Rates of Reactions & Equilibrium (Qualitative) AS & A Level

Question Paper 4

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Periodic Table & Energy
Topic	Rates of Reactions & Equilibrium(Qualitative)
Paper	AS & A Level
Booklet	Question Paper 4

Time allowed: **49 minutes**

Score: **/36**

Percentage: **/100**

Grade Boundaries:

| A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

A student was asked to carry out an experiment to determine the initial rate of reaction of zinc and hydrochloric acid.

The student plans to collect a total of about 72 cm^3 of hydrogen at RTP and to use an excess of zinc.

The student selects the following apparatus:
- the apparatus shown in the diagram
- 100 cm^3 measuring cylinder
- stop clock
- 2 decimal place balance

100 cm^3 gas syringe
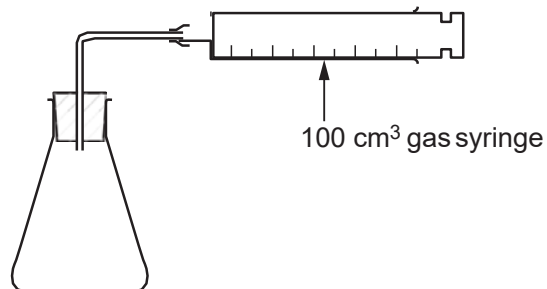
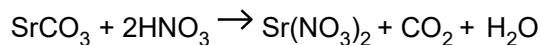Outline how the student could carry out the experiment and explain how the results could be processed graphically.
Show all working in your calculations.

[6]

(Total 6 marks)

A student investigates the reaction between strontium carbonate and dilute nitric acid.

$$SrCO_3 + 2HNO_3 \rightarrow Sr(NO_3)_2 + CO_2 + H_2O$$

The rate of reaction is determined from the loss in mass over a period of time.

(a) **(i)** Explain why there is a loss in mass during the reaction.

[1]

(ii) An excess of strontium carbonate, $SrCO_3$, is mixed with 20.0 cm^3 of 1.25 mol dm^{-3} nitric acid, HNO_3. Calculate the mass of $SrCO_3$ that reacts with the HNO_3.

[3]

(b) The student plots a graph of total mass (reagents + container) against time.
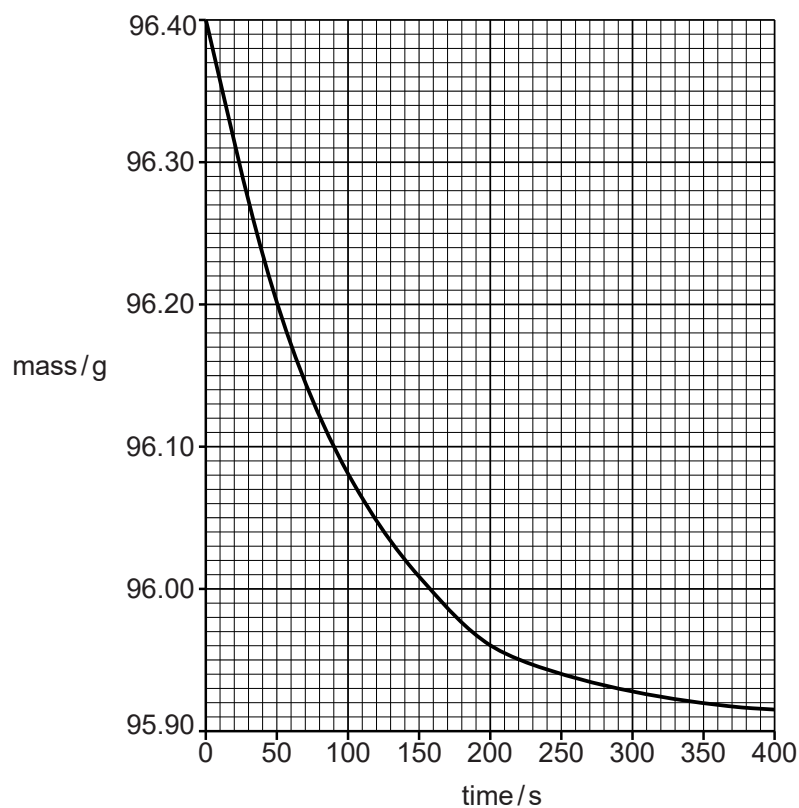
(i) Describe and explain the change in the rate of the reaction during the first 200 seconds of the experiment.

[2]

(ii) Using the graph, calculate the rate of reaction, in g s⁻¹, at 200 seconds.

Show your working on the graph.

[2]

(c) Outline a method that could be used to obtain the results that are plotted on the graph.

Your answer should include the apparatus required and the procedure for the experiment.
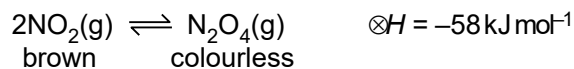
[3]

(Total 11 marks)

Question 3

This question is about equilibrium and catalysts.

(a) The equilibrium between NO_2 and N_2O_4 gases is set up in a gas syringe at room temperature. The two gases are different in appearance.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \otimes H = -58\,kJ\,mol^{-1}$$
$$\text{brown} \qquad \text{colourless}$$

Using le Chatelier's principle, predict and explain how the following changes would affect the appearance of the equilibrium mixture.

(i) The gas mixture is compressed by pushing in the plunger of the gas syringe. [2]

(ii) The gas syringe is placed in a warm water bath. [2]

(b) When potassium chromate(VI), K_2CrO_4, is dissolved in water an equilibrium is set up. The position of equilibrium is well to the left and the solution is a yellow colour.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$
$$\text{yellow} \qquad\qquad\qquad \text{orange}$$
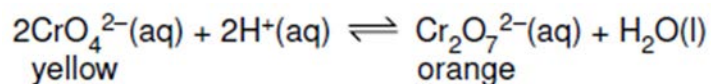
The addition of aqueous acid turns the solution an orange colour.
Aqueous alkali is then added and the solution turns a yellow colour.

Explain these observations in terms of le Chatelier's principle. [2]

(c) Catalysts can be used to change the rate of some chemical reactions.

(i) Zinc and sulfuric acid react together to form a solution of zinc sulfate, $ZnSO_4$, and hydrogen gas. The reaction is exothermic.

The rate of the reaction increases when a catalyst is added.

- Complete the enthalpy profile diagram for this reaction using the formulae of the reactants and products.
- Label activation energies, E_a (without catalyst) and E_c (with catalyst).
- Label the enthalpy change of reaction, ΔH.
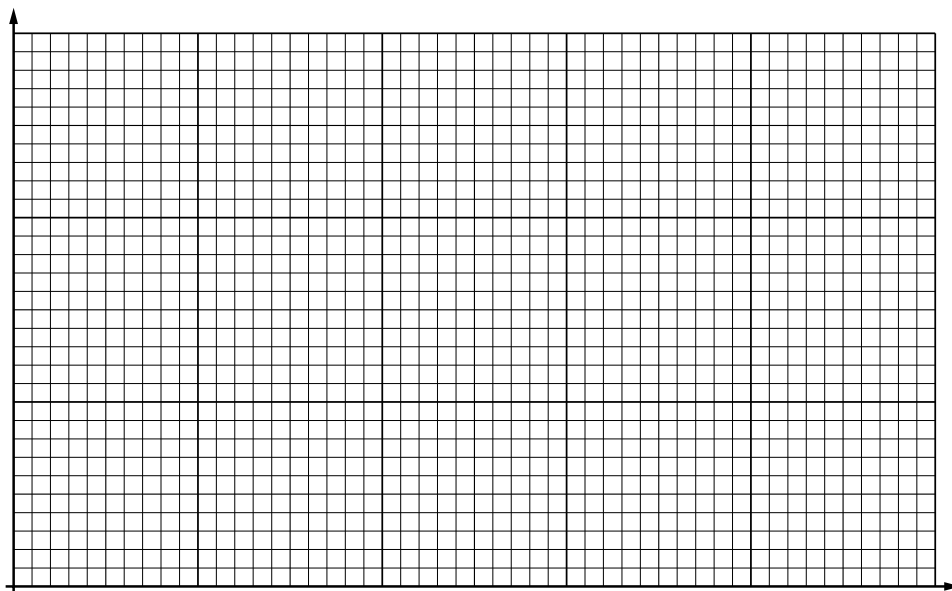
enthalpy

progress of reaction

[3]
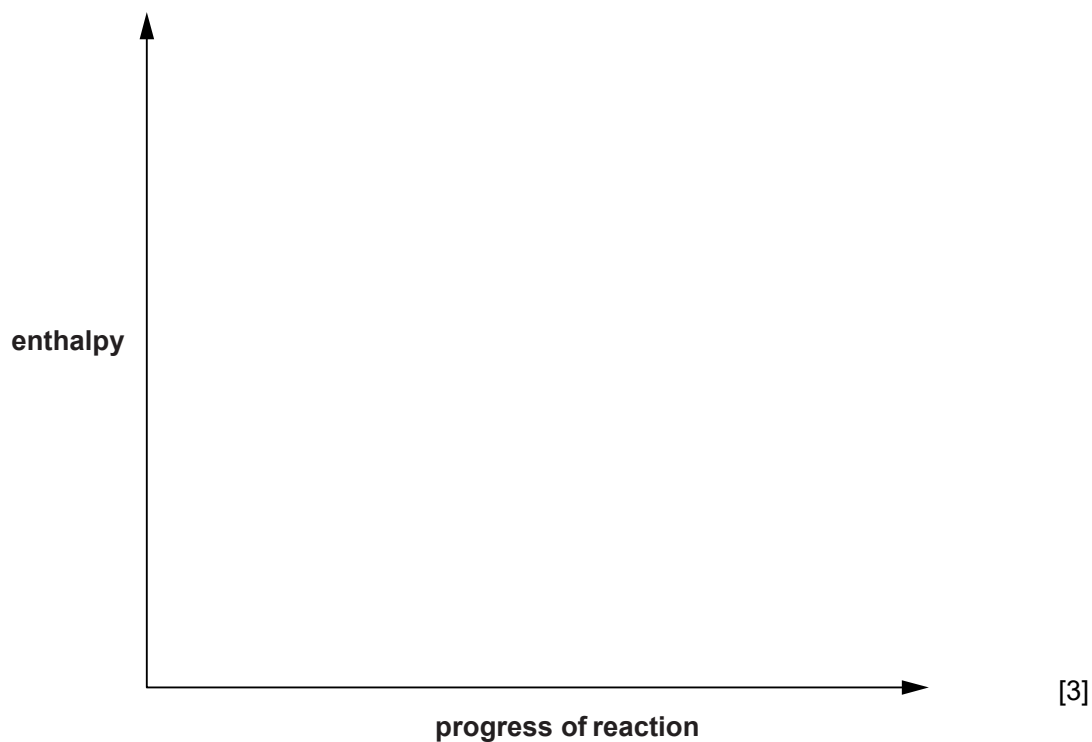
(ii) Using a Boltzmann distribution, explain how a catalyst increases the rate of a chemical reaction.

Include a labelled sketch of your Boltzmann distribution on the grid below. Label the axes and any other important features.

Your answer needs to be clear and well organised using the correct terminology.

[4]

(d)   The chemical industry uses catalysts for many of its reactions.

   (i)   State an example of a catalyst used by the chemical industry and write the equation for
         the reaction that is catalysed.   [1]

   (ii)   State **two** ways that the use of catalysts helps chemical companies to make their
          processes more sustainable and less harmful to the environment.   [2]

(e)   In the stratosphere, nitrogen oxides can catalyse the breakdown of ozone.

   (i)   State **two** sources of nitrogen oxides in the stratosphere.   [1]

   (ii)   Write equations to show how nitrogen monoxide catalyses the breakdown of ozone.   [2]

[Total 19 Marks]