Examiner only

SECTION A

Task A1 (15 minutes)
Your task is to determine a value for the density of a glass marble.

(a) Determine the mean **radius**, *r*, of the marbles. [2]

(b) Calculate the **percentage** uncertainty in your answer. [2]

(c) Calculate the mean volume of a marble along with its **percentage** uncertainty. [2]

(d) Use the information on the mean mass of a marble to calculate the density of the glass from which the marbles are made. State your results along with its **absolute** uncertainty. [2]

SECTION A

TASK A1

Candidates will make measurements on glass marbles.

Test 1:

- 5 × marbles
- 2 blocks of wood of sufficient length to accommodate 5 marbles placed side by side
- 1 × ruler with 1 mm scale, e.g. ½ metre ruler (± 1 mm)
- Card with the mean mass of a marble ± 0.2 g given. Card should be worded:
  Mean mass of marble = x.x ± 0.2 g*

* Determine by weighing a set of 5 marbles.

Test 2:

The apparatus is as for **Test 1** except that steel ball bearings should be used instead of marbles.

TEST 1 – MARK SCHEME

SECTION A

A1

(a) Diameter of greater than 4 marbles measured *(1)*
Average diameter correctly calculated **with** unit *(1)* [2]

(b) Resolution = ± 1 mm (accept 0.5 mm) *(1)*
% uncertainty calculated correctly *(1)*
Allow e.c.f. from *(a)* [2]

(c) Volume correct with unit *(1)*
% uncertainty = 3×*(b) (1)* e.c.f. [2]

(d) Density correct with unit *(1)* allow e.c.f. from *(c)*
Absolute uncertainty correct *(1)* allow e.c.f. from *(c)* [2]

Total [8]

SECTION A

Task A1 (15 minutes)
In this task you are going to determine the mean density of a golf ball. **Repeat readings are not required for this task**.

(a) Measure the mass of the ball and calculate its percentage uncertainty. [2]

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(b) By taking a suitable measurement determine the volume of the golf ball. Ignore the effect of the dimples.
[You do not need to determine the percentage uncertainty.] [3]

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(c) (i) Determine the mean density of the golf ball and its percentage uncertainty assuming the percentage uncertainty in the volume to be 0.5%. [2]

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(ii) Explain how the dimples in the golf ball affect the value of the density calculated in part *(c)*(i). [1]

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SECTION A

TASK A1

Candidates will make measurements on a ball.

Test 1:

- Electronic balance – suggested resolution ± 0.1 g
- Callipers – suggested resolution ± 0.01 mm (digital callipers can also be used)
- Golf ball

Test 2:

The apparatus is as for **Test 1** except that a dice should be used.
E.g. Large wooden dice – 5 cm are available.

TEST 1 – MARK SCHEME

A1. *(a)* Mass measured correctly, given to the resolution of the balance with unit. *(1)*
Percentage uncertainty calculated correctly using the resolution of the balance and expressed to 1 [accept 2] significant figures. *(1)* [2]

(b) Diameter correctly measured with unit. *(1)* [This mark can be awarded 'by implication' if the volume is correct.]
Volume calculated correctly with correct units *(1)* [e.c.f. on incorrect diameter].
Volume given to 3 or 4 s.f. *(1)* [e.c.f. on incorrect volume]. [3]

(c) (i) Density calculated correctly with units [Allow ecf from part *(b)*]. *(1)*
Percentage uncertainty calculated correctly [Ans: uncertainty in *(a)* + 0.5%]. *(1)* [2]

(ii) The true density is greater than the measured / calculated density *because* the true volume is less than the measured volume [or equiv, e.g. accept "there is missing mass which would fill up the dimples!"]
NB Effect on density **and** reason required. [1]

Total [8]

Turn over.

Question 3

You are going to use a sheet of aluminium foil to determine the density of aluminium by two different methods.

Method 1

(a) (i) Measure the length, *l,* and width, *w,* of the foil. Explain how you ensured your values were accurate. [3]

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(ii) Fold the sheet of aluminium a number of times. Hence determine the average thickness of the foil. [3]

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(iii) Do you think this method of finding the thickness of the foil sheet is accurate? Explain your answer. [2]

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(iv) Use the scales to find the mass of the foil. [1]

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(v) Density can be calculated using the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Use your results in parts (i) - (iv) to calculate the density of the foil. [2]

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Method 2

(b) Archimedes suggested a different method to find the volume. He stated that the volume of the object was equal to the volume of the water it displaced.

Fill the measuring cylinder with water up to the 30 cm^3 (ml) mark. Roll up your folded piece of foil so that it fits into the measuring cylinder and is completely covered with water.

(i) What is the new level of the water in the cylinder? [1]

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(ii) What is the volume of the foil? [1]

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(iii) Use this new value of volume to calculate the density of aluminium. [1]

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(iv) A result for this type of experiment can be said to be accurate if it is within 5% of the actual value. Given that the density of the aluminium you used is 2·7 g cm^{-3}, comment on the accuracy of your two results. [2]

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(c) State what you think the biggest uncertainty was in **each** experiment and say, in **each** case, how you could reduce it to improve your results. [4]

Method 1

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Improvement

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Method 2

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Improvement

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Experiment 3

The candidates will be expected to determine the density of aluminium foil.

Test 1

Apparatus required:

1 × rectangular sheet of aluminium (cooking) foil approximately 30 cm wide and 100 cm long.
1 × metre ruler.
1 × digital vernier callipers [or a micrometer] of resolution 0·01 mm.
1 × 50 ml measuring cylinder.
1 × balance of resolution 0·1 g or 0·01 g.
1 × water bottle or beaker containing at least 50 cm^3 of water.

All the above apparatus should be available to the candidate at the start of the experiment. The micrometer/vernier callipers could be shared between candidates, as could the balance.

Test 2

The apparatus is as for **Test 1**, except that the sheet of aluminium foil should be approximately 30 cm × 80 cm.

Question			Marking details	Marks Available
3	*(a)*	(i)	Repeat readings / accurate technique (1) Length and width correct [Area within 5% of centre value](1) Measurements to nearest mm with units (1)	3
		(ii)	Minimum of 8 thicknesses used (1) [i.e. 3 folds] Thickness correct to 0.01 mm (1) Units (1)	3
		(iii)	Larger thickness measured (1) ∴ smaller uncertainty (1) [Accept: Foil could be creased (1) ∴ larger uncertainty (1)]	2
		(iv)	Mass recorded with unit [10 ± 5 g or centre value]	1
		(v)	Density correct [e.c.f.](1) with density units (1)	2
	(b)	(i)	Correct reading with units[m^3 or cm^3]	1
		(ii)	Answer to (i) − 30 [accept − 50]	1
		(iii)	Density calculated correctly [with correct units]	1
		(iv)	5% of 2.7 = 0.14 g cm^{-3}. (1) [or equivalent] Both own values correctly compared to 2.7 ± 1.4 (1) [**Or for 1 mark** - valid comment comparing their values to 2.7]	2
Total question 3				**20**