Past-paper walk-through

Rate of reaction ▪ 8.1

eXercise

Questions in this set

- 9701/12 N25 Q14 ▪ 1 mark
- 9701/33 N25 Q1 ▪ 15 marks

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 14

9701/12 N25 ▪ Q14 ▪ 1 mark

14 20.0 cm^3 of hydrogen peroxide decomposes to water and oxygen in the presence of a suitable catalyst.

160 cm^3 of oxygen, measured at room conditions, is produced in 5.00 minutes.

What is the average rate of decomposition of hydrogen peroxide during this reaction period?

A $2.22 \times 10^{-5}\,mol\,s^{-1}$

B $4.44 \times 10^{-5}\,mol\,s^{-1}$

C $1.76 \times 10^{-4}\,mol\,s^{-1}$

D $2.67 \times 10^{-3}\,mol\,s^{-1}$

Solution 14

Answer: **B**

Why

- $n(\mathrm{O_2}) = 0.160/24.0 = 6.67 \times 10^{-3}$ mol.
- $2\mathrm{H_2O_2} \rightarrow 2\mathrm{H_2O} + \mathrm{O_2}$, so twice as much peroxide decomposed: 1.33×10^{-2} mol.
- Rate $= 1.33 \times 10^{-2}/300 = 4.44 \times 10^{-5}$ mol $\mathrm{s^{-1}}$; A omits the factor of 2.

Question 1

9701/33 N25 ▪ Q1 ▪ 15 marks

1 The thiosulfate ion, $S_2O_3^{2-}$, decomposes when an acid is added.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(aq) + H_2O(l)$$

The rate of this reaction can be investigated by measuring how long it takes for the solid sulfur forming to obscure the print on the insert.
You will investigate how the concentration of the thiosulfate ion affects the rate of the reaction.

Note: A small amount of sulfur dioxide gas may be formed in the experiment. It is very important that you avoid inhaling any fumes. As soon as each experiment is complete, add the reaction mixture to the quenching bath and rinse the beaker thoroughly.

FA 1 is 0.100 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FA 2 is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.

(a) Method

Experiment 1

Question 1

- Fill a burette with **FA 1**.
- Run 40.00 cm^3 of **FA 1** into the 100 cm^3 beaker.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FA 2**.
- Add the **FA 2** to the **FA 1** in the beaker and start timing immediately.
- Stir the mixture once and place the beaker on the printed insert.
- View the printing on the insert from above through the solution.
- Stop timing when the print on the insert becomes obscured.
- Record this reaction time to the nearest second in the space for results.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready to use in **Experiment 2**.

Experiment 2

- Refill the burette with **FA 1**.
- Fill the second burette with distilled water.
- Run 20.00 cm^3 of **FA 1** into the 100 cm^3 beaker.
- Run 20.00 cm^3 of distilled water into the same beaker.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FA 2**.
- Add the **FA 2** to the **FA 1** in the beaker and start timing immediately.

Question 1

- Add the **FA 2** to the **FA 1** in the beaker and start timing immediately.
- Stir the mixture once and place the beaker on the printed insert.
- View the printing on the insert from above through the solution.
- Stop timing when the print on the insert becomes obscured.
- Record this reaction time to the nearest second in the space for results.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready to use in the next experiment.

Experiments 3–5

- Carry out three further experiments to investigate how using different volumes of **FA 1** affects the reaction time.

Note: the combined volumes of **FA 1** and distilled water must always be 40.00 cm^3.
Do not use a volume of **FA 1** that is less than 15.00 cm^3.

Record all your results in a table. You should include the volume of **FA 1**, the volume of distilled water, the reaction time and the reaction rate for each of your five experiments.

The rate of reaction can be calculated using the following formula.

Question 1

Question 1

reaction time

Results

I	
II	
III	
IV	
V	
VI	
VII	

Question 1

| VII |

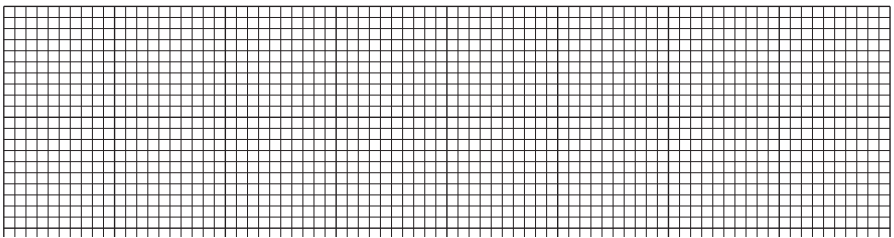
Question 1

VIII	

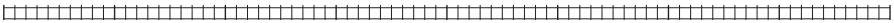
[8]

(b) (i) On the grid in Fig. 1.1, plot the rate (*y*-axis) against the volume of **FA 1** (*x*-axis). Start each axis at the origin (0, 0).

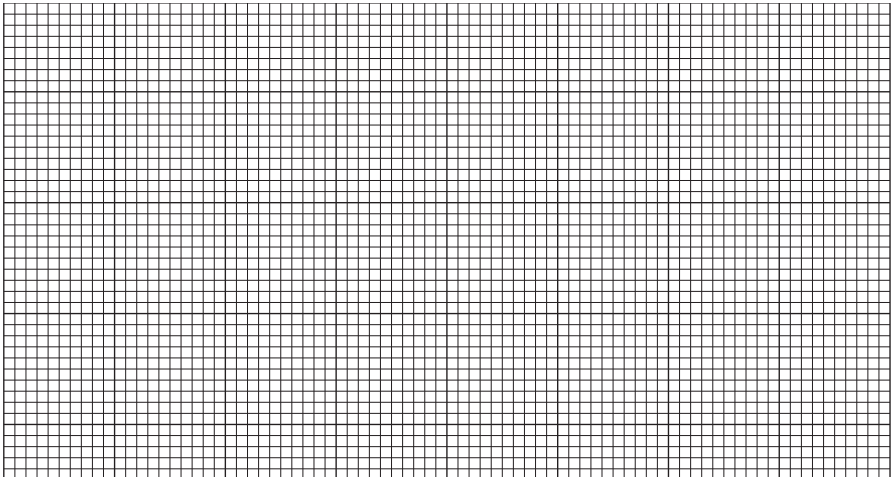
Ring any anomalous points. Draw a line of best fit.



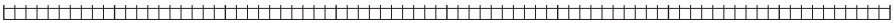
Question 1



Question 1



Question 1



Question 1

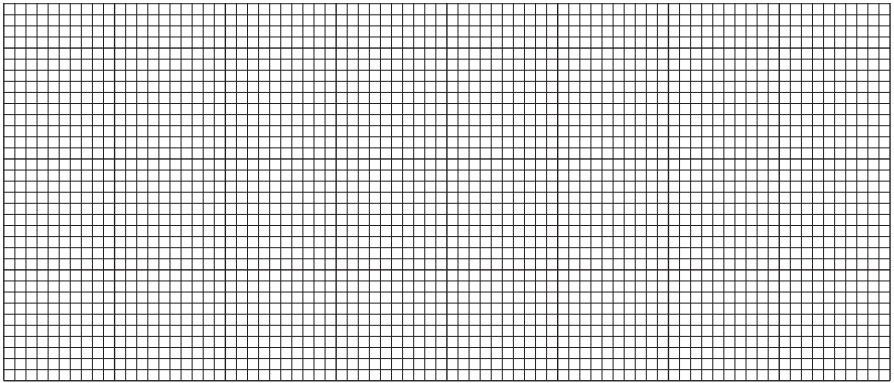


Fig. 1.1

Question 1

Question 1

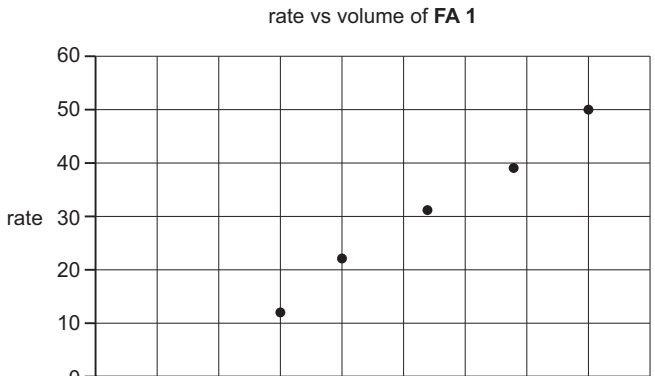
I	
II	
III	

[3]

(ii) Use your graph in Fig. 1.1 to determine the time it would take for the print to be obscured if 7.50 cm^3 of **FA 1**, 32.50 cm^3 of water and 10.0 cm^3 of **FA 2** had been used.
Show clearly on the graph how you worked out your answer.

Question 1

(c) A student carries out the same method as given in **(a)** but using a different concentration of acid. The student's calculated values for the rate are plotted on the grid in Fig. 1.2.



Question 1

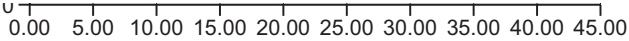


Fig. 1.2

State whether the student's results show that the rate is directly proportional to the volume of **FA 1** used.
Explain your answer.

Question 1

[Total: 15]

Solution 1

(a) Mark scheme

- I
- Five experiments completed
- AND
- Table to show Volume of FA 1, Volume of water, Time and Rate
- 1
- II Correct units for all data
- Volume: / cm3 OR (cm3) OR in cm3 OR cm3 by each volume
- Time: / s OR (s) OR in s OR s by each time

Solution 1

- Rate: / s–1 OR (s–1) OR in s–1 OR s–1 by each rate
- 1
- III All times recorded to nearest second
- AND
- Volumes of FA 1 and water both given 2 d.p. ending with 0 or 5/1 IV Three additional experiments with volume FA 1 $\quad 15.00\,\text{cm3}, < 40.00\,\text{cm3}$ and no volume closer than 5.00 cm3 to
- another volume.
- AND
- Volumes of water chosen so that total volume $= 40.00\,\text{cm3}$ for additional experiments.

Solution 1

- 1
- V Correctly calculates rate for all experiments and shown to 2 – 4 s.f.
- 1
- VI Award if all times recorded increase with decreasing volume of FA 1.
- 1
- Examiner corrects time for VFA1 = 40.00 cm3 and VFA1 = 20.00 cm3 to the nearest s then calculates 20/40 /
- t
- t
- to 2 d.p.

Solution 1

- VII Award if candidate's ratio is within the range 1.80 to 2.30.
- 1
- VIII Award if candidate's ratio is within the range 1.90 to 2.20.
- 1
- 9701/33
- October/November 2025

Solution 1

(b)(i) Mark scheme

- I
- Unambiguous labelled axes with rate on the y-axis and volume of FA 1 on the x-axis OR correct units
- AND
- suitable linear scales starting at (0,0).
- 1
- II Points plotted correctly.
- 1

Solution 1

- III Line of best fit drawn, straight line or smooth curve, that ignores anomalous results identified by the candidate.
- 1

Solution 1

(b)(ii) Mark scheme

- M1 Correct line(s) drawn
- AND
- Rate correctly read within half a small square. **M2**
- 1000 / rate
- AND
- correctly calculates answer to 2 – 4 s.f.
- 2

Solution 1

(c) Mark scheme

- M1 Correct line of best fit **M2**
- (Rate and volume of FA 1 are) not directly proportional as the (straight) line / data / results does not / do not pass
- through the origin / (0,0)
- OR **M1**
- unavailable for line of best fit through the origin. **M2**
- (Rate and volume of FA 1 are) directly proportional as the (straight) line / data / results pass through the origin / (0,0)

Solution 1

- 2
- 9701/33
- October/November 2025