Chapter: 7
Density and Temperature

Numerical Response Questions

Q1. Sarah has two objects, a wooden block and a metal ball, with the following properties:

(a) The wooden block has a mass of 300 g and a volume of 150 cm^3.
(b) The metal ball has a mass of 500 g and a volume of 50 cm^3.
Calculate the density of each object and determine which one is denser.

Given Data:

- Wooden block mass = 300 g
- Wooden block volume = 150 cm^3
- Metal ball mass = 500 g
- Metal ball volume = 50 cm^3

To Find:
Density of the wooden block and the metal ball, and which one is denser.

Solution:

The formula for density is:

$$\text{Density}(\rho) = \frac{\text{Mass}}{\text{Volume}}$$

For the wooden block:

$$\rho_{\text{wood}} = \frac{300\ \text{g}}{150\ \text{cm}^3} = 2\ \text{g/cm}^3$$

For the metal ball:

$$\rho_{\text{metal}} = \frac{500\ \text{g}}{50\ \text{cm}^3} = 10\ \text{g/cm}^3$$

Result:

- The density of the wooden block is **2 g/cm^3**.
- The density of the metal ball is **10 g/cm^3**.

Thus, the metal ball is denser than the wooden block.

Answer:
Metal ball density = 10 g/cm^3, Wooden block density = 2 g/cm^3.

Q2. You have a container with 500 milliliters of cooking oil, and it has a mass of 450 grams.
Calculate the density of the cooking oil in grams per milliliter (g/mL).

Given Data:

- Volume of cooking oil = 500 mL
- Mass of cooking oil = 450 g

To Find:
Density of cooking oil.

Solution:

The formula for density is:

$$\text{Density}(\rho) = \frac{\text{Mass}}{\text{Volume}}$$

Substituting the values:

$$\rho_{\text{oil}} = \frac{450\ \text{g}}{500\ \text{mL}} = 0.9\ \text{g/mL}$$

Result:
The density of the cooking oil is **0.9 g/mL**.

Answer:
Density = 0.9 g/mL.

Q3. A 70 cm × 10 cm × 30 cm plastic box has a mass of 2500 g. Find the density of plastic.

Given Data:

- Dimensions of the box: 70 cm × 10 cm × 30 cm
- Mass of the box = 2500 g

To Find:
Density of plastic.

Solution:

First, calculate the volume of the box:

Volume = Length × Width × Height Volume = $70\,\text{cm} \times 10\,\text{cm} \times 30\,\text{cm} = 21000\,\text{cm}^3$

Now, use the formula for density:

$$\rho = \frac{\text{Mass}}{\text{Volume}}$$

Substitute the values:

$$\rho = \frac{2500\,\text{g}}{21000\,\text{cm}^3} = 0.12\,\text{g/cm}^3$$

Result:
The density of the plastic is **0.12 g/cm³**.

Answer:
Density = 0.12 g/cm³.

Q4. Aluminum has a density of 2700 kg/m³. Find the mass of a solid 25 cm diameter aluminum ball.

Given Data:

- Density of aluminum = 2700 kg/m³
- Diameter of aluminum ball = 25 cm (radius = 12.5 cm)

To Find:
Mass of the aluminum ball.

Solution:

First, calculate the volume of the spherical ball using the formula for the volume of a sphere:

$$V = \frac{4}{3}\pi r^3$$

Substitute the value for radius (r = 12.5 cm = 0.125 m):

$$V = \frac{4}{3}\pi(0.125)^3 = 0.000818\,\text{m}^3$$

Now, use the formula for mass:

$$\text{Mass} = \text{Density} \times \text{Volume}$$

Substitute the values:

$$\text{Mass} = 2700\ \text{kg/m}^3 \times 0.000818\ \text{m}^3 = 2.21\ \text{kg}$$

Result:
The mass of the aluminum ball is **2.21 kg**.

Answer:
Mass = 2.21 kg.

Q5. A cube of iron has a side length of 10 cm. What is the volume of this cube? Mass of this iron cube is half kilogram. This cube has a cavity inside it, find the volume of the cavity?

Given Data:

- Side length of the iron cube = 10 cm
- Mass of the iron cube = 0.5 kg (500 g)

To Find:
Volume of the cavity inside the cube.

Solution:

First, calculate the volume of the cube using the formula for the volume of a cube:

$$V = a^3$$

Substitute the value for side length $a = 10$ cm:

$$V = (10)^3 = 1000\ \text{cm}^3$$

Now, calculate the density of iron using the formula for density:

$$\rho = \frac{\text{Mass}}{\text{Volume}}$$

The density of iron is typically $7.8\ \text{g/cm}^3$. Use this value and the mass of the cube:

$$7.8 = \frac{500}{\text{Volume of the cube (iron)}} \quad \Rightarrow \quad \text{Volume of the cube (iron)} = \frac{500}{7.8} = 64.1\ \text{cm}^3$$

Finally, calculate the volume of the cavity inside the cube by subtracting the volume of the iron from the total volume of the cube:

Volume of cavity = Total Volume − Volume of iron Volume of cavity $= 1000\ \text{cm}^3 - 64.1\ \text{cm}^3 = 935.9\ \text{cm}^3$

Result:
The volume of the cavity inside the cube is **935.9 cm^3**.

Answer:
Volume of cavity = 935.9 cm^3.

Q6. Mass of an irregular shaped stone is 200 grams (g). When it is lowered in a measuring cylinder, it rises the water level from 40 mL to 73 mL. Find volume and density of this stone.

Given Data:

- Mass of the stone = 200 g
- Initial volume of water = 40 mL
- Final volume of water = 73 mL

To Find:
Volume and density of the stone.

Solution:

First, calculate the volume of the stone using the displacement method:

Volume of stone = Final volume − Initial volume Volume of stone = 73 mL − 40 mL = 33 mL

Now, calculate the density using the formula for density:

$$\rho = \frac{\text{Mass}}{\text{Volume}}$$

Substitute the values:

$$\rho = \frac{200\ \text{g}}{33\ \text{mL}} = 6.1\ \text{g/mL}$$

Result:
The volume of the stone is **33 mL** and its density is **6.1 g/mL**.

Answer:
Volume = 33 mL, Density = 6.1 g/mL.
