The Density of Wood and an Unknown Metal

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1 Abstract

The density of a block of wood and a cylinder made from an unknown metal were determined from measurements of the dimensions and the mass. The dimensions of the wood block were measured using a ruler and the dimensions of the metal cylinder were measured using vernier calipers. The density of the wood was measured to be 0.6129 ± 0.0071 g/cm^3 and the density of the metal cylinder was measured to be 2.7344 ± 0.0278 g/cm^3.

2 Introduction

In this lab the density of two materials was calculated from the Mass of an object and certain lengths of that object. Density is the mass per unit volume of a material and is commonly expressed in units of kilograms per cubic meter or grams per cubic centimeter.

3 Procedure

The length, width, and height of a rectangular prism made of wood were measured using a ruler with markings at each millimeter. The height and diameter of a cylinder made of an unknown metal were measured using vernier calipers with markings at each millimeter. The mass of both objects was measured using a triple beam balance. The beam with the largest weight has notches indicating hundreds of grams, the beam with the middle weight has notches indicating tens of grams, and the beam with the smallest weight has markings indicating tenths of grams.

4 Data

Table 1. Wooden Block

Trial	M(g)	L(cm)	W(cm)	H(cm)
1	73.72	6.19	6.02	3.25
2	73.85	6.21	6.01	3.27
3	73.80	6.22	5.99	3.21
4	73.73	6.19	6.01	3.19
$\overline{x}$	73.775	6.203	6.008	3.230
σ	0.061	0.015	0.013	0.037

Table 2. Metal Cylinder

Trial	M(g)	H(cm)	D(cm)
1	65.81	5.01	2.47
2	65.83	5.01	2.49
3	65.85	5.01	2.46
4	65.88	5.02	2.47
$\overline{x}$	65.843	5.0150	2.473
σ	0.030	0.0058	0.013

Table 3. Results

	Wood	Metal
ρ(g/cm^3)	0.6129	2.734
σ_ρ	0.0071	0.028

5 Calculations

$$\begin{aligned}
\overline{m}_w &= \frac{73.72\text{g} + 73.85\text{g} + 73.80\text{g} + 73.73\text{g}}{4} \\
&= 73.775\text{g} \\
\sigma_{mw}^2 &= \frac{(73.72\text{g} - 73.775\text{g})^2 + (73.85\text{g} - 73.775\text{g})^2 + (73.80\text{g} - 73.775\text{g})^2 + (73.73\text{g} - 73.775\text{g})^2}{3} \\
&= \frac{(-0.055\text{g})^2 + (0.075\text{g})^2 + (0.025\text{g})^2 + (-0.045\text{g})^2}{3} \\
&= \frac{0.0113\text{g}^2}{3} \\
&= 0.00376667\text{g}^2 \\
\sigma_{mw} &= \sqrt{0.00376667\text{g}^2} \\
&= 0.061\text{g}
\end{aligned}$$

$$\frac{\sigma_{mw}}{\overline{m}_w} = \frac{73.775\text{g}}{0.061\text{g}}$$
$$= 0.083\%$$
$$\rho_w = \frac{73.775\text{g}}{(6.203\text{cm})(6.008\text{cm})(3.230\text{cm})}$$
$$= 0.6129\text{g/cm}^3$$
$$\rho_{wM} = \frac{73.775\text{g} + 0.061\text{g}}{(6.203\text{cm})(6.008\text{cm})(3.230\text{cm})}$$
$$= 0.6134\text{g/cm}^3$$
$$\rho_{wL} = \frac{73.775\text{g}}{(6.203\text{cm} + 0.015\text{cm})(6.008\text{cm})(3.230\text{cm})}$$
$$= 0.6115\text{g/cm}^3$$
$$\rho_{wW} = \frac{73.775\text{g}}{(6.203\text{cm})(6.008\text{cm} + 0.013\text{cm})(3.230\text{cm})}$$
$$= 0.6117\text{g/cm}^3$$
$$\rho_{wH} = \frac{73.775\text{g}}{(6.203\text{cm})(6.008\text{cm})(3.230\text{cm} + 0.037\text{cm})}$$
$$= 0.6061\text{g/cm}^3$$
$$\sigma^2_{\rho w} = (0.6115\text{g/cm}^3 - 0.6129\text{g/cm}^3)^2 + (0.6117\text{g/cm}^3 - 0.6129\text{g/cm}^3)^2 + (0.6061\text{g/cm}^3 - 0.6129\text{g/cm}^3)^2$$
$$= 0.000051\text{g}^2/\text{cm}^6$$
$$\sigma_{\rho w} = \sqrt{0.000051}$$
$$= 0.0071\text{g/cm}^3$$
$$\rho_m = \frac{65.843\text{g}}{\pi 5.0150\text{cm}(\frac{2.473\text{cm}}{2})^2}$$
$$= 2.734\text{g/cm}^3$$
$$\sigma^2_{\rho m} = (2.731\text{g/cm}^3 - 2.734\text{g/cm}^3)^2 + (2.706\text{g/cm}^3 - 2.734\text{g/cm}^3)^2$$
$$= 0.000773\text{g}^2/\text{cm}^6$$
$$\sigma_{\rho m} = \sqrt{0.000773\text{g}^2/\text{cm}^6}$$
$$= 0.028\text{g/cm}^3$$

6 Conclusion

Overall this experiment succeeded in determining the density of these two materials. The published density of aluminum is within two standard deviations of the measured density of the cylinder in this experiment.

The measured density of the wood block is well within the range of published values for types of wood, but there is such a wide range of densities for wood and the densities of many species of wood overlap so it is not possible to say what species of wood was measured without further investigation. Random error arose in this experiment from limitations in the precision of the instruments used for measurement. These results could be improved with more precise measurement instruments.