3.14 Chemistry: Reactions, Energy and Rates: 1-hour Pack

Total Marks

ISEB CE 13+ Science (Chemistry) · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 12 g of carbon makes 44 g of carbon dioxide. What mass of carbon is needed to make 220 g of carbon dioxide?

- ☐ A) 60 g
- ☐ B) 188 g
- ☐ C) 2640 g
- ☐ D) 600 g
- ☐ E) 220 g

---

2 The theoretical yield of a drug is 120 g and the percentage yield is 70%. Calculate the mass actually collected in g.

- ☐ A) 50 g
- ☐ B) 8400 g
- ☐ C) 840 g
- ☐ D) 36 g
- ☐ E) 84 g

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3 Aisha mixes two chemicals together in a polystyrene cup and measures the temperature of the mixture every 30 seconds.
Time (s): 0, 30, 60, 90, 120, 150
Temperature (C): 18.0, 21.5, 24.0, 25.5, 25.5, 25.5

(a) Calculate the rise in temperature during the experiment. **(2)**

.....

(b) State, giving a reason from the data, whether this reaction is exothermic or endothermic. **(2)**

(c) Suggest why the temperature stopped changing after 90 seconds. **(1)**

(d) Suggest one improvement Aisha could make to her method to reduce heat loss to the surroundings. **(1)**

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4 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50. Volume of gas (cm3): 0, 96, 144, 168, 180, 186. Calculate the mean rate of reaction between 10 s and 30 s in cm3/s.

- ☐ A) 8.4 cm^3/s
- ☐ B) 3.6 cm^3/s
- ☐ C) 36 cm^3/s
- ☐ D) 2.4 cm^3/s
- ☐ E) 72 cm^3/s

---

5 12 g of carbon makes 44 g of carbon dioxide. What mass of carbon is needed to make 110 g of carbon dioxide?

- ☐ A) 300 g
- ☐ B) 110 g
- ☐ C) 78 g
- ☐ D) 30 g
- ☐ E) 1320 g

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6 In an experiment, marble chips react with hydrochloric acid and the gas is collected in a syringe. Time (s): 0, 20, 40, 60, 80, 100, 120, 140. Volume of gas (cm3): 0, 64, 96, 112, 120, 124, 126, 126. Calculate the mean rate of reaction between 80 s and 100 s in cm3/s.

- ☐ A) 0.2 cm^3/s
- ☐ B) 5 cm^3/s
- ☐ C) 0.04 cm^3/s
- ☐ D) 4 cm^3/s
- ☐ E) 6.2 cm^3/s

---

7 12 g of carbon makes 44 g of carbon dioxide. What mass of carbon is needed to make 22 g of carbon dioxide?

- ☐ A) 264 g
- ☐ B) 0.6 g
- ☐ C) 6 g
- ☐ D) 60 g
- ☐ E) 22 g

---

8 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 96, 144, 168, 180, 186, 189. Calculate the mean rate of reaction between 10 s and 20 s in cm3/s.

- ☐ A) 4.8 cm^3/s
- ☐ B) 0.48 cm^3/s
- ☐ C) 2.4 cm^3/s
- ☐ D) 14.4 cm^3/s
- ☐ E) 48 cm^3/s

---

9 The theoretical yield of ammonia is 80 g and the percentage yield is 64%. Calculate the mass actually collected in g.

- ☐ A) 125 g
- ☐ B) 51.2 g
- ☐ C) 28.8 g
- ☐ D) 16 g
- ☐ E) 5120 g

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10 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 20, 40, 60, 80, 100, 120. Volume of gas (cm3): 0, 64, 96, 112, 120, 124, 126. Calculate the mean rate of reaction between 40 s and 80 s in cm3/s.

- ☐ A) 0.3 cm^3/s
- ☐ B) 6 cm^3/s
- ☐ C) 3 cm^3/s
- ☐ D) 0.6 cm^3/s
- ☐ E) 24 cm^3/s

---

11 40 g of calcium makes 56 g of calcium oxide. What mass of calcium oxide is made from 10 g of calcium?

- ☐ A) 140 g
- ☐ B) 10 g
- ☐ C) 26 g
- ☐ D) 560 g
- ☐ E) 14 g

---

12 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 30, 60, 90, 120, 150, 180. Volume of gas (cm3): 0, 96, 144, 168, 180, 186, 189. Calculate the mean rate of reaction between 60 s and 120 s in cm3/s.

- ☐ A) 3 cm^3/s
- ☐ B) 0.3 cm^3/s
- ☐ C) 0.6 cm^3/s
- ☐ D) 6 cm^3/s
- ☐ E) 36 cm^3/s

---

13 100 g of calcium carbonate makes 56 g of calcium oxide. What mass of calcium oxide is made from 25 g of calcium carbonate?

- ☐ A) 140 g
- ☐ B) 1400 g
- ☐ C) 14 g
- ☐ D) 25 g
- ☐ E) 1.4 g

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14 Ravi investigates how the concentration of sodium thiosulfate solution affects the rate of its reaction with dilute hydrochloric acid. He places each mixture in a flask over a piece of paper marked with a black cross, and times how long it takes until the cross can no longer be seen through the cloudy sulfur produced.

Concentration of sodium thiosulfate (g/dm^3): 10, 20, 30, 40

Time for cross to disappear (s): 100, 50, 33, 25

(a) Describe how the time taken for the cross to disappear changes as the concentration of sodium thiosulfate increases. **(2)**

(b) Explain, in terms of particles, why increasing the concentration of sodium thiosulfate increases the rate of reaction. **(2)**

(c) The rate of reaction can be estimated using rate = 1 / time. Calculate the rate of reaction at a concentration of 20 g/dm^3, in s^{-1}. Give your answer to 3 significant figures. **(3)**

(d) State one variable that should be kept constant in this investigation, other than the concentration of sodium thiosulfate. **(1)**

---

15 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50. Volume of gas (cm3): 0, 48, 72, 84, 90, 93. Calculate the mean rate of reaction between 30 s and 50 s in cm3/s.

- ☐ A) 4.5 cm^3/s
- ☐ B) 0.45 cm^3/s
- ☐ C) 9 cm^3/s
- ☐ D) 0.18 cm^3/s
- ☐ E) 4.65 cm^3/s

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16 24 g of magnesium makes 40 g of magnesium oxide. What mass of magnesium oxide is made from 240 g of magnesium?

- [ ] A) 256 g
- [ ] B) 9600 g
- [ ] C) 144 g
- [ ] D) 240 g
- [ ] E) 400 g

---

17 24 g of magnesium makes 40 g of magnesium oxide. What mass of magnesium oxide is made from 48 g of magnesium?

- [ ] A) 80 g
- [ ] B) 28.8 g
- [ ] C) 64 g
- [ ] D) 1920 g
- [ ] E) 48 g

---

18 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 20, 40, 60, 80, 100. Volume of gas (cm3): 0, 16, 24, 28, 30, 31. Calculate the mean rate of reaction over the first 20 s in cm3/s.

- [ ] A) 0.4 cm^3/s
- [ ] B) 16 cm^3/s
- [ ] C) 0.8 cm^3/s
- [ ] D) 1.25 cm^3/s
- [ ] E) 320 cm^3/s

---

19 40 g of calcium makes 56 g of calcium oxide. What mass of calcium is needed to make 140 g of calcium oxide?

- [ ] A) 140 g
- [ ] B) 5600 g
- [ ] C) 124 g
- [ ] D) 196 g
- [ ] E) 100 g

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20 In an experiment, marble chips react with hydrochloric acid and the gas is collected in a syringe. Time (s): 0, 30, 60, 90, 120, 150, 180. Volume of gas (cm3): 0, 80, 120, 140, 150, 155, 155. Calculate the mean rate of reaction over the first 60 s in cm3/s.

- ☐ A) 2 cm^3/s
- ☐ B) 7200 cm^3/s
- ☐ C) 20 cm^3/s
- ☐ D) 0.5 cm^3/s
- ☐ E) 120 cm^3/s

---

21 A reaction should make 100 g of a salt (the theoretical yield) but only 85 g is collected. Calculate the percentage yield.

- ☐ A) 850%
- ☐ B) 85%
- ☐ C) 8.5%
- ☐ D) 15%
- ☐ E) 170%

---

22 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 80, 120, 140, 150, 155, 155. At what time had the reaction first finished (the volume stopped changing)?

- ☐ A) 20 s
- ☐ B) 30 s
- ☐ C) 10 s
- ☐ D) 50 s
- ☐ E) 60 s

---

23 The theoretical yield of ammonia is 50 g and the percentage yield is 50%. Calculate the mass actually collected in g.

- ☐ A) 2500 g
- ☐ B) 100 g
- ☐ C) 250 g
- ☐ D) 25 g
- ☐ E) 2.5 g

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24 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 20, 40, 60, 80, 100. Volume of gas (cm3): 0, 32, 48, 56, 60, 62. Calculate the mean rate of reaction between 0 s and 20 s in cm3/s.

- [ ] A) 0.16 cm^3/s
- [ ] B) 0.625 cm^3/s
- [ ] C) 16 cm^3/s
- [ ] D) 32 cm^3/s
- [ ] E) 1.6 cm^3/s

---

25 100 g of calcium carbonate makes 56 g of calcium oxide. What mass of calcium carbonate is needed to make 560 g of calcium oxide?

- [ ] A) 604 g
- [ ] B) 56000 g
- [ ] C) 1000 g
- [ ] D) 313.6 g
- [ ] E) 560 g

---

26 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 64, 96, 112, 120, 124, 126. Calculate the mean rate of reaction between 0 s and 10 s in cm3/s.

- [ ] A) 3.2 cm^3/s
- [ ] B) 6.4 cm^3/s
- [ ] C) 12.8 cm^3/s
- [ ] D) 64 cm^3/s
- [ ] E) 0.64 cm^3/s

---

27 The theoretical yield of ammonia is 40 g and the percentage yield is 60%. Calculate the mass actually collected in g.

- [ ] A) 24 g
- [ ] B) 240 g
- [ ] C) 2400 g
- [ ] D) 2.4 g
- [ ] E) 16 g

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28 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50. Volume of gas (cm3): 0, 32, 48, 56, 60, 62. Calculate the mean rate of reaction between 0 s and 20 s in cm3/s.

- ☐ A) 0.24 cm^3/s
- ☐ B) 24 cm^3/s
- ☐ C) 2.4 cm^3/s
- ☐ D) 4.8 cm^3/s
- ☐ E) 48 cm^3/s

---

29 The theoretical yield of an ester is 200 g and the percentage yield is 40%. Calculate the mass actually collected in g.

- ☐ A) 160 g
- ☐ B) 80 g
- ☐ C) 500 g
- ☐ D) 120 g
- ☐ E) 8000 g

---

30 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 30, 60, 90, 120, 150. Volume of gas (cm3): 0, 48, 72, 84, 90, 93. Calculate the mean rate of reaction between 90 s and 150 s in cm3/s.

- ☐ A) 0.15 cm^3/s
- ☐ B) 1.55 cm^3/s
- ☐ C) 1.5 cm^3/s
- ☐ D) 0.06 cm^3/s
- ☐ E) 9 cm^3/s

---

31 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 64, 96, 112, 120, 124, 126. Calculate the mean rate of reaction between 10 s and 30 s in cm3/s.

- ☐ A) 48 cm^3/s
- ☐ B) 5.6 cm^3/s
- ☐ C) 24 cm^3/s
- ☐ D) 1.6 cm^3/s
- ☐ E) 2.4 cm^3/s

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32 The theoretical yield of a drug is 40 g and the percentage yield is 70%. Calculate the mass actually collected in g.

- [ ] A) 12 g
- [ ] B) 2800 g
- [ ] C) 280 g
- [ ] D) 2.8 g
- [ ] E) 28 g

---

33 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 30, 60, 90, 120, 150. Volume of gas (cm3): 0, 96, 144, 168, 180, 186. Calculate the mean rate of reaction between 30 s and 90 s in cm3/s.

- [ ] A) 2.8 cm^3/s
- [ ] B) 72 cm^3/s
- [ ] C) 1.2 cm^3/s
- [ ] D) 0.8 cm^3/s
- [ ] E) 12 cm^3/s

---

34 A reaction should make 80 g of ammonia (the theoretical yield) but only 64 g is collected. Calculate the percentage yield.

- [ ] A) 16%
- [ ] B) 125%
- [ ] C) 64%
- [ ] D) 80%
- [ ] E) 20%

---

35 In an experiment, zinc reacts with sulfuric acid and the gas is collected in a syringe. Time (s): 0, 20, 40, 60, 80, 100, 120. Volume of gas (cm3): 0, 96, 144, 168, 180, 186, 189. Calculate the mean rate of reaction between 0 s and 20 s in cm3/s.

- [ ] A) 0.48 cm^3/s
- [ ] B) 4.8 cm^3/s
- [ ] C) 96 cm^3/s
- [ ] D) 9.6 cm^3/s
- [ ] E) 48 cm^3/s

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36 The theoretical yield of crystals of copper sulfate is 100 g and the percentage yield is 75%. Calculate the mass actually collected in g.

- [ ] A) 75 g
- [ ] B) 7.5 g
- [ ] C) 750 g
- [ ] D) 25 g
- [ ] E) 7500 g

---

37 In an experiment, marble chips react with hydrochloric acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 16, 24, 28, 30, 31, 31. Calculate the mean rate of reaction between 20 s and 40 s in cm3/s.

- [ ] A) 3 cm^3/s
- [ ] B) 0.15 cm^3/s
- [ ] C) 0.3 cm^3/s
- [ ] D) 1.5 cm^3/s
- [ ] E) 6 cm^3/s

---

38 12 g of carbon makes 44 g of carbon dioxide. What mass of carbon dioxide is made from 6 g of carbon?

- [ ] A) 220 g
- [ ] B) 38 g
- [ ] C) 264 g
- [ ] D) 22 g
- [ ] E) 6 g

---

39 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 10, 20, 30, 40, 50, 60. Volume of gas (cm3): 0, 32, 48, 56, 60, 62, 62. At what time had the reaction first finished (the volume stopped changing)?

- [ ] A) 50 s
- [ ] B) 60 s
- [ ] C) 30 s
- [ ] D) 20 s
- [ ] E) 10 s

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40 100 g of calcium carbonate makes 56 g of calcium oxide. What mass of calcium oxide is made from 1000 g of calcium carbonate?

- [ ] A) 956 g
- [ ] B) 56000 g
- [ ] C) 5600 g
- [ ] D) 1000 g
- [ ] E) 560 g

---

41 In an experiment, magnesium ribbon reacts with dilute acid and the gas is collected in a syringe. Time (s): 0, 30, 60, 90, 120, 150, 180, 210. Volume of gas (cm3): 0, 96, 144, 168, 180, 186, 189, 189. Calculate the mean rate of reaction over the first 30 s in cm3/s.

- [ ] A) 1.6 cm^3/s
- [ ] B) 3.2 cm^3/s
- [ ] C) 96 cm^3/s
- [ ] D) 2880 cm^3/s
- [ ] E) 32 cm^3/s

---

42 40 g of calcium makes 56 g of calcium oxide. What mass of calcium is needed to make 84 g of calcium oxide?

- [ ] A) 84 g
- [ ] B) 68 g
- [ ] C) 117.6 g
- [ ] D) 3360 g
- [ ] E) 60 g

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43 A student wants to investigate the effect of temperature on the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid, using the disappearing cross method. Describe how the student could carry out this investigation, including the measurements taken and how a fair test would be ensured.

(6)

---

44 Tariq heats a piece of shiny copper foil strongly in a Bunsen flame. The copper turns black.

(a) Write a word equation for the reaction between copper and oxygen. **(2)**

(b) Explain, in terms of oxygen, why this reaction is called oxidation. **(2)**

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Mark scheme · 3.14 Chemistry: Reactions, Energy and Rates: 1-hour Pack

Question 1

A (60 g) **B1**

Answer: A) 60 g

Question 2

E (84 g) **B1**

Answer: E) 84 g

Question 3

(a) 25.5 - 18.0, oe **M1**

(a) 7.5 (C), cao **A1**

(a) Answer: 7.5C

(b) exothermic, cao **B1**

(b) because the temperature of the mixture increased, showing that energy was released to the surroundings, oe **B1**

(b) Answer: Exothermic, because the temperature increased, showing energy was released to the surroundings.

(c) the reaction had finished (one of the reactants had been completely used up), oe **B1**

(c) Answer: The reaction had finished, so no more energy was being released.

(d) put a lid on the polystyrene cup, or wrap/insulate the cup (e.g. with cotton wool), oe **B1**

(d) Answer: Put a lid on the cup (or insulate the cup with cotton wool) to reduce heat loss.

Question 4

B (3.6 cm^3/s) **B1**

Answer: B) 3.6 cm^3/s

Question 5

D (30 g) **B1**

Answer: D) 30 g

Question 6

A (0.2 cm^3/s) **B1**

Answer: A) 0.2 cm^3/s

Question 7

C (6 g) **B1**

Answer: C) 6 g

Question 8

A (4.8 cm^3/s) **B1**

Answer: A) 4.8 cm^3/s

Question 9

B (51.2 g) **B1**

Answer: B) 51.2 g

Question 10

D (0.6 cm^3/s) **B1**

Answer: D) 0.6 cm^3/s

Question 11

E (14 g) **B1**

Answer: E) 14 g

Question 12

C (0.6 cm^3/s) **B1**

Answer: C) 0.6 cm^3/s

Question 13

C (14 g) **B1**

Answer: C) 14 g

Question 14

(a) the time taken decreases as the concentration increases, oe **B1**

(a) so the rate of reaction increases as the concentration increases, oe **B1**

(a) Answer: As the concentration increases, the time taken for the cross to disappear decreases, showing that the rate of reaction increases with concentration.

(b) at a higher concentration there are more sodium thiosulfate particles in the same volume of solution, oe **B1**

(b) so collisions between sodium thiosulfate and acid particles happen more frequently, increasing the rate, oe **B1**

(b) Answer: A higher concentration means more sodium thiosulfate particles are packed into the same volume, so collisions between the reacting particles happen more often, increasing the rate.

(c) identifies the correct time for 20 g/dm^3, 50 (s) **M1**

(c) 1 / their 50 **dM1**

(c) 0.0200 s^{-1}, awrt **A1**

(c) Answer: 0.0200 s^{-1}

(d) any one of: volume of sodium thiosulfate solution, volume/concentration of hydrochloric acid, temperature, the same flask/cross viewed from the same position **B1**

(d) Answer: Example: the temperature of the solutions.

Question 15

B (0.45 cm^3/s) **B1**

Answer: B) 0.45 cm^3/s

Question 16

E (400 g) **B1**

Answer: E) 400 g

Question 17

A (80 g) **B1**

Answer: A) 80 g

Question 18

C (0.8 cm^3/s) **B1**

Answer: C) 0.8 cm^3/s

Question 19

E (100 g) **B1**

Answer: E) 100 g

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Question 20

A ($2\ cm^3/s$) **B1**

Answer: A) $2\ cm^3/s$

Question 21

B (85%) **B1**

Answer: B) 85%

Question 22

D (50 s) **B1**

Answer: D) 50 s

Question 23

D (25 g) **B1**

Answer: D) 25 g

Question 24

E ($1.6\ cm^3/s$) **B1**

Answer: E) $1.6\ cm^3/s$

Question 25

C (1000 g) **B1**

Answer: C) 1000 g

Question 26

B ($6.4\ cm^3/s$) **B1**

Answer: B) $6.4\ cm^3/s$

Question 27

A (24 g) **B1**

Answer: A) 24 g

Question 28

C ($2.4\ cm^3/s$) **B1**

Answer: C) $2.4\ cm^3/s$

Question 29

B (80 g) **B1**

Answer: B) 80 g

Question 30

A ($0.15\ cm^3/s$) **B1**

Answer: A) $0.15\ cm^3/s$

Question 31

E ($2.4\ cm^3/s$) **B1**

Answer: E) $2.4\ cm^3/s$

Question 32

E (28 g) **B1**

Answer: E) 28 g

Question 33

C ($1.2\ cm^3/s$) **B1**

Answer: C) $1.2\ cm^3/s$

Question 34

D (80%) **B1**

Answer: D) 80%

Question 35

B ($4.8\ cm^3/s$) **B1**

Answer: B) $4.8\ cm^3/s$

Question 36

A (75 g) **B1**

Answer: A) 75 g

Question 37

C ($0.3\ cm^3/s$) **B1**

Answer: C) $0.3\ cm^3/s$

Question 38

D (22 g) **B1**

Answer: D) 22 g

Question 39

A (50 s) **B1**

Answer: A) 50 s

Question 40

E (560 g) **B1**

Answer: E) 560 g

Question 41

B ($3.2\ cm^3/s$) **B1**

Answer: B) $3.2\ cm^3/s$

Question 42

E (60 g) **B1**

Answer: E) 60 g

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Question 43

Level 1 Basic, isolated statements about heating the solution and timing, with little or no detail on method, measurements or fair test. **1-2**

Level 2 A reasonable method is described, including heating or cooling the solution to different temperatures and timing until the cross disappears, with some attempt to keep other variables constant, though detail may be incomplete. **3-4**

Level 3 A clear, logical, detailed method describing how to vary and measure the temperature, how the disappearance of the cross is used to measure rate, and how the volumes/concentrations of both solutions, the flask, the cross and the observer are kept constant across repeats, using accurate scientific vocabulary throughout. **5-6**

Indicative content:

- Use the same volume and concentration of sodium thiosulfate solution and the same volume and concentration of hydrochloric acid in each repeat.
- Heat (or cool) the sodium thiosulfate solution in a water bath to the required temperature and measure its temperature with a thermometer before adding the acid.
- Place the flask on a piece of paper marked with a black cross, viewed from above.
- Add the acid to the sodium thiosulfate, swirl to mix, and immediately start a stopwatch/timer.
- Look down through the solution and stop the timer as soon as the cross can no longer be seen through the cloudy sulfur produced.
- Record the time taken at that temperature.
- Repeat the experiment at several different temperatures (e.g. every 10C), keeping the same flask, the same observer/viewing position and the same volumes each time.
- Repeat each temperature at least once more and calculate a mean time.
- Plot a graph of temperature against time (or temperature against 1/time as a measure of rate) to see the trend.

Question 44

(a) copper + oxygen -> **B1**

(a) copper oxide, cao **B1**

(a) Answer: copper + oxygen -> copper oxide

(b) oxidation is defined as a reaction in which a substance gains oxygen, oe **B1**

(b) the copper gains/combines with oxygen from the air to form copper oxide, oe **B1**

(b) Answer: Oxidation is a reaction in which a substance gains oxygen; the copper gains oxygen from the air to form copper oxide, so it has been oxidised.

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