

# Density

## KEY IDEAS

**Density** is how much mass is packed into a given volume:  $D = m \div V$ . Units: g/cm<sup>3</sup> or g/mL (1 cm<sup>3</sup> = 1 mL).

Rearrange it:  $m = D \times V$  and  $V = m \div D$ . Find the volume of an odd-shaped object by **water displacement**.

An object **floats** in a liquid if it is **less dense** than the liquid, and **sinks** if it is denser. Water = 1.00 g/mL.

## A Calculate the density, then identify the substance

8 marks

Use the table of densities. 1 mark for the density, 1 for the substance.

|    | Mass    | Volume             | Density (show work) | Substance |
|----|---------|--------------------|---------------------|-----------|
| 1. | 81 g    | 30 cm <sup>3</sup> |                     |           |
| 2. | 179.2 g | 20 cm <sup>3</sup> |                     |           |
| 3. | 12 g    | 50 cm <sup>3</sup> |                     |           |
| 4. | 193 g   | 10 cm <sup>3</sup> |                     |           |

| Substance     | g/cm <sup>3</sup> |
|---------------|-------------------|
| Cork          | 0.24              |
| Ice           | 0.92              |
| Vegetable oil | 0.92              |
| Water         | 1.00              |
| Honey         | 1.42              |
| Aluminum      | 2.70              |
| Iron          | 7.87              |
| Copper        | 8.96              |
| Gold          | 19.3              |

## B Find the mass or volume

3 marks

5. A beaker holds 250 mL of water (density 1.00 g/mL). What is the mass of the water?

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6. A block of iron (7.87 g/cm<sup>3</sup>) has a mass of 393.5 g. What is its volume?

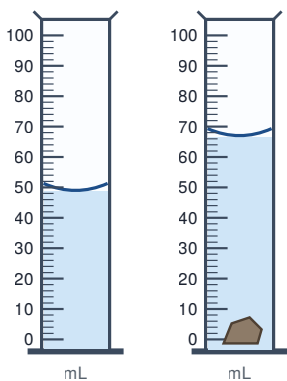
\_\_\_\_\_

7. What is the mass of 500 mL of honey (1.42 g/mL)?

\_\_\_\_\_

## C Volume by displacement

4 marks (2 each)



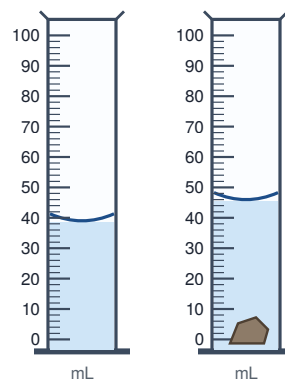
8. A rock with a mass of **54 g** is lowered into the water.

Volume before: \_\_\_\_\_

Volume after: \_\_\_\_\_

Volume of rock: \_\_\_\_\_

Density: \_\_\_\_\_



9. A metal key with a mass of **18.9 g** is lowered into the water.

Volume before: \_\_\_\_\_

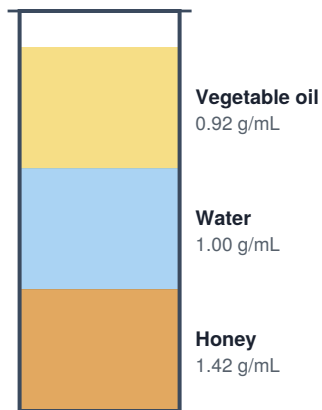
Volume after: \_\_\_\_\_

Volume of metal key: \_\_\_\_\_

Density: \_\_\_\_\_

**D Sink or float?****4 marks ( $\frac{1}{2}$  +  $\frac{1}{2}$  each)**

|     | Object         | Mass   | Volume              | Density | Sinks or floats in water? |
|-----|----------------|--------|---------------------|---------|---------------------------|
| 10. | Candle wax     | 18 g   | 20 cm <sup>3</sup>  |         |                           |
| 11. | Granite pebble | 13.5 g | 5 cm <sup>3</sup>   |         |                           |
| 12. | Apple          | 170 g  | 200 cm <sup>3</sup> |         |                           |
| 13. | Pine block     | 125 g  | 250 cm <sup>3</sup> |         |                           |

**E The density column****3 marks**

Four objects are dropped into this column of liquids. Decide where each one ends up.  $\frac{1}{2}$  mark each.

|     | Object                           | Where does it end up? |
|-----|----------------------------------|-----------------------|
| 14. | Object W: 0.24 g/cm <sup>3</sup> |                       |
| 15. | Object X: 0.96 g/cm <sup>3</sup> |                       |
| 16. | Object Y: 1.2 g/cm <sup>3</sup>  |                       |
| 17. | Object Z: 7.87 g/cm <sup>3</sup> |                       |

18. Why do the three liquids form separate layers in this order?

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**F Explain your thinking****6 marks (2 each)**

19. Explain why ice floats in a glass of water.

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20. When oil spills from a tanker, it spreads out on top of the ocean instead of sinking. Why?

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21. Steel is about 8 times denser than water, yet a huge steel ship floats. Explain how.

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**G Spot the mistake****2 marks**

22. A student says, "A big log is heavier than a small pebble, so the log is denser and will sink." Explain the error.

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**Density****ANSWER KEY****KEY IDEAS**

**Density** is how much mass is packed into a given volume:  $D = m \div V$ . Units: g/cm<sup>3</sup> or g/mL (1 cm<sup>3</sup> = 1 mL).

Rearrange it:  $m = D \times V$  and  $V = m \div D$ . Find the volume of an odd-shaped object by **water displacement**.

An object **floats** in a liquid if it is **less dense** than the liquid, and **sinks** if it is denser. Water = 1.00 g/mL.

**A Calculate the density, then identify the substance****8 marks**

Use the table of densities. 1 mark for the density, 1 for the substance.

|    | Mass    | Volume             | Density (show work)                   | Substance       |
|----|---------|--------------------|---------------------------------------|-----------------|
| 1. | 81 g    | 30 cm <sup>3</sup> | $81 \div 30 = 2.7 \text{ g/cm}^3$     | <b>Aluminum</b> |
| 2. | 179.2 g | 20 cm <sup>3</sup> | $179.2 \div 20 = 8.96 \text{ g/cm}^3$ | <b>Copper</b>   |
| 3. | 12 g    | 50 cm <sup>3</sup> | $12 \div 50 = 0.24 \text{ g/cm}^3$    | <b>Cork</b>     |
| 4. | 193 g   | 10 cm <sup>3</sup> | $193 \div 10 = 19.3 \text{ g/cm}^3$   | <b>Gold</b>     |

| Substance     | g/cm <sup>3</sup> |
|---------------|-------------------|
| Cork          | 0.24              |
| Ice           | 0.92              |
| Vegetable oil | 0.92              |
| Water         | 1.00              |
| Honey         | 1.42              |
| Aluminum      | 2.70              |
| Iron          | 7.87              |
| Copper        | 8.96              |
| Gold          | 19.3              |

**B Find the mass or volume****3 marks**

5. A beaker holds 250 mL of water (density 1.00 g/mL). What is the mass of the water?

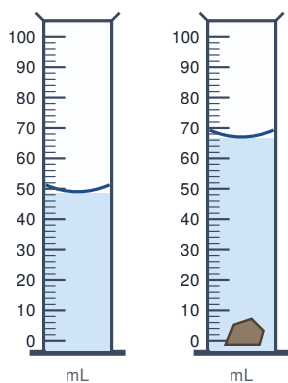
$$m = D \times V = 1.00 \times 250 = \mathbf{250 \text{ g}}$$

6. A block of iron (7.87 g/cm<sup>3</sup>) has a mass of 393.5 g. What is its volume?

$$V = m \div D = 393.5 \div 7.87 = \mathbf{50 \text{ cm}^3}$$

7. What is the mass of 500 mL of honey (1.42 g/mL)?

$$m = 1.42 \times 500 = \mathbf{710 \text{ g}}$$

**C Volume by displacement****4 marks (2 each)**

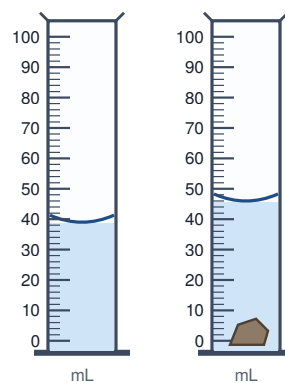
8. A rock with a mass of **54 g** is lowered into the water.

Volume before: **50 mL**

Volume after: **68 mL**

Volume of rock: **18 mL**

Density:  $54 \div 18 = \mathbf{3.0 \text{ g/mL}}$



9. A metal key with a mass of **18.9 g** is lowered into the water.

Volume before: **40 mL**

Volume after: **47 mL**

Volume of metal key: **7 mL**

Density:  $18.9 \div 7 = \mathbf{2.7 \text{ g/mL}}$

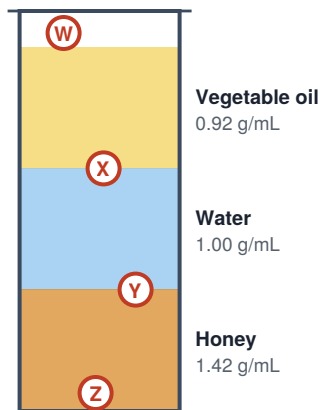
### D Sink or float?

4 marks ( $\frac{1}{2}$  +  $\frac{1}{2}$  each)

|     | Object         | Mass   | Volume              | Density                | Sinks or floats in water? |
|-----|----------------|--------|---------------------|------------------------|---------------------------|
| 10. | Candle wax     | 18 g   | 20 cm <sup>3</sup>  | 0.9 g/cm <sup>3</sup>  | Floats                    |
| 11. | Granite pebble | 13.5 g | 5 cm <sup>3</sup>   | 2.7 g/cm <sup>3</sup>  | Sinks                     |
| 12. | Apple          | 170 g  | 200 cm <sup>3</sup> | 0.85 g/cm <sup>3</sup> | Floats                    |
| 13. | Pine block     | 125 g  | 250 cm <sup>3</sup> | 0.5 g/cm <sup>3</sup>  | Floats                    |

### E The density column

3 marks



Four objects are dropped into this column of liquids. Decide where each one ends up.  $\frac{1}{2}$  mark each.

|     | Object                           | Where does it end up?           |
|-----|----------------------------------|---------------------------------|
| 14. | Object W: 0.24 g/cm <sup>3</sup> | floats on top of the oil        |
| 15. | Object X: 0.96 g/cm <sup>3</sup> | between the oil and the water   |
| 16. | Object Y: 1.2 g/cm <sup>3</sup>  | between the water and the honey |
| 17. | Object Z: 7.87 g/cm <sup>3</sup> | sinks to the bottom             |

18. Why do the three liquids form separate layers in this order?

Each liquid has a different density. The **densest** (honey) sinks to the bottom and the **least dense** (oil) floats on top.

### F Explain your thinking

6 marks (2 each)

19. Explain why ice floats in a glass of water.

Ice (0.92 g/cm<sup>3</sup>) is **less dense** than liquid water (1.00 g/mL), so it floats. Water expands when it freezes, so the same mass takes up more volume.

20. When oil spills from a tanker, it spreads out on top of the ocean instead of sinking. Why?

Oil is **less dense** than sea water, so it floats and spreads across the surface.

21. Steel is about 8 times denser than water, yet a huge steel ship floats. Explain how.

The ship's hull is mostly filled with **air**. Its total mass divided by its total volume (its average density) is less than the density of water, so it floats.

### G Spot the mistake

2 marks

22. A student says, "A big log is heavier than a small pebble, so the log is denser and will sink." Explain the error.

Density is mass **per unit volume**, not total mass. The log is heavy but takes up a lot of space; wood is less dense than water, so the log floats, while the pebble (denser than water) sinks.