and discussion

The density of the cube and the rectangular object appears very close to that of aluminum ($\rho = 2.70$ g/cm^3), while the density of the sphere is very close to that of iron ($\rho = 7.87$ g/cm^3). On the other hand, the measured density of the cylinder does not appear close to known metals. For the cube, the rectangular plate, and the sphere, therefore, the inaccuracy of the final results can be estimated from the following formula:

$$\%\text{error} = \frac{|(measured\ density) - (actual\ density)|}{(actual\ density)} \times 100\%$$

The results of this experiment are summarized in the following table:

object	measured density	most likely material	actual density	percent error
cube	2.78	aluminum	2.70	3 %
rectang.	2.72	aluminum	2.70	1 %
cylinder	5.671	unknown		
sphere	7.85	iron	7.87	0.3 %