Rates and Maxwell-Boltzmann distributions

OCR A H032 and H432 · AS and A level

Answer on your own paper. Show your working where needed.

1. Gas syringe readings

A gas syringe reads 17.0 cm^3 at 10.0 s and 48.0 cm^3 at 40.0 s. Calculate the average rate of gas production over this interval in $cm^3\ s^{-1}$. Give your answer to three significant figures.

2. Compare two ways to follow a reaction

Calcium carbonate and dilute acid release carbon dioxide. Suggest two measurements that could be recorded at regular intervals to follow the progress of this reaction. Explain why each changes.

3. Most collisions are unsuccessful

In a reacting gas, only a small proportion of collisions lead to a reaction. Define activation energy and use it to explain this observation.

4. Concentration at constant temperature

A solution reacts with a solid. A second run uses the same volume of a more concentrated solution and an identical piece of solid. The starting temperature is the same. Predict and explain how the initial rate changes.

5. The same gas with and without a catalyst

Two samples of a reacting gas have the same temperature and number of molecules. One has a catalyst. Use a Maxwell-Boltzmann diagram to compare the two samples. Label the axes and any activation energies you show.

6. Two temperatures

Sketch Maxwell-Boltzmann curves for a fixed number of gas molecules at two temperatures. Label the axes and mark the activation energy. Use the curves to explain the difference in reaction rate.

7. Concentration against time

At a chosen time, a tangent to a reactant concentration curve passes through (20 s, 0.162 mol dm^{-3}) and (70 s, 0.082 mol dm^{-3}). Calculate the rate of disappearance of the reactant.

8. Two activation energies

At a fixed temperature, 1.6% of molecules have energy at or above the uncatalysed activation energy. With a catalyst, 8.0% have at least the new activation energy. By what factor does the fraction change? Explain why the rate increases.

9. Extra challenge · Assess a particle-size result

Equal masses of calcium carbonate from the same sample react completely with excess acid. Run A uses chips and run B uses powder. Gas volumes for A after 0, 10 and 120 s are 0, 18 and 42 cm^3. For B they are 0, 32 and 66 cm^3. Neither volume changes after 120 s.

Compare the mean rates for the first 10 s. Explain why the final volumes suggest a problem with the comparison. Suggest one flaw that fits the pattern, and one way to check it.

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chemistryhelp.co.uk/worksheets/ocr-a-rates-and-maxwell-boltzmann