3.4 Working Scientifically: 30-minute Pack

ISEB Common Entrance 13+ Science · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student measures the length of a metal wire five times using a metre ruler. The results are: 84.2 cm, 84.5 cm, 84.1 cm, 84.6 cm, 84.3 cm.

(a) Calculate the mean length of the wire. **(2)**

.....

(b) Calculate the range of the results. **(2)**

.....

2 Aled is investigating how the concentration of salt solution affects the growth rate of cress seedlings. State three variables, other than the concentration of salt solution, that Aled should control to make this a fair test.

(3)

3 A student measures the time for a trolley to travel down a ramp three times: 2.14 s, 2.09 s and 2.21 s.

(a) Calculate the mean time, giving your answer to 3 significant figures. **(2)**

.....

(b) State why it is good scientific practice to repeat a measurement more than once. **(1)**

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4 As the amount of water added to a plant increases, so does its growth rate. State the type of relationship shown by this data.

(1)

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5 Which piece of apparatus is used to measure the volume of hydrogen gas released when a metal reacts with acid? The gas must be collected directly, without using water displacement.

- ☐ A) Gas syringe
- ☐ B) Top-pan balance
- ☐ C) Measuring cylinder
- ☐ D) Thermometer

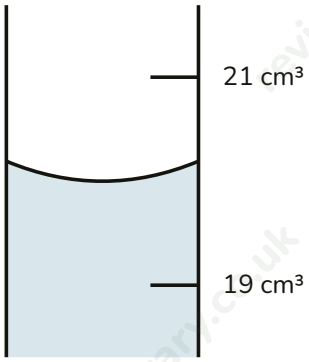
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6 State why it is important to read the meniscus at eye level with a measuring cylinder.

(1)

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7 The liquid level in a measuring cylinder is halfway between the 19 cm^3 and 21 cm^3 graduations. State the volume of liquid.



(1)

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8 In a different investigation, a graph is plotted of the volume of gas produced (cm^3) against time (s) for a reaction that slows down over time. A tangent is drawn to the curve at t = 10 s. The tangent passes through the points (0 s, 6 cm^3) and (20 s, 30 cm^3). Calculate the gradient of the tangent, and use this to state the rate of reaction at t = 10 s, including units.

(3)

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9 A thermometer has graduations every 1°C. A student takes a single temperature reading of 25°C. Calculate the percentage uncertainty in this reading, giving your answer to the nearest whole per cent. (Uncertainty = half of the smallest graduation.)

(3)

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10 A group of pupils wants to investigate how the concentration of hydrochloric acid affects the rate of its reaction with magnesium ribbon. Plan a method they could use to investigate this, including how they would make it a fair test and how they would ensure their results are reliable.

(6)

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11 At t = 5 s, volume was 10 cm^3. At t = 35 s, volume was 30 cm^3. Calculate the percentage increase.

(1)

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12 What does a measuring cylinder measure?

- ☐ A) mass
- ☐ B) length
- ☐ C) time
- ☐ D) the volume of a liquid
- ☐ E) temperature

---

13 Match each term to its correct definition.

Terms: 1. Precision 2. Validity

Definitions:

A. Whether an investigation truly answers the question being asked.

B. How close together repeated measurements are to each other.

(1)

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14 As rainfall increases, plant growth increases. State the type of correlation shown.

(1)

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15 What does a thermometer measure?

- ☐ A) temperature
- ☐ B) force
- ☐ C) the volume of a liquid
- ☐ D) length
- ☐ E) current

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16 Calculate the percentage increase in the mass of precipitate from 16 g at 0 minutes to 32 g at 5 minutes.

(1)

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Mark scheme · 3.4 Working Scientifically: 30-minute Pack

Question 1

(a) (84.2 + 84.5 + 84.1 + 84.6 + 84.3) / 5 **M1**

(a) 84.34 cm (accept 84.3 cm) awrt **A1**

(a) Answer: 84.34 cm

(b) 84.6 - 84.1 **M1**

(b) 0.5 cm cao **A1**

(b) Answer: 0.5 cm

Question 2

one valid control, e.g. same species/starting size of seedling, volume of solution, temperature, light exposure, size/type of container or experiment duration **B1**

a second distinct valid control from the examples above or equivalent **B1**

a third distinct valid control from the examples above or equivalent **B1**

Answer: Any three of: same species/starting size of seedling, same volume of solution, same temperature, same amount of light, same size/type of container, same length of experiment.

Question 3

(a) (2.14 + 2.09 + 2.21) / 3 **M1**

(a) 2.15 s (3 s.f.) awrt **A1**

(a) Answer: 2.15 s

(b) allows an anomaly to be identified and a mean to be calculated, making the result more reliable oe **B1**

(b) Answer: It allows anomalies to be spotted and a mean to be calculated, giving a more reliable result.

Question 4

A (positive) correlation (oe) **B1**

Answer: A (positive) correlation

Question 5

A (Gas syringe) cao **B1**

Answer: A) Gas syringe

Question 6

To avoid parallax error (oe) **B1**

Answer: To avoid parallax error

Question 7

20 cm^3 (oe) **B1**

Answer: 20 cm^3

Question 8

gradient = (30 - 6) / (20 - 0) **M1**

1.2 cao **A1**

rate of reaction at t = 10 s = 1.2 cm^3/s (correct unit stated) ft **B1**

Answer: 1.2 cm^3/s

Question 9

uncertainty = 1 / 2 = 0.5°C **M1**

percentage uncertainty = (0.5 / 25) x 100 **M1**

2% (nearest whole per cent) awrt **A1**

Answer: 2%

Question 10

Level 0 No relevant content, or the answer does not address planning an investigation. **0**

Level 1 A basic method is given. The independent and/or dependent variable may be named, but there is little or no reference to controlling other variables, apparatus, or improving reliability. **1-2**

Level 2 A clear method is given describing suitable apparatus and key steps. Some relevant variables to control are stated and/or repeats are mentioned, but detail is incomplete or not fully linked together. **3-4**

Level 3 A detailed, logically ordered method is given. It states a suitable range of concentrations, clearly controlled variables, an appropriate method for measuring the dependent variable, and explains how repeats and means will be used to improve reliability. Relevant safety precautions are included. **5-6**

Indicative content:

- Use a fixed length or mass of magnesium ribbon for every test, e.g. 3 cm each time.
- Use the same volume of acid each time, e.g. 50 cm^3.
- Vary the concentration of the acid across a range of values, e.g. by diluting a stock acid to give concentrations such as 2.0, 1.5, 1.0 and 0.5 mol/dm^3.
- Keep the temperature the same for every test, e.g. by working at room temperature or using a water bath.
- Measure the volume of gas produced using a gas syringe connected to the reaction flask.
- Start a stopwatch as soon as the magnesium is added to the acid.
- Record the volume of gas at regular time intervals, e.g. every 10 seconds, or record the time taken to collect a fixed volume of gas.
- Repeat each concentration at least three times and calculate a mean.
- Identify and exclude any anomalous results before averaging.
- Wear eye protection and keep hydrogen gas away from naked flames.
- Plot a graph of rate (or time taken) against concentration to identify the pattern.

Question 11

200% (oe) **B1**

Answer: 200%

Question 12

D (the volume of a liquid) **B1**

Answer: D) the volume of a liquid

Question 13

1-B, 2-A (oe) **B1**

Answer: 1-B, 2-A

Question 14

A positive correlation (oe) **B1**

Answer: A positive correlation

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Question 15

A (temperature) **B1**

Answer: A) temperature

Question 16

100% (oe) **B1**

Answer: 100%

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