Past-paper walk-through

Rate of reaction ▪ 6.2

eXercise

Questions in this set

- 0620/21 N25 Q16 ▪ 1 mark
- 0620/22 N25 Q16 ▪ 1 mark
- 0620/21 J25 Q15 ▪ 1 mark
- 0620/22 J25 Q15 ▪ 1 mark
- 0620/23 J25 Q15 ▪ 1 mark
- 0620/61 J25 Q2 ▪ 17 marks
- 0620/63 J25 Q2 ▪ 18 marks
- 0620/22 M25 Q19 ▪ 1 mark

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 16

0620/21 N25 ▪ Q16 ▪ 1 mark

16 Hydrogen peroxide solution decomposes very slowly at room temperature to produce oxygen gas. This gas forms a rising foam when liquid detergent is added.

Five test-tubes are half-filled with hydrogen peroxide solution. A drop of liquid detergent is added to each one.

Different metal oxides are added to four of the test-tubes and the height of the foam formed after one minute is measured. The results are shown.

metal oxide	height of foam / cm
no metal oxide added	0.1
aluminium oxide	0.1
calcium oxide	0.2

Question 16

copper(II) oxide	2.3
manganese(IV) oxide	5.4

Which conclusion can be drawn from these results?

A Metal oxides do **not** affect the rate of this reaction.

B All metal oxides increase the rate of this reaction and act as catalysts.

C Manganese(IV) oxide is the best catalyst of the four metal oxides tested.

D Only transition element oxides increase the rate of this reaction.

Solution 16

Answer: **C**

Why

- Only the catalyst differs between the tubes, so compare how fast the foam rises.
- The most effective catalyst gives the fastest decomposition and the tallest foam soonest.
- A tube with no catalyst, or with a substance that is not a catalyst, shows almost no change.

Question 16

0620/22 N25 ▪ Q16 ▪ 1 mark

16 Aqueous sodium thiosulfate, $Na_2S_2O_3$, reacts with dilute hydrochloric acid to form a yellow precipitate of sulfur.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + S(s) + SO_2(g)$$

The precipitate forms more quickly when the reactants are heated.

Which statements explain this observation?

1 The reacting particles collide more frequently.

2 The collisions between reacting particles have more energy.

3 The activation energy of the reaction is lower.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

Solution 16

Answer: **A**

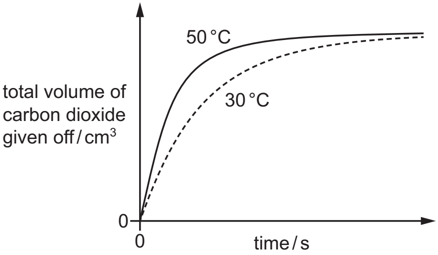
Why

- The rate rises when the particles collide more often or with more energy.
- Raising the concentration or the temperature does exactly that.
- So the yellow sulfur precipitate forms – and hides the cross – sooner.

Question 15

0620/21 J25 ▪ Q15 ▪ 1 mark

15 The graph shows the results of adding excess calcium carbonate to hydrochloric acid at 50 °C and at 30 °C. Only the temperature is changed.



Which row describes the reacting particles at 30 °C compared to those at 50 °C?

Question 15

	frequency of collisions between particles	average kinetic energy of particles
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

Solution 15

Answer: **D**

Why

- Raising the temperature makes the reaction faster, so the $50\,^{\circ}\mathrm{C}$ curve is steeper at the start.
- The acid is the limiting reagent in both, and its amount has not been changed.
- So both curves level off at the *same* final volume of carbon dioxide.

Question 15

0620/22 J25 ▪ Q15 ▪ 1 mark

15 Which statement describes the effect of adding a catalyst to a chemical reaction?

A The activation energy, E_a, of the reaction is increased.

B The enthalpy change, ΔH, of the reaction stays unchanged.

C The frequency of collisions between the particles is decreased.

D The kinetic energy of the particles is increased.

Solution 15

Answer: **B**

Why

- A catalyst *lowers* the activation energy; it never raises it.
- It does not change the reactants or the products, so the overall enthalpy change is unaffected.
- It works by offering an alternative pathway, not by making collisions more frequent.

Question 15

0620/23 J25 ▪ Q15 ▪ 1 mark

15 The rate of reaction between magnesium and dilute hydrochloric acid is increased by increasing the concentration of the acid.

How does this affect the reacting particles?

	collision rate of particles	proportion of particles with sufficient energy to react
A	increases	increases
B	increases	stays the same
C	stays the same	increases
D	stays the same	stays the same

Solution 15

Answer: **B**

Why

- More concentrated acid means more particles in the same volume.
- So collisions happen more often, and the rate rises.
- But the *energy* of the particles is unchanged, so the proportion with enough energy to react stays the same.

Question 2

0620/61 J25 ▪ Q2 ▪ 17 marks

2 A student investigates how the rate of reaction of magnesium ribbon with dilute acid changes as the concentration of the acid is changed. The student uses five solutions of the same acid, **A**, **B**, **C**, **D**, and **E**. Each solution has a different concentration. The acid is in excess in all experiments.

The student does five experiments.

Experiment 1

- Use a 50 cm^3 measuring cylinder to pour 30 cm^3 of acid **A** into a 100 cm^3 conical flask.
- Add a coil of magnesium ribbon to the acid in the conical flask and immediately start a stop-watch.
- Continually swirl the mixture in the conical flask until the magnesium ribbon disappears completely. Immediately stop the stop-watch and record the time in seconds to the nearest second.
- Empty and rinse the conical flask with distilled water.

Experiment 2

Question 2

- Repeat Experiment 1 using 30 cm^3 of acid **B** instead of acid **A**.

Experiment 3

- Repeat Experiment 1 using 30 cm^3 of acid **C** instead of acid **A**.

Experiment 4

- Repeat Experiment 1 using 30 cm^3 of acid **D** instead of acid **A**.

Experiment 5

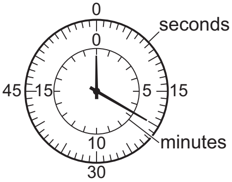
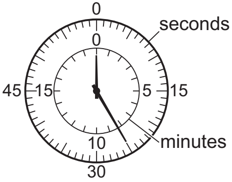
- Repeat Experiment 1 using 30 cm^3 of acid **E** instead of acid **A**.

(a) Use the stop-watch diagrams to complete Table 2.1

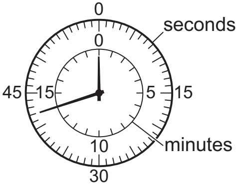
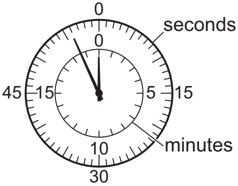
Table 2.1

		concentration of		time for

Question 2

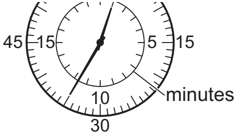
experiment	acid	concentration of acid in mol / dm^3	stop-watch diagram	magnesium to disappear in s
1	**A**	2.0		
2	**B**	1.5		

Question 2

3	**C**	1.0		
4	**D**	0.8		
				

Question 2

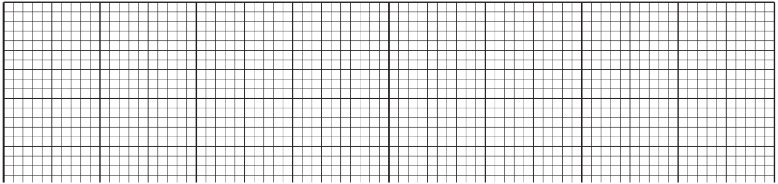
Question 2

5	**E**	0.5		

[2]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on Fig. 2.1.

Draw a line of best fit.



Question 2

Question 2

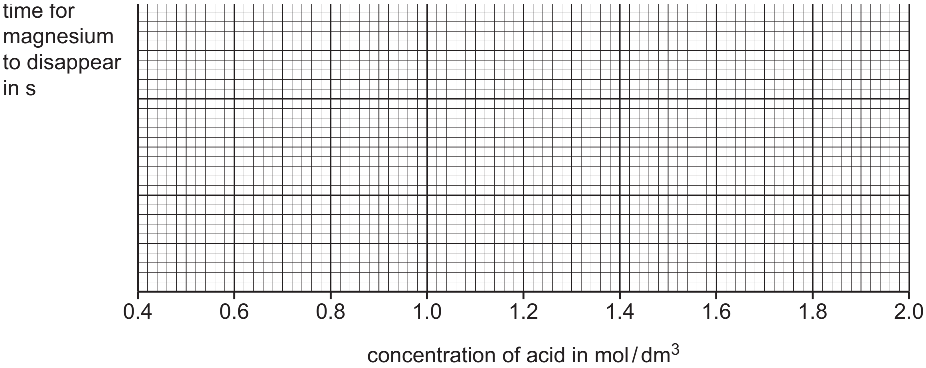


Fig. 2.1

[4]

Question 2

(c) From your graph in Fig. 2.1, deduce the time for the magnesium to disappear when the

Question 2

(c) From your graph in Fig. 2.1, deduce the time for the magnesium to disappear when the concentration of the acid is 1.3 mol / dm^3.

Show clearly on Fig. 2.1 how you worked out your answer.

Question 2

(d) The mean rate of reaction is calculated using the equation shown.

$$\text{mean rate of reaction} = \frac{\text{length of magnesium ribbon in cm}}{\text{time for magnesium to disappear in s}}$$

The length of each coil of magnesium ribbon used in all five experiments was 5 cm.

(i) Calculate the mean rate of reaction in Experiment 1. Give units for the rate you have calculated.

Question 2

[2]

(ii) Deduce in which Experiment, 1, 2, 3, 4 or 5, the mean rate of reaction is the slowest.

Question 2

(e) Explain why repeating each experiment is an improvement.

Question 2

(f) The student does another experiment to find the temperature change when magnesium reacts with acid **A**.

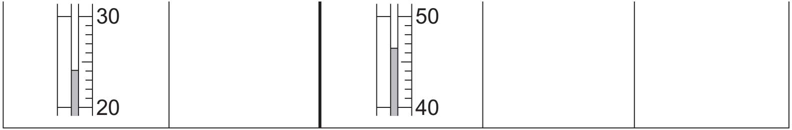
- Use the measuring cylinder to pour 30 cm^3 of acid **A** into the 100 cm^3 conical flask.
- Measure the initial temperature of the acid in the conical flask.
- Add a coil of magnesium ribbon to the acid in the conical flask.
- Continually swirl the conical flask until the magnesium ribbon disappears completely.
- Measure the final temperature of the acid in the conical flask.

(i) Use the thermometer diagrams to complete Table 2.2.

Table 2.2

thermometer diagram for initial temperature	initial temperature / °C	thermometer diagram for final temperature	final temperature / °C	temperature change / °C

Question 2



[2]

(ii) Explain why controlling the temperature of the acid so that it remains constant is an improvement.

Question 2

(iii) Explain why using a polystyrene cup instead of the 100 cm^3 conical flask does **not** control the temperature of the acid.

Question 2

(iv) Describe how the temperature of the acid can be controlled and kept constant.

Question 2

[Total: 17]

Solution 2

(a)

Mark scheme

- M1 times are correct for all five experiments (20, 25, 42, 56, 95)
- 1 M2
- All times recorded in whole numbers of seconds only
- 1

Solution 2

(b)

Mark scheme

- M1 y-axis scale is linear and points take up over half of space available
- 1 M2
- and M3 All points plotted correctly
- 2 M4
- best fit line
- 1

Solution 2

(c)

Mark scheme

- M1 correct working shown at a concentration of 1.3 on graph
- 1 M2
- correct reading from their working shown on graph
- 1
- 0620/61
- May/June 2025

Solution 2

(d)(i)

Mark scheme

- M1 0.25
- 1 **M2**
- cm / s
- 1

(d)(ii)

Mark scheme

- Experiment 5/1

Solution 2

(e)

Mark scheme

- to check / verify / compare results / to get concordant results /
- 1

Solution 2

(f)(i)

Mark scheme

- M1 both temperatures are correct (24.0, 46.5)
- 1 M2
- temperature change calculated correctly (22.5) and all temperatures and temperature change given to one dp
- 1

Solution 2

(f)(ii)

Mark scheme

- a change of temperature will change the rate of reaction
- 1

(f)(iii)

Mark scheme

- the polystyrene would prevent heat escaping
- 1

Solution 2

(f)(iv)

Mark scheme

- use a water bath (at room temperature / at starting temperature)
- 1

Question 2

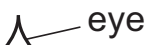
0620/63 J25 ▪ Q2 ▪ 18 marks

2 A student investigates how the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate changes as the concentration of the aqueous sodium thiosulfate decreases. During the reaction, the solution slowly becomes cloudy. As the solution becomes cloudy, it becomes more difficult to see through the solution.

The student does five experiments.

Experiment 1

- Use a 50 cm^3 measuring cylinder to pour 50 cm^3 of aqueous sodium thiosulfate into a 100 cm^3 beaker.
- Use a 10 cm^3 measuring cylinder to pour 5 cm^3 of dilute hydrochloric acid into the beaker containing the aqueous sodium thiosulfate.
- Immediately start a stop-watch and stir the contents of the beaker.
- Stand the beaker on a printed sheet and look down from above the beaker as shown in Fig. 2.1.



Question 2

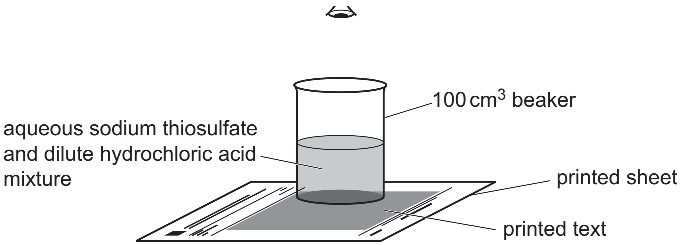


Fig. 2.1

- When the text on the printed sheet is **not** visible, stop the stop-watch and record the time to the nearest whole number of seconds.
- Empty the contents of the beaker and rinse the beaker with distilled water.

Experiment 2

- Repeat Experiment 1 using 40 cm^3 of aqueous sodium thiosulfate instead of 50 cm^3. Use the

Question 2

- Repeat Experiment 1 using 40 cm^3 of aqueous sodium thiosulfate instead of 50 cm^3. Use the 50 cm^3 measuring cylinder to add 10 cm^3 of distilled water to the beaker **before** adding the dilute hydrochloric acid.

Experiment 3

- Repeat Experiment 2 using 30 cm^3 of aqueous sodium thiosulfate and 20 cm^3 of distilled water.

Experiment 4

- Repeat Experiment 2 using 25 cm^3 of aqueous sodium thiosulfate and 25 cm^3 of distilled water.

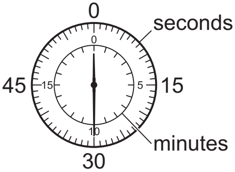
Experiment 5

- Repeat Experiment 2 using 20 cm^3 of aqueous sodium thiosulfate and 30 cm^3 of distilled water.

(a) Use the information in the description of the experiments and the stop-watch diagrams to complete Table 2.1.

Table 2.1

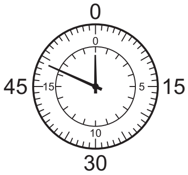
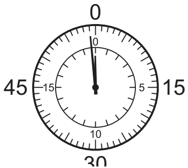
Table 2.1

experiment	volume of aqueous sodium thiosulfate / cm^3	volume of distilled water / cm^3	volume of dilute hydrochloric acid / cm^3	stop-watch diagram	time taken for text to **not** be visible / s
1	50	0	5		
					

Question 2

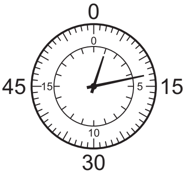
2				45 15 5 15	

Question 2

					
3					
4					

Question 2

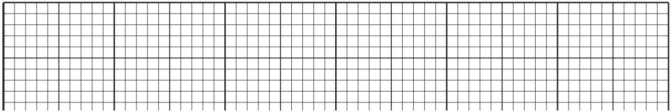
Question 2

5					

[3]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on Fig. 2.2.

Draw a curve of best fit.



Question 2

Question 2

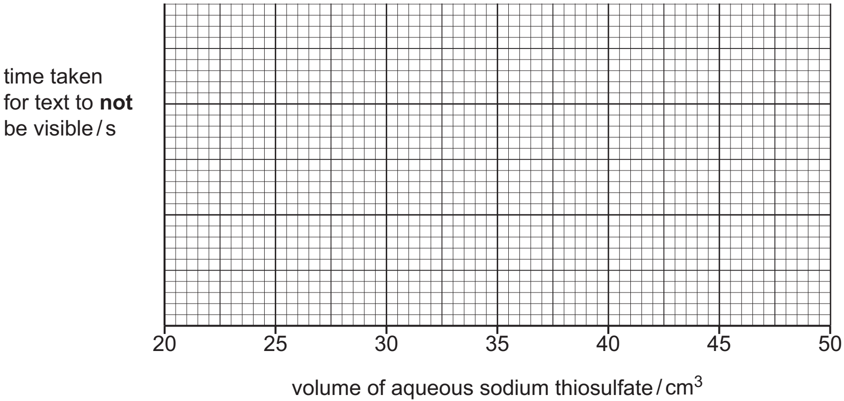


Fig. 2.2

[4]

Question 2

Question 2

(c) The relative rate of reaction in each experiment is calculated using the equation shown.

$$\text{relative rate of reaction} = \frac{1}{\text{time taken}}$$

(i) Calculate the relative rate of reaction in Experiment 1.
Do **not** give units for your answer.

Question 2

(ii) State in which Experiment, 1, 2, 3, 4 or 5, the relative rate of reaction was greatest.

Question 2

(d) In each experiment the total volume of aqueous sodium thiosulfate and distilled water is constant.

(i) Calculate the volume of distilled water needed when the volume of aqueous sodium thiosulfate is 37 cm^3.

Question 2

(ii) From your graph in Fig. 2.2, deduce the time for the text to **not** be visible when the volume of aqueous sodium thiosulfate is 37 cm^3.

Show clearly on Fig. 2.2 how you worked out your answer.

Question 2

(iii) Explain why the total volume of aqueous sodium thiosulfate and distilled water is kept constant.

Question 2

(e) **(i)** State why measuring the volume of the dilute hydrochloric acid with a burette instead of a measuring cylinder would be an improvement.

Question 2

(ii) Explain why it is **not** possible to use a volumetric pipette to measure the volume of aqueous sodium thiosulfate in each experiment.

Question 2

(f) Explain why it is important **not** to change the size of the beaker to a larger beaker during the investigation.

Question 2

[Total: 18]

Solution 2

(a) Mark scheme

- M1 volume of aqueous sodium thiosulfate and volume of water correctly recorded for all five experiments
- and
- volume of dilute hydrochloric acid shown as 5 cm3 for all experiments.
- 50
- 0
- 5
- 40

Solution 2

- 10
- 5
- 30
- 20
- 5
- 25
- 25
- 5
- 20
- 30

Solution 2

- 5
- 1 M2
- all five stop clock reading correct
- 30
- 37
- 49
- 59
- 73
- 1 M3
- all times in whole number of seconds only

Solution 2

- 1

Solution 2

(b) Mark scheme

- M1 y-axis linear scale linear and points extend over more than half of the y-axis
- 1 M2
- and M3 all points plotted correctly
- 2 M4
- line of best fit
- 1
- 0620/63
- May/June 2025

Solution 2

(c)(i)

Mark scheme

- correct evaluation of 1 $\div$ time for experiment one.
- expected answer is $1 \,/\, 30 = 0.033$
- 1

Solution 2

(c)(ii)

Mark scheme

- 1
- 1

Solution 2

(d)(i)

Mark scheme

- M1 13/1 M2 cm3
- 1

Solution 2

(d)(ii)

Mark scheme

- M1 correct working shown at 37 cm3 on graph to show where value read
- 1 M2
- correct reading from their working shown on graph.
- 1

Solution 2

(d)(iii)

Mark scheme

- so depth of liquid in beaker is the same in all experiments / so concentration of dilute hydrochloric acid in mixture is the
- same for all experiments
- 1

Solution 2

(e)(i)

Mark scheme

- a burette is more accurate than a measuring cylinder
- 1

Solution 2

(e)(ii) Mark scheme

- Any one from:
- ▪
- volume of aqueous sodium thiosulfate is not 25 cm3
- ▪
- volume of aqueous sodium thiosulfate is not constant / fixed
- ▪
- volumetric pipettes not available in those sizes
- 1

Solution 2

(f)

Mark scheme

- M1 (different size beaker would) change depth
- 1 M2
- so changes time measured
- 1
- 0620/63
- May/June 2025

Question 19

0620/22 M25 ▪ Q19 ▪ 1 mark

19 Which statements explain why increasing the temperature in a reaction involving gases increases the rate of reaction?

1 It increases the collision frequency between the gas particles.

2 It lowers the activation energy.

3 It increases the kinetic energy of the gas particles.

4 It increases the number of gas particles per unit volume.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

Solution 19

Answer: **A**

Why

- Higher temperature means faster particles, so they collide more often – statement 1 is right.
- It also raises their kinetic energy, so more of them exceed the activation energy – statement 3 is right.
- The activation energy belongs to the reaction and does not change, and a fixed volume holds the same number of particles.