DENSITY-MASS-VOLUME-WEIGHT

1 The list below gives the approximate densities of various metals.

gold	19 g/cm^3
lead	11 g/cm^3
copper	9 g/cm^3
iron	8 g/cm^3

At an antiques market, a collector buys what is advertised as a small ancient gold statue. When the collector tests it in the laboratory, he finds its mass is 600 g and its volume is 65 cm^3.

(a) In the space below, describe how the volume of the statue could be measured. You may draw diagrams if you wish.

[3]

(b) Use the figures given above to decide whether the statue was really made of gold. Show your working.

Was the statue made of gold? (Tick one box.)

yes	
no	

[3]

[Total: 6]

(a) measuring cylinder with liquid B1
immerse statue B1
volume from difference of readings from measuring cylinder B1
OR
displacement can or equivalent or beaker filled to overflowing with liquid (B1)
immerse statue (B1)
measure volume displaced with measuring cylinder (B1)

(b) (D =) M/V OR 600/65 B1
9.23 g/cm^3 (minimum 2 s.f.) N.B. unit penalty applies B1
OR
(For gold) (M =) V × D OR 65 × 19 (B1)
1235 g (minimum 2 s.f.) N.B. unit penalty applies (B1)
OR
(For gold) (V =) M / D OR 600/19 (B1)
31.6 cm^3 (minimum 2 s.f.) N.B. unit penalty applies (B1)

'NO' ticked if justified by previous work in **(a)** or **(b)**.
e.c.f from wrong values above B1

[6]

2 A student wishes to find the volume of a piece of wood of irregular shape. Her experiment requires the use of a small brass object of mass 200 g.

(a) Calculate the volume of the brass object. The density of brass is 8.4 g/cm^3.

volume = ...[2]

(b) To find the volume of the piece of wood, the student has a measuring cylinder, a supply of water and the brass object in **(a)**. The piece of wood and the brass object are small enough to be placed in the measuring cylinder.

(i) The piece of wood does not sink in water.

Suggest why.

.....[1]

(ii) Describe what the student does to find the volume of the piece of wood, stating the measurements that she makes and any calculations required.

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.....[4]

[Total: 7]

(a)		d = m/V in any form OR (V =) m/d OR 200/8.4	C1
		24 cm^3	A1
(b)	**(i)**	density less (than water) OR upthrust ≥ weight	B1
	(ii)	determine any volume of any liquid (V_1)	B1
		states viable method to submerge wood	B1
		reads volume (V_2) from previous line and determines volume of (wood + brass) ($V_2 - V_1$)	B1
		subtract volume of brass from above (to give volume of wood)	B1

[Total: 7]

3 A student is given the following apparatus in order to find the density of a piece of rock.

100 g mass
metre rule
suitable pivot on which the rule will balance
measuring cylinder that is big enough for the piece of rock to fit inside
cotton
water

The rock has a mass of approximately 90 g.

(a) (i) In the space below, draw a labelled diagram of apparatus from this list set up so that the student is able to find the mass of the piece of rock.

(ii) State the readings the student should take and how these would be used to find the mass of the rock.

.....

.....

.....

[5]

(b) Describe how the volume of the rock could be found.

.....

.....

.....[2]

(c) The mass of the rock is 88 g and its volume is 24 cm^3.
Calculate the density of the rock.

density of rock = ... [2]

a(i)	outline, ruler pivoted (at centre), mass one side, rock other side			C1	
	quality set-up, each mass at (marked) point + labels		2	A1	
(ii)	~~rod must be balanced before readings can be taken or record mass as 100 g~~			~~B1~~	
	distances to pivot from rock ~~and mass~~ B1 distance pivot to mass B1			B2	
	mass or 100 x distance to pivot = mass of rock x distance rock to pivot		3	B1	5
b	put water in cylinder, read value			B1	
	insert rock until covered, read value			B1	
	difference in values is volume of rock		2	B1	M2*
c	density = mass/volume or 88/24			C1	
	= 3.7 g/cm^3* (accept $3\frac{2}{3}$ g/cm^3)		2	A1	2
				QT	9

4 **(a)** Define *density*.

.....

.....[1]

(b) The density of aluminium is 2.70 g/cm^3. The thickness of a rectangular sheet of aluminium foil varies, but is much less than 1 mm.

A student wishes to find the average thickness. She obtains the following measurements.

mass of sheet = 60.7 g
length of sheet = 50.0 cm
width of sheet = 30.0 cm

Calculate the student's values for

(i) the volume of the sheet,

volume = ...[2]

(ii) the average thickness of the sheet.

thickness = ...[2]

(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 she could use.

.....[1]

(ii) Describe the procedure she should follow to obtain an accurate value of the average thickness of the sheet.

Details of how to read the instrument are not required.

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.....[3]

[Total: 9]

MARKING SCHEME:

(a) (density =) mass/volume OR mass per unit volume
OR m/V with symbols explained — B1

(b) (i) (vol =) mass/density OR 60.7/2.70 — C1
= 22.48 cm^3 to 2 or more sig. figs — A1

(ii) $V = A \times$ (average) thickness OR thickness = V/A
OR 22.48 / (50 × 30) — C1
0.01499 cm to 2 or more sig. figs. e.c.f. **(b)(i)** — A1

(c) (i) micrometer/screw gauge / (vernier/digital) callipers — B1

(ii) check zero of device used / cut sheet into several pieces / detail of how to use device / fold sheet — B1

measure thickness of sheet in different places
OR measure thickness of several pieces together — B1
calculate/obtain average thickness OR divide answer by number of measurements/ pieces/places — B1

[Total 9]

5 A student has a large number of coins of different diameters, all made of the same metal. She wishes to find the density of the metal by a method involving placing the coins in water.

(a) State the formula needed to calculate the density.

..... [1]

(b) Describe how the measurements of the required quantities are carried out.

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.....

..... [5]

(c) State **one** precaution taken when carrying out the measurements in **(b)** to ensure that the result is as accurate as possible.

.....

..... [1]

[Total: 7]

MARKING SCHEME;

(a) (density =) mass / volume B1

(b) water used in measuring / graduated cylinder B1

volume of water known or read / recorded / taken B1

place the coins in the water and read / record / take new level of water in cylinder B1

subtract readings B1

OR ALTERNATIVE METHOD:
pour water into displacement can to level of spout (B1)

place the coins / several coins in the water (B1)

collect overflow (B1)

measure volume of overflow water using measuring graduated cylinder (B1)

measure mass / weigh the coins used with balance / spring balance B1

(c) one from:
read measuring cylinder levels at bottom of meniscus
repeat volume measurement and find average
place eye level with surface in measuring cylinder (to avoid parallax error)
place coins one at a time to avoid air bubbles between coins
avoid splashing when adding coins to water
make sure coins are dry / clean
use narrow / small measuring cylinder
place containers on horizontal surface
check zero of balance / spring balance / scales
displacement can method: make sure dripping finishes before and after adding coins B1

[Total: 7]

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[6]

7 An astronaut has a mass of 65 kg on Earth, where the gravitational field strength is 10 N/kg.

(a) Calculate the astronaut's weight on Earth.

weight on Earth = ...[2]

(b) Complete the following sentence.

The astronaut's weight on Earth is the ..... force

between the astronaut and ..... . [1]

(c) The astronaut undertakes a Moon landing. On the Moon the gravitational field strength is 1.6 N/kg.

(i) State the astronaut's mass on the Moon.

mass = ...

(ii) Calculate the weight of the astronaut on the Moon.

weight on Moon = ...
[2]

[Total: 5]

MARKING SCHEME:

(a)	*mg* in any form	C1	
	650 N	A1	
(b)	gravitational / attractive and the Earth	B1	
(c)	**(i)** 65 kg	B1	
	(ii) 104 OR 100 N ecf **(i)**	B1	[5]