

GCSE Chemistry

Worksheet: Chemical measurements and uncertainty

TIME 35 min	TOTAL 32 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Chemical measurements and uncertainty

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

Every measurement made with an instrument has some uncertainty.

0 1 . 1

A balance shows the mass of a sample as 12.47 g.

What is the resolution of the balance?

Tick (✓) **one** box.

0.01 g

☐

0.1 g

☐

1 g

☐

12.47 g

☐

[1 mark]

0 1 . 2

Give **one** reason why scientists repeat a measurement several times and calculate a mean.

.....

.....

[1 mark]

0 1 . 3

A student measured the temperature of a solution three times: 21.5 °C, 22.0 °C and 21.0 °C.
Calculate the mean temperature.

.....

.....

.....

Mean temperature = °C

[1 mark]

0 1 . 4

The uncertainty in the mean can be estimated as half the range of the readings.
Calculate the uncertainty in the mean temperature.

.....

.....

.....

Uncertainty = °C

[1 mark]

0 2

A student added excess barium chloride solution to a sample of a sulfate solution, then filtered, dried and weighed the white precipitate. The student carried out the experiment four times.
Table 1 shows the results.

Table 1

Repeat	1	2	3	4
Mass of precipitate in g	3.57	3.55	3.53	3.55

0 2 . 1

Calculate the mean mass of precipitate.
Give your answer to 2 decimal places.

.....

.....

.....

Mean = g

[1 mark]

0 2 . 2

Calculate the range of the results.

.....

.....

.....

Range = g

[1 mark]

0 2 . 3

Give **one** reason why the student carried out the experiment more than once.

.....

.....

[1 mark]

0 3

A student added zinc powder to an excess of copper sulfate solution. The student filtered off the copper produced, then washed, dried and weighed it. The student did the experiment five times, using the same mass of zinc powder each time.
Table 2 shows the results.

Table 2

Trial	1	2	3	4	5
Mass of copper in g	1.27	1.31	1.52	1.29	1.28

0 3 . 1

Which trial gave an anomalous result?

.....

.....

.....

.....

[1 mark]

0 3 . 2

Calculate the mean mass of copper. Do **not** include the anomalous result.
Give your answer to 2 decimal places.

.....

.....

.....

.....

Mean mass = g

[2 marks]

0 3 . 3

Give the range of the four results used to calculate the mean.

.....

.....

.....

Range = g

[1 mark]

0 3 . 4

Why do repeat measurements usually give slightly different values?

Tick (✓) **one** box.

- There is always some uncertainty when a measurement is made. ☐
- The balance changes the mass of the copper. ☐
- The mass of copper is different each time because atoms are made. ☐
- Only anomalous results have any uncertainty. ☐

[1 mark]

0 4

A student measured the mass lost when marble chips reacted with excess dilute hydrochloric acid in an open flask on a balance. The student carried out the experiment four times. Table 3 shows the results.

Table 3

Repeat	1	2	3	4
Mass lost in g	2.39	2.45	2.43	2.42

0 4 . 1

Calculate the mean mass lost.
Give your answer to 2 decimal places.

.....

.....

.....

Mean = g

[1 mark]

0 4 . 2

The uncertainty in the mean can be estimated as half the range of the results.
Calculate the uncertainty in the mean.

.....

.....

.....

.....

Uncertainty = g

[2 marks]

0 4 . 3

Write the mean mass lost with its uncertainty.

.....

.....

[1 mark]

.....

0 5

A student measured the volume of hydrogen gas produced when a small piece of zinc reacted with excess dilute sulfuric acid. The student repeated the experiment four times with identical pieces of zinc.

Table 4 shows the results.

Table 4

Experiment	1	2	3	4
Volume of hydrogen in cm ³	37.6	38.2	37.8	38.0

0 5 . 1

Calculate the mean volume of hydrogen.

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.....

.....

Mean volume = cm³

[1 mark]

0 5 . 2

The uncertainty of the mean can be estimated from the range of the results.
Calculate the uncertainty of the mean.

.....

.....

.....

.....

Uncertainty = cm³

[2 marks]

0 5 . 3

Write the mean volume of hydrogen with its uncertainty.

.....

.....

[1 mark]

0 5 . 4

The student's teacher did the same experiment and got a volume of 38.4 cm^3 . Is the teacher's value within the uncertainty of the student's mean? Explain your answer.

.....

.....

.....

.....

[2 marks]

0 6

A student investigated the reaction between sodium thiosulfate solution and dilute hydrochloric acid, which produces a fine yellow precipitate of sulfur. The student measured the time for a mark viewed through the mixture to disappear, and repeated the experiment at the same temperature four times.

Times: 28.4 s, 30.1 s, 27.9 s, 29.6 s.

0 6 . 1

Calculate the mean time and its uncertainty.

.....

.....

.....

.....

.....

[3 marks]

0 6 . 2

Explain, in terms of particles, why increasing the temperature would decrease the mean time for the mark to disappear.

.....

.....

.....

.....

[2 marks]

0 6 . 3

Suggest why using the same depth of liquid and the same mark in every repeat is important for a fair comparison of rates.

.....

.....

[1 mark]

0 7

A student measured the time taken for a fixed mass of magnesium ribbon to react completely with excess dilute hydrochloric acid. The student repeated the experiment four times. Table 5 shows the results.

Table 5

Repeat	1	2	3	4
Time in s	42.6	44.8	43.5	44.1

0 7 . 1

Calculate the mean time.
Give your answer to 1 decimal place.

.....

.....

.....

Mean time = s

[1 mark]

0 7 . 2

Calculate the uncertainty of the mean, using the range of the four results.

.....

.....

.....

.....

Uncertainty = s

[2 marks]

0 7 . 3

Suggest **one** reason why the times are not identical in every repeat, even though the same mass of magnesium and the same volume and concentration of acid were used each time.

[1 mark]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Chemistry · Worksheet: Chemical measurements and uncertainty · 32 marks

Question 1 (4 marks)

01.1 [1 mark]

Correct: 0.01 g

01.2 [1 mark]

- a single reading may be unusually high or low (anomalous) / repeating reduces the effect of random errors / repeating shows whether the results are repeatable (1)
-

01.3 [1 mark]

Answer: 21.5 °C

- 21.5 (°C) (1)
-

01.4 [1 mark]

Answer: ± 0.5 °C

- range = $22.0 - 21.0 = 1.0$ (°C), so the uncertainty is ± 0.5 (°C) (1)
-
-

Question 2 (3 marks)

02.1 [1 mark]

Answer: 3.55 g

- 3.55 (g) (1)
-

02.2 [1 mark]

Answer: 0.04 g

- $3.57 - 3.53 = 0.04$ (g) (1)
-

02.3 [1 mark]

- to calculate a mean / to identify anomalous results / to reduce the effect of random errors / to check that the results are repeatable (1)
-

Question 3 (5 marks)

03.1 [1 mark]

Answer: Trial 3 (1.52 g)

- trial 3 / 1.52 (g) (1)

03.2 [2 marks]

Answer: 1.29 g

- $(1.27 + 1.31 + 1.29 + 1.28) \div 4$ (1)
- 1.29 (g) (1)

Notes: Allow 1.2875 for 1 mark only. An answer of 1.33 (anomaly included) scores 1 mark.

03.3 [1 mark]

Answer: 1.27 g to 1.31 g (a spread of 0.04 g)

- 1.27 to 1.31 (g) / 0.04 (g) (1)

03.4 [1 mark]

Correct: There is always some uncertainty when a measurement is made.

Question 4 (4 marks)

04.1 [1 mark]

Answer: 2.42 g

- 2.42 (g) (1)

04.2 [2 marks]

Answer: ± 0.03 g

- range = $2.45 - 2.39 = 0.06$ (g) (1)
- uncertainty = $0.06 \div 2 = \pm 0.03$ (g) (1)

04.3 [1 mark]

Answer: 2.42 ± 0.03 g

- 2.42 ± 0.03 (g) (1)

Notes: Allow ECF from the mean and uncertainty calculated above.

Question 5 (6 marks)

05.1 [1 mark]

Answer: 37.9 cm^3

- $37.9 \text{ (cm}^3\text{)} (1)$

05.2 [2 marks]

Answer: $\pm 0.3 \text{ cm}^3$

- $\text{range} = 38.2 - 37.6 = 0.6 \text{ (cm}^3\text{)} (1)$
- $\text{uncertainty} = \pm 0.3 \text{ (cm}^3\text{)} (1)$

Notes: $\pm$ half the range. An answer of ± 0.6 scores 1 mark.

05.3 [1 mark]

Answer: $37.9 \pm 0.3 \text{ cm}^3$

- $37.9 \pm 0.3 \text{ (cm}^3\text{)} (1)$

Notes: Allow ECF from parts 1 and 2.

05.4 [2 marks]

- the student's mean $\pm$ uncertainty covers 37.6 to 38.2 (cm^3) (1)
- 38.4 is outside this range, so no (1)

Notes: Allow ECF from part 2.

Question 6 (6 marks)

06.1 [3 marks]

Answer: 29.0 ± 1.1 s

- mean = $(28.4 + 30.1 + 27.9 + 29.6) \div 4 = 29.0$ (s) (1)
 - range = $30.1 - 27.9 = 2.2$ (s) (1)
 - uncertainty = ± 1.1 (s) (1)
-

06.2 [2 marks]

- at a higher temperature the particles have more energy and move faster, so they collide more frequently and with more energy (1)
 - this increases the frequency of successful collisions, so the reaction rate increases and the precipitate forms more quickly (1)
-

06.3 [1 mark]

- so that the same amount of sulfur (precipitate) must form to block out the mark each time, making the comparison fair / a valid measure of rate (1)
-

Question 7 (4 marks)

07.1 [1 mark]

Answer: 43.8 s

- 43.8 (s) (1)

Notes: Do not accept 43.75 (not given to 1 decimal place).

07.2 [2 marks]

Answer: ± 1.1 s

- range = $44.8 - 42.6 = 2.2$ (s) (1)
 - uncertainty = ± 1.1 (s) (1)
-

07.3 [1 mark]

- allow: slightly different starting temperature each time / human reaction time when starting or stopping the clock / the magnesium ribbon may not be perfectly identical each time (surface area) (1)

Notes: Allow any sensible source of random error/variation.
