

Density

Mark Scheme



www.scienceexamssorted.co.uk

1. Density is simply a measure of how tightly packed the atoms or molecules are within a specific amount of space. For each of the following questions **circle** the letter of the correct answer.

- a) The figure below shows a metal bar. The mass of the bar is 1500 g.

What is the density of the metal bar?

C – is the only correct answer.	1 mark
	Total: 1 mark

- b) The figure below shows a measuring cylinder containing 40 ml of water before and after 7 identical solid spheres of silver were added. Each of the spheres of silver have a mass of 20 g.

What is the density of the silver that the spheres are made from?

A – is the only correct answer.	1 mark
	Total: 1 mark

- c) The mass of a solid stone is 1800 g. A measuring cylinder contains 150 cm³ of water.

What is the density of the stone?

C – is the only correct answer.	1 mark
	Total: 1 mark

- d) The table provides the masses and volumes of four different objects.

Which **one** of the four objects has the greatest density?

C – is the only correct answer.	1 mark
	Total: 1 mark

- e) The figures below show four spheres, A, B, C and D that are made from the same material. The mass of each sphere is given. Which **two** spheres have the same density.

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 5 marks)

2. Complete the following questions based density.

a) For part (i) to part (iv) calculate the density of the material.

i. A block of metal has a mass of 500 g and a volume of 50 cm³.

Density = mass ÷ volume Density = 500 ÷ 50 Density = 10	1 mark
Unit: g/cm³	1 mark
	Total: 2 marks

ii. A wooden shipping crate has a mass of 120 kg and a volume of 0.4 m³.

Density = mass ÷ volume Density = 120 ÷ 0.4 Density = 300	1 mark
Unit: kg/m³	1 mark
	Total: 2 marks

iii. A student measures out 250 cm³ of a liquid. The mass of the liquid is 200 g.

Density = mass ÷ volume Density = 200 ÷ 250 Density = 0.8	1 mark
Unit: g/cm³	1 mark
	Total: 2 marks

iv. A solid metal cube has sides of 2 cm and a mass of 64 g.

Volume = 2 × 2 × 2 = 8 cm ³	
Density = mass ÷ volume Density = 64 ÷ 8 Density = 8	1 mark
Unit: g/cm³	1 mark
	Total: 2 marks

b) For part (v) to part (viii) calculate the volume of the material.

i. A piece of gold has a mass of 386 g. If the density of gold is 19.3 g/cm³, calculate its volume.

Volume = mass ÷ density Volume = 386 ÷ 19.3 Volume = 20	1 mark
Unit: cm³	1 mark
	Total: 2 marks

- ii. A large concrete block has a mass of 4800 kg. The density of concrete is 2400 kg/m³. Calculate the volume of the block.

Volume = mass ÷ density Volume = 4800 ÷ 2400 Volume = 2	1 mark
Unit: m ³	1 mark
	Total: 2 marks

- iii. The density of ethanol is 0.8 g/cm³. What volume does 400 g of ethanol occupy?

Volume = mass ÷ density Volume = 400 ÷ 0.8 Volume = 500	1 mark
Unit: cm ³	1 mark
	Total: 2 marks

(Total for Question 2 is 14 marks)

3. A teacher is clearing out an old cupboard and finds a random oddly shaped bit of brass. The teacher wants to find the density of the bit of brass.

Using this information and the figure above. Determine each of the following.

- i. Give the mass of the bit of brass.

Mass = 65.6 – 7.2	1 mark
Mass = 58.40	1 mark
	Total: 2 marks

- ii. Give the volume of the bit of brass.

Volume = 50 – 30	1 mark
Volume = 20	1 mark
	Total: 2 marks

- iii. What is the density of the bit of brass?

Density = mass ÷ volume Density = 58.4 ÷ 20	1 mark
Density = 2.92	1 mark
Unit: g/cm ³	1 mark
	Total: 3 marks

(Total for Question 3 is 7 marks)

4. This question is about density.

a) The density of an object is an important quantity to know. What is the density of an object?

The mass per unit volume (of a material).	1 mark
Allow: mass divided by volume.	
	Total: 1 mark

A student is working with some copper foil as part of an electronics project.

The density of copper is 8.90 g/cm^3 . The thickness of a rectangular sheet of copper foil varies, but is less than 1 mm thick. The student wants to find the **average** thickness.

The table below shows the measurements the student took.

Mass of copper foil	133.5 g
Length of copper foil	40.0 cm
Width of copper foil	25.0 cm

b) Using the students measurements, calculate the following.

i. The volume of the foil.

Volume = mass $\div$ density	
Volume = $133.5 \div 8.90$	1 mark
Volume = 15 cm^3	1 mark
	Total: 2 marks

ii. The average thickness of the foil.

Calculate surface area: Area = $40.0 \times 25.0 = 1000 \text{ cm}^2$	
thickness = volume $\div$ area thickness = $15 \div 1000$	1 mark
thickness = 0.015	1 mark
	Total: 2 marks

c) Another student, provided with a means of cutting the sheet, decides to find its average thickness using a single measuring instrument. Assume the surfaces of the sheet are perfectly smooth.

i. Name a measuring instrument he could use.

Ruler or measuring tape or micrometer or calipers.	1 mark
	Total: 1 mark

- ii. Describe the procedure he should follow to obtain an accurate value of the average thickness of the sheet. Details of how to read the instrument are not required.

Any three of the following logically sequenced points:	
• Fold / cut and stack the foil into multiple layers (e.g., 10 layers). • Measure the total thickness of the stack using the micrometer/caliper. • Divide the total measured thickness by the number of layers (e.g., divide by 10). • Repeat this process at different points / along different edges of the stack and calculate a mean.	
	Total: 3 marks

- d) The student notes that the stacking method described in (c)(ii) often yields a slightly larger value for the average thickness than the true thickness of the foil.

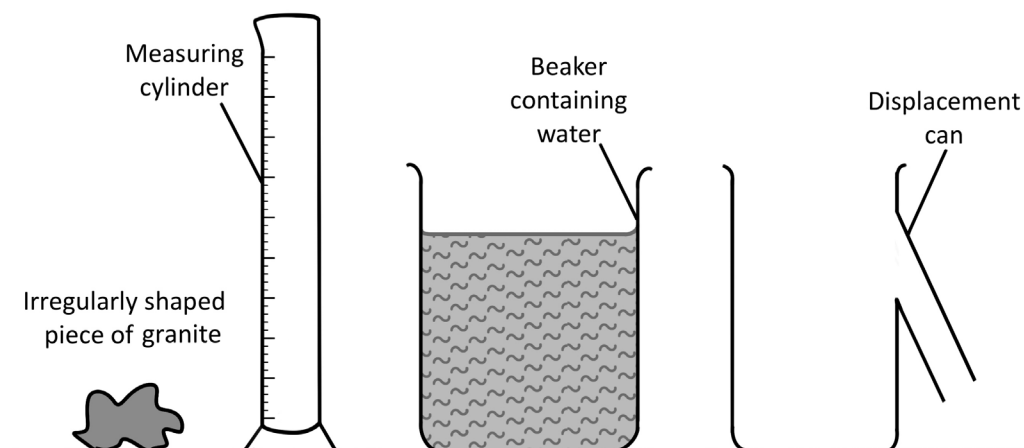
Suggest **one** practical reason for this, and state how the student could adjust their method to minimise this effect.

Reason: air gets trapped between the layers (when stacking/folding).	1 mark
Adjustment: press down firmly / squeeze the stack tightly (before measuring) to remove the air.	1 mark
	Total: 2 marks

(Total for Question 4 is 11 marks)

5. A student determines the density of an irregularly shaped lump of granite.

They are provided with the lump of granite and the following **unlabelled** equipment:



a) Describe how the student can use this equipment to find the volume of the lump of granite.

Your description should include the identity of each piece of equipment.

Any five of the following logically sequenced points:	
• Fill the displacement can / Eureka can with water until it (just) drips out of the spout. • Place the (empty) measuring cylinder directly under the spout. • Carefully lower/submerge the lump of granite completely into the water. • Catch all the displaced water in the measuring cylinder. • Read the volume of water collected in the measuring cylinder (at eye level / bottom of meniscus). • The volume of the displaced water is equal to the volume of the granite.	
	Total: 5 marks

b) The mass of a different lump of granite is 135 g. The volume of this piece is 50 cm³.

Calculate the density of the granite.

Density = mass ÷ volume	
Density = 135 ÷ 50	1 mark
Density = 2.7	1 mark
Unit: g/cm ³	1 mark
	Total: 3 marks

(Total for Question 5 is 8 marks)

6. A student mixes two different liquids, Liquid A and Liquid B, in a beaker to create a new mixture.

- She uses 200 cm³ of **Liquid A**, which has a density of 0.80 g/cm³.
- She uses 300 cm³ of **Liquid B**, which has a density of 1.10 g/cm³.

a) Calculate the density of the final mixture.

Calculate mass of liquid A: Mass = density × volume Mass = 0.8 × 200 Mass = 160 g	1 mark
Calculate mass of liquid B: Mass = density × volume Mass = 1.10 × 300 Mass = 330 g	1 mark
Calculate total density: Total mass = 160 + 330 = 490 g Total volume = 200 + 300 = 500 cm³ Density = mass ÷ volume Density = 490 ÷ 500	1 mark
Final answer & unit: 0.98 g/cm³	1 mark
	Total: 4 marks

b) A metal worker creates a new alloy by melting together two different metals, **Metal X** and **Metal Y**.

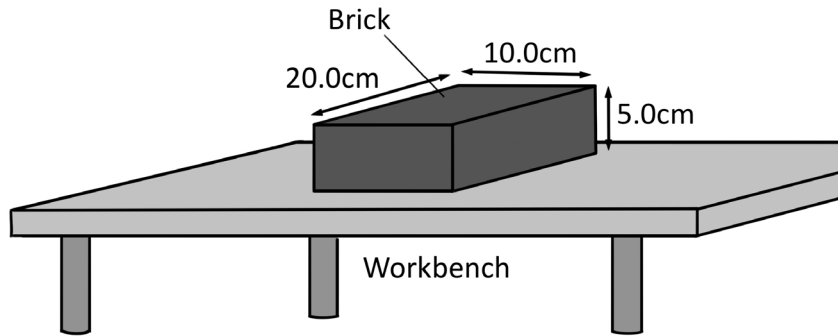
- He uses 300 g of Metal X, which has a density of 15.0 g/cm³.
- She uses 270 g of Metal Y, which has a density of 9.0 g/cm³.

Assume the total volume of the solid alloy is exactly equal to the volume of Metal X plus the volume of Metal Y. Calculate the density of the final alloy.

Calculate volume of metal X: Volume = mass ÷ density Volume = 300 ÷ 15 Volume = 20 cm³	1 mark
Calculate volume of metal Y: Volume = mass ÷ density Volume = 270 ÷ 9 Volume = 30 cm³	1 mark
Calculate total density: Total mass = 300 + 270 = 570 g Total volume = 20 + 30 = 50 cm³	1 mark
Final answer & unit: 11.4 g/cm³	1 mark
	Total: 4 marks

(Total for Question 6 is 8 marks)

7. A solid rectangular brick has dimensions of 20.0 cm (length), 10.0 cm (width), and 5.0 cm (height). It is placed on a flat, horizontal workbench.



- a) Calculate the area of the brick in contact with the workbench when it is resting on its largest face.

$\text{Area} = 20.0 \times 10.0$	1 mark
$\text{Area} = 200 \text{ cm}^2$	1 mark
	Total: 2 marks

- b) The mass of the brick is 2.5 kg.

Calculate the weight of the brick. (Assume gravitational field strength, $g = 9.8 \text{ N/kg}$).

$W = m \times g$	
$W = 2.5 \times 9.8$	1 mark
$W = 24.5$	1 mark
	Total: 2 marks

- c) A completely different concrete block has a weight of 450 N.
The area of this block in contact with the ground is 0.15 m^2 .

Calculate the pressure this concrete block exerts on the ground. Give your answer in Pascals (Pa).

$\text{Pressure} = \text{force} \div \text{area}$	
$\text{Pressure} = 450 \div 0.15$	1 mark
$\text{Pressure} = 3000 \text{ Pa}$	1 mark
	Total: 2 marks

- d) Calculate the maximum pressure that this brick could possibly exert on the workbench.
Give your answer in N/cm^2 .

$\text{Area} = 10.0 \times 5.0 = 50 \text{ (cm}^2\text{)}$	1 mark
$\text{Pressure} = \text{force} \div \text{area}$	
$\text{Pressure} = 24.5 \div 50$	1 mark
$\text{Pressure} = 0.49 \text{ N/cm}^2$	1 mark
	Total: 3 marks

(Total for Question 7 is 9 marks)