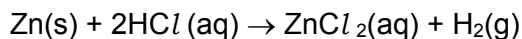


## **AS level Chemistry A**

**H032/02** Depth in chemistry

### **Question Set 17**

1. Zinc reacts with hydrochloric acid,  $\text{HCl}(\text{aq})$ , as shown in the following equation.



A student investigates the rate of this reaction.

- (a) The student plans to react  $50.0\text{ cm}^3$  of  $0.100\text{ mol dm}^{-3}$   $\text{HCl}$  with  $0.200\text{ g}$  of zinc (an excess).

Calculate the volume, in  $\text{cm}^3$ , of hydrogen that should be produced at RTP.

$$\begin{aligned} \text{moles HCl} &: 0.05 \times 0.1 \\ &= 0.005 \end{aligned}$$

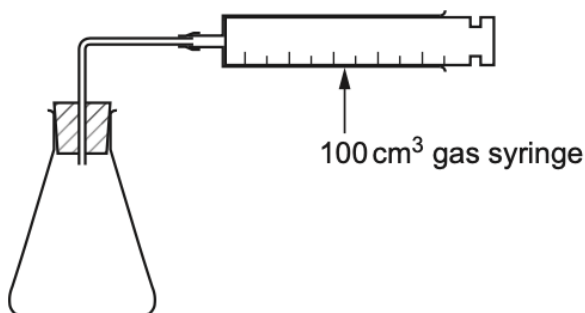
$$\text{moles H}_2 = 0.005 \div 2 = 0.0025$$

[3]

- 1 mole of any gas occupies  $24\text{ dm}^3$  at RTP

$$\Rightarrow 0.025 \times 24000 = \underline{\underline{60\text{ cm}^3}}$$

- (b) The student uses the apparatus in the diagram.



The student's method is outlined below:

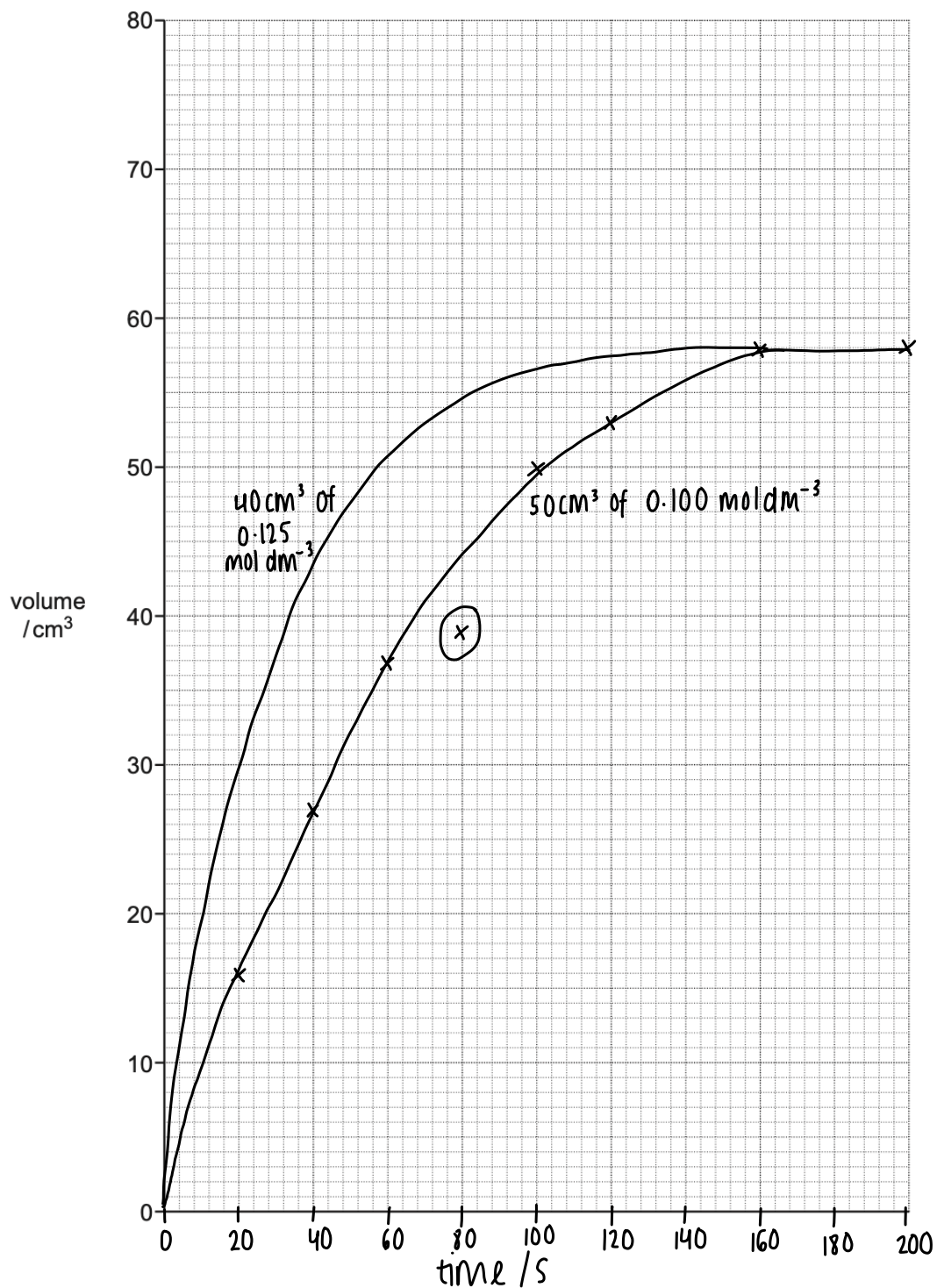
- Pour  $50.0\text{ cm}^3$  of  $0.100\text{ mol dm}^{-3}$   $\text{HCl}$  into the conical flask.
- Add  $0.200\text{ g}$  of zinc (an excess), and quickly attach the delivery tube and gas syringe.
- Measure the volume of gas collected every 20 seconds until the reaction stops.

The student obtains the results shown in **Table 4.1**.

| Time/s                       | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 160 | 200 |
|------------------------------|---|----|----|----|----|-----|-----|-----|-----|
| Volume of gas/ $\text{cm}^3$ | 0 | 16 | 27 | 37 | 39 | 50  | 53  | 58  | 58  |

**Table 4.1**

- (i) On the graph paper in **Fig. 4.1**, label the x axis **and** plot the results in **Table 4.1**. [1]



**Fig 4.1**

- (ii) Circle any anomalous results present in the graph you have drawn in **Fig. 4.1**. [1]
- (iii) Draw a best-fit smooth curve on the graph you have drawn in **Fig. 4.1**. [1]

- (c) The student repeats the experiment using:
- zinc with the same mass (0.200 g) and same surface area
  - the same temperature and pressure
  - 40.0 cm<sup>3</sup> of 0.125 mol dm<sup>-3</sup> HCl, instead of 50.0 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> HCl.

On your graph in Fig. 4.1 sketch the curve you would expect in this experiment. [2]

- (d) The graph shows that rate of reaction decreases over time.

Explain why, in terms of collision theory.

as the reaction proceeds the reactant particles are used up and the products are formed so there are less frequent successful collisions and the rate of reaction decreases. [2]

- (e) (i) The rate of the reaction between zinc and hydrochloric acid can be increased using a solution of copper(II) sulfate as a catalyst.

Explain how a catalyst increases the rate of reaction. [2]

a catalyst provides an alternative pathway for the reaction, one with a lower activation energy.

- (ii) Why is it difficult to classify the solution of copper(II) sulfate as a homogeneous or heterogeneous catalyst in this reaction? [1]

the reactants are in different states (one is solid and one is aqueous).

**Total Marks for Question Set 4: 13**

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