4.3 Working Scientifically: Measuring, Recording and Risk

Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A pupil records the growth of a bean plant in this table.

Time after planting	Stem height
3 days	2.0 cm
6 days	4 cm
9 days	7.50 cm

State two mistakes in how the table has been set out and write corrected column headings.

(3)

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2 Choose the two statements that are measurements rather than observations.

A The solution turned cloudy.
B The rock sample has a mass of 84 g.
C The crystals look shiny.
D The temperature rose by 7°C.

(2)

3 A pupil counts oxygen bubbles from pondweed in one minute. Trial 4 is an anomaly because the lamp was knocked out of position during that trial.

Trial	Bubbles per minute
1	24
2	26
3	25
4	9
5	25

(a) Calculate the mean number of bubbles per minute, leaving out the anomaly.
(b) Explain why the pupil should still write the value 9 in the results table.

(4)

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4 For each hazard, choose the control measure from the list that best fits it.

Hazards:
(i) A splash of dilute acid could reach the eyes.
(ii) A boiling tube has just been heated.
(iii) A power pack is plugged in beside a sink of water.

Control measures: tie long hair back; keep electrical equipment away from water; wear eye protection; hold the tube with a holder and let it cool before touching it.

(3)

5 A pupil gently heats 10 cm^3 of dilute alkali in a test tube over a Bunsen burner. The hazard is that hot liquid could spit out and reach the eyes. Four precautions are suggested.

A Wear eye protection.
B Tie long hair back.
C Point the open end of the tube away from everyone.
D Wash hands after the practical.

Choose the two precautions that reduce the risk of liquid reaching the eyes. Then explain why one of the other two does not reduce this risk.

(3)

6 A gas syringe collects 0.12 dm3 of gas from a reaction in 40 s. Convert the volume into cm3 and then calculate the mean rate of gas production in cm3 per second.

(4)

7 A pupil records the temperature of cooling water every minute.

Time (min)	Temperature (°C)
0	80
1	75
2	71
3	86
4	64
5	61

Identify the reading that is most likely a recording error, give a reason, suggest what the correct value probably is, and state what the pupil should do to check it.

(4)

8 Year 9 pupils will do pond dipping from a muddy bank. Write a short risk assessment by giving two different hazards. For each hazard, state how a person could be harmed and give one control measure that fits that hazard.

(5)

9 Convert each measurement into the unit shown.

(a) 350 g into kg.
(b) 2.4 m into cm.

(2)

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10 A pupil times how long a 2 cm strip of magnesium ribbon takes to stop fizzing in 20 cm^3 of dilute hydrochloric acid at 40°C. She measures the acid in a 100 cm^3 measuring cylinder marked every 10 cm^3 and reads it from above. Her thermometer reads 2°C when placed in melting ice. She does not wear eye protection. Her times for three trials are 38 s, 41 s and 62 s. She writes 'Time = 38 s, 41 s, 62 s' and calculates the mean of all three.

Evaluate how well she measured and recorded and how safely she worked. Calculate the mean she used, show what the mean would be without the 62 s trial, and suggest improvements.

(6)

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11 A pupil carries a beaker of hot water across a laboratory. State what is meant by (a) a hazard and (b) a risk.

(2)

12 A pupil measures the length of a bean seed with a ruler marked in millimetres. The seed ends 3 mm beyond the 4 cm mark. Give the length of the seed in cm.

(2)

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13 A tank holds 1.5 dm3 of pond water. Each sample for a biology test needs 250 cm^3. How many complete samples can be taken from the tank?

(2)

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14 A top-pan balance displays 0.6 g with nothing on the pan. A pupil places crystals of copper sulfate on the pan and the display reads 12.4 g.

(a) Name this type of fault in the balance.
(b) Calculate the true mass of the crystals.

(3)

15 A pupil must find the volume of water in a measuring cylinder. Describe how the pupil should take the reading to avoid parallax error and to read the curved surface of the water correctly.

(3)

16 The true mass of a standard mass is 50.0 g. A pupil weighs it three times on one balance and gets 52.3 g, 52.4 g and 52.3 g.

Calculate the mean reading to one decimal place. Then state whether the balance is precise and whether it is accurate, giving a reason for each.

(4)

Mark scheme · 4.3 Working Scientifically: Measuring, Recording and Risk

Question 1

Units are written in every cell instead of once in the column heading.	B1
The number of decimal places is not consistent (2.0, 4 and 7.50).	B1
Corrected headings such as Time after planting (days) and Stem height (cm).	B1

Answer: **Units are in the cells, and decimal places are inconsistent. Headings: Time after planting (days); Stem height (cm).**

Question 2

B is a measurement (a number with a unit).	B1
D is a measurement (a number with a unit).	B1

Answer: **B and D.**

Question 3

24 + 26 + 25 + 25 = 100.	M1
Divides by 4, not 5.	M1
25 bubbles per minute.	A1
So the result is not hidden and others can see it was recorded and why it was left out (accept so it can be checked or repeated).	B1

Answer: **(a) 25 bubbles per minute; (b) So the unusual value is kept as a record and can be checked, with the reason it was left out.**

Question 4

(i) Wear eye protection.	B1
(ii) Hold the tube with a holder and let it cool before touching it.	B1
(iii) Keep electrical equipment away from water.	B1

Answer: **(i) Wear eye protection; (ii) Use a holder and let it cool; (iii) Keep electrical equipment away from water.**

Question 5

A is chosen.	B1
C is chosen.	B1
B controls a different hazard, hair catching fire in the flame, or D deals with chemicals left on the skin after the practical; neither stops liquid reaching the eyes.	B1

Answer: **A and C. B controls a different hazard (hair catching fire).**

Question 6

0.12 x 1000.	M1
120 cm^3.	A1
120 / 40.	M1
3 cm^3 per second.	A1

Answer: **120 cm^3; 3 cm^3 per second.**

Question 7

The 86°C reading at 3 minutes.	B1
Cooling water cannot get hotter, and the reading breaks the falling pattern.	B1
Probably 68°C, with the digits swapped (accept any value between 64°C and 71°C if supported).	B1
Check the original written note or repeat the cooling run, and record the correction clearly rather than quietly changing it.	B1

Answer: **86°C at 3 min. Water was cooling so it cannot rise. Probably 68°C. Check the original note or repeat the run.**

Question 8

First valid hazard, for example slippery bank or deep water.	B1
Harm that fits the hazard, for example falling in or drowning.	B1
A control measure that fits it, for example stay behind the marked line with supervision, or keep away from deep edges.	B1
Second different valid hazard with a harm that fits it, for example germs in pond water causing illness, or sharp objects in mud causing cuts.	B1
A fitting control for the second hazard, for example cover cuts and wash hands before eating, or wear gloves.	B1

Answer: **Hazard 1: slippery bank, a person could fall in; stay behind the marked line with a supervisor. Hazard 2: germs in pond water, which could cause illness; cover cuts and wash hands before eating.**

Question 9

(a) 0.35 kg.	B1
(b) 240 cm.	B1

Answer: **(a) 0.35 kg; (b) 240 cm.**

Question 10

Level 0 No relevant content.	**0**
Level 1 Gives isolated relevant statements about measuring, recording or safety, with little use of the data or justification.	**1-2**
Level 2 Calculates a mean correctly and identifies some measuring, recording or safety weaknesses with some linked improvements, but coverage of the three areas is incomplete.	**3-4**
Level 3 Calculates both means correctly and gives a coherent evaluation of measuring, recording and safety, linking each weakness to a specific improvement. Award 6 for a thorough, well-supported response; 5 for a mostly complete response.	**5-6**

Indicative content:

- Mean of all three = (38 + 41 + 62) / 3 = 141 / 3 = 47 s. Without 62 s: (38 + 41) / 2 = 39.5 s.
- The 62 s trial is far from the others and should be investigated before being left out; it should stay in the table with a note, and a further repeat would help decide.
- A 100 cm³ cylinder marked every 10 cm³ has a resolution too coarse for 20 cm³ of acid; use a 25 cm³ or 50 cm³ cylinder with smaller divisions.
- Reading from above gives parallax error; read with the eyes level with the bottom of the meniscus.
- The thermometer reads 2°C in melting ice that is at 0°C, so it has a zero error of +2°C; the acid may really be at 38°C, not 40°C. Check against ice, or use a different thermometer, and correct or replace.
- Units are written in the cells; put them once in the column heading, for example Time (s), and use a table with one row per trial.
- Eye protection should be worn because acid could splash into the eyes; this controls the hazard of acid in the eyes.
- Keep the acid volume, magnesium length and acid concentration the same, and repeat the trials to check consistency.

Question 11

(a) A hazard is something that could cause harm, for example the hot water (accept scald).	**B1**
(b) A risk is the chance that the harm actually happens, with how serious it would be (accept likelihood of someone being harmed).	**B1**

Answer: **A hazard is something that could cause harm. A risk is the chance of that harm happening.**

Question 12

Converts 3 mm to 0.3 cm, or writes the length as 43 mm.	**M1**
4.3 cm.	**A1**

Answer: **4.3 cm.**

Question 13

Converts 1.5 dm3 to 1500 cm³ (1 dm3 = 1000 cm³).	**M1**
6 samples.	**A1**

Answer: **6 samples.**

Question 14

Zero error, accept systematic error.	**B1**
12.4 - 0.6.	**M1**
11.8 g.	**A1**

Answer: **(a) Zero error; (b) 11.8 g.**

Question 15

Stand the cylinder on a flat level surface (accept hold it upright).	**B1**
Put the eyes level with the water surface and the scale mark, not looking down or up at it.	**B1**
Read at the bottom of the curved surface (meniscus).	**B1**

Answer: **Place the cylinder on a flat surface, bring the eyes level with the surface, and read the bottom of the meniscus.**

Question 16

(52.3 + 52.4 + 52.3) / 3.	**M1**
Mean = 52.3 g.	**A1**
Precise, because the three readings are very close to each other.	**B1**
Not accurate, because the mean is 2.3 g above the true value of 50.0 g.	**B1**

Answer: **Mean 52.3 g. Precise but not accurate.**