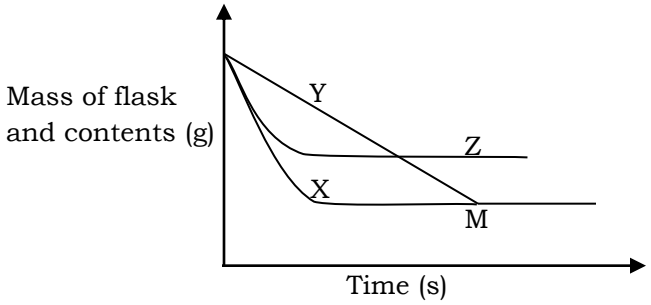
ORDINARY LEVEL CHEMISTRY PROBLEMS

PART 13: RATES OF REACTION

(1) Curve Y in the diagram below shows the results that were obtained during the investigation of the rate of reaction between iron and dilute hydrochloric acid under normal conditions. Curve X and Z were obtained when some of the conditions of the experiment were changed



(a) (i) List three conditions that were changed to obtain curve X
(ii) state what point M represents

(b) some conditions you have listed in (a) (i) were changed to obtain curve Z
(i) state the conditions changed
(ii) give a reason for your answer

(2) Sodium thiosulphate reacts with dilute acids according to the equation

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

(a) State what would be observed if dilute hydrochloric acid was added to sodium thiosulphate

(b) The rate of reaction is affected by concentration of thiosulphate
(i) State one factor other than concentration that can affect the rate of reaction
(ii) Briefly explain the effect of the factor on the rate of reaction you have named
(iii) Describe an experiment that can be carried out in the laboratory to show the effect of the factor you have named on the rate on the rate of the reaction

(c) Table below shows the variation in the concentration of sodium thiosulphate with time

Time (s)	200	100	40	20	10
Concentration of thiosulphate (moldm^3)	0.00	0.09	0.14	0.20	0.25
$\frac{1}{concentration\ of\ thiosulphate}(dm^3mol^{-1})$					

(i) Complete the table by determining the values of $\frac{1}{concentration\ of\ thiosulphate}$

(ii) Plot a graph of $\frac{1}{concentration\ of\ thiosulphate}$ against time

(iii) State any conclusion you can draw from the shape from the graph

(3) State and explain the effect of each of the following conditions on the rate of a chemical reaction
   (a) Temperature
   (b) Particle size
   (c) Concentration

(4) (a) (i) Write an equation for the reaction between dilute nitric acid and calcium carbonate
   (ii) State how temperature can affect the rate of the reaction
   (iii) Give a reason why a large surface area of calcium carbonate can speed up the rate of reaction in (a) (i)
   (b) Magnesium can react with hydrochloric acid to form hydrogen. State the conditions and write an ionic equation for the reaction
   (c) The table below shows the volumes of hydrogen evolved when various lengths of magnesium ribbon were reacted with fixed volumes of hydrochloric acid

Length of ribbon (cm)	1.0	2.0	3.0	5.0	6.0
Volume of hydrogen (cm^3/min)	2.2	3.6	5.2	9.2	10.8

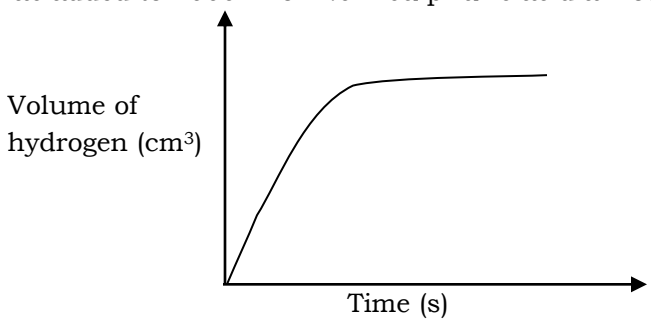
   (i) Plat a graph of volume of hydrogen against length of magnesium ribbon
   (ii) Explain the shape of the graph
   (iii) Using the graph determine the rate of the reaction if 4.0cm of magnesium ribbon was used.

(5) (a) Define the term *rate of reaction*
   (b) The table below shows the variation in volume of hydrogen evolved with time when dilute hydrochloric acid was added to excess zinc.

Volume of hydrogen (cm^3)	0	20	35	46	56	72	79	79
Time (s)	0	10	20	30	40	60	80	90

   Plot a graph of volume of hydrogen evolved against time.
   (c) Using the graph determine the time taken to collect 60cm^3 of hydrogen gas
   (d) (i) Draw tangents on your graph at points when the time is 20 60 seconds and determine the gradient
   (ii) Compare the rate of the reaction at 20 seconds and 60 seconds
   (e) Comment on the rate of the reaction after 20 seconds and 60 seconds. Explain.

(6) The graph below shows the variation of volume of hydrogen with time when excess magnesium was added to 100cm^3 of 1.0M sulphuric acid ar room temperature



(a) Calculate the number of moles of hydrogen ions contained in $100cm^3$ of
  (i) 0.5M sulphuric acid
  (ii) 1.0M sulphuric acid

(b) (i) Sketch on the same axes of the graph in the figure, the graph that would be obtained if the same mass of magnesium was added to $100cm^3$ of 0.5M sulphuric acid at room temperature
  (ii) Mark on the graphs the times when the two reactions reach completion
  (iii) Compare the time the reaction took to reach completion when 0.5M sulphuric acid was used to that when 1.0M sulphuric acid was used

(7) (a) Describe an experiment to show how surface area can affect the rate of the reaction between calcium carbonate and 2M hydrochloric acid

(b) Briefly explain why when a 4M hydrochloric acid was used instead of the 2M acid, the rate of reaction was faster

(c) State one factor other than those mentioned above than can affect the rate of the reaction between hydrochloric acid and calcium carbonate

(8) (a) What is meant by *rate of chemical reaction*

(b) State how the following factors affect the rate of a chemical reaction
  (i) Temperature
  (ii) Surface area of the reactants

(c) The table below shows the volume of hydrogen collected at various time intervals when magnesium was reacted with a 2M hydrochloric acid

Time (s)	0	1	2	3	4	5	6	7
Volume of hydrogen (cm^3)	0	25	45	60	70	75	77	77

  (i) Plot a graph of hydrogen against time
  (ii) Determine the rate of the reaction at 3s
  (iii) Determine the volume of hydrogen evolved at 3.5s

(d) State how the rate of a chemical reaction at 3s would be affected if a 1M hydrochloric acid was used

(9) When a certain volume of 0.1M hydrochloric acid was reacted at room temperature with excess iron fillings. $120cm^3$ of a gas were produced

(a) Draw a diagram to show how the rate of reaction was determined.

(b) Write equation for the reaction that took place

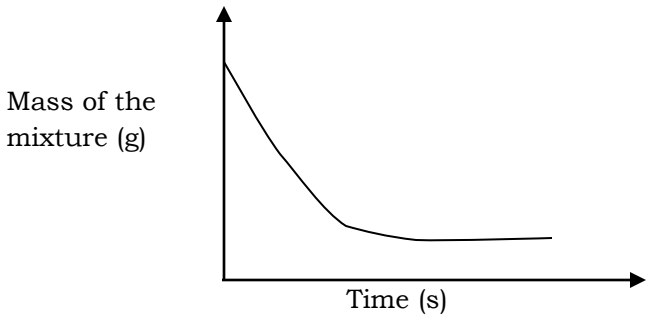
(c) Calculate the
  (i) Volume of 0.1M hydrochloric acid required to produce $120cm^3$ of the gas.
  (ii) Mass of iron filings reacted

(d) Draw a sketch graph of the volume against time.

(e) State how the rate of reaction would change if the reaction was carried out at a temperature above room temperature

(10) (a) State three factors that can affect the rate of a chemical reaction

(b) A mixture of a known mass of magnesium and a certain volume of 2M hydrochloric was put in a conical flask and the mass of the mixture was recorded at various intervals. The results of the experiment are as shown



On the same axes, draw a graph that would be obtained when the same mass of magnesium was reacted with the same volume of 1M hydrochloric acid

(c) 5.0g of calcium carbonate was reacted with 20cm^3 of 2M hydrochloric acid

(i) Write equation for the reaction

(ii) Calculate the mass of calcium carbonate that was left

(11) (a) (i) What is rate of reaction

(ii) How does particle size affect rate of reaction. Explain

(b) The table below shows the time taken for sulphur to form various concentration of thiosulphate, $S_2O_3^{2-}$, were used

Concentration of $S_2O_3^{2-}$ (M)	0.2	0.6	0.8	1.2	1.6
Time for sulphur to form (s)	60	20	15	10	7.5

Plot a graph of $\frac{1}{time}$ against concentration of $S_2O_3^{2-}$

(c) (i) explain the relationship between rate of reaction and $\frac{1}{time}$

(ii) deduce from the graph, how the rate of reaction varies with concentration of $S_2O_3^{2-}$

(12) In an experiment to determine the rate of reaction between zinc and sulphuric, dilute sulphuric acid was reacted with zinc granules to which some copper(II) sulphate solution was added. The volumes of hydrogen gas collected at various time intervals were measured. Results were as shown.

Time (minutes)	0	5	10	15	20	25	30
Volume of gas (cm^3)	0	10	20	25.5	29.5	32	32

(a) (i) What is the role of copper(II) sulphate

(ii) Write an ionic equation for the reaction

(iii) Explain what would happen if zinc granules were replaced with zinc powder

(b) (i) Plot a graph of volume of hydrogen evolved against time

(ii) Describe how you would determine the rate of reaction at 12 minutes

(iii) Compare the rates of reaction at 12 minutes with that at 20 minutes. Give a reason for your answer.

(iv) What happens to the shape of the graph after 25 minutes? Explain your answer.

(13) A certain mass of zinc powder was reacted with hydrochloric acid at room temperature.

(a) (i) Write equation for the reaction.

(ii) Draw a graph to show how

- The volume of the gaseous product varied with time
- The mass of the reaction flask and its contents varied with time.

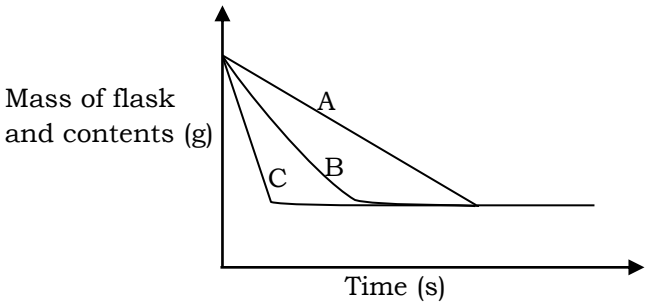
(b) What would be the effect on the rate of reaction of

(i) Adding copper(II) sulphate solution to the reaction mixture at room temperature.

(ii) Using the same mass of zinc granules instead of zinc powder

(c) Give a reason for your answer in b(i) and b(ii) above

(14) The graphs below show the effect of temperature of the rate of reaction between marble chips of the same mass and excess 2M hydrochloric acid.



(a) If curve B is for the reaction at 40°C, which curve shows the reaction taking place at

(i) 20°C

(ii) 60°C

(b) Explain why the curves eventually end at the same level

(c) State one other method that can be used to determine the rate of reaction between marble and hydrochloric acid.

(15) 8g of zinc powder was added to 50cm^3 of 1M hydrochloric acid in a conical flask.

(a) Write equation for the reaction

(b) (i) Describe how the rate of the reaction can be determined. Draw a diagram to illustrate your answer

(ii) Sketch a graph to show the rate of the reaction. Label this X

(c) In another experiment, 8g of zinc powder was added to 100cm^3 of 0.5M hydrochloric acid.

(i) Sketch a graph for the rate of reaction using the same axes in b(ii). Label this Y

(ii) Explain the shape of the two graphs

(16) Oxygen is formed from hydrogen peroxide in the presence of manganese(IV) oxide according to the equation

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

(a) In an experiment, a certain volume of hydrogen peroxide was used to prepare oxygen at room temperature. With aid of a suitable diagram, describe how the following can be determined
  (i) Volume of oxygen evolved
  (ii) The rate of evolution of oxygen

(b) (i) In another experiment, one half of the volume of hydrogen peroxide used in (a) was diluted with an equal volume of water. On the same axes, draw graphs to show the variation of the volume of oxygen with time for experiments in (a) and (b)
  (ii) Explain the differences in the shapes of the curve
  (iii) Comment of the time taken for the reactions to reach completion

(c) Oxygen produced from 200cm^3 of 0.5M hydrogen peroxide was completely reacted with magnesium. Calculate the mass of magnesium that reacted.

17. (a). Hydrogen peroxide produces gas bubbles slowly when exposed to air, but when aqueous iron(III) chloride is added, the production of bubbles becomes more rapid.
  (i). Name the gas produced when hydrogen peroxide is exposed to air
  (ii). Write the equation for the reaction that takes place
  (iii). State the role of iron(III) chloride in the reaction
  (iv). Name another substance that can affect the production pf the gas in the same way as iron(III) chloride

(b). The table below shows the variation if the concentration of hydrogen peroxide with time when a sample of hydrogen peroxide was mixed with iron(III) chloride at room temperature

$Concentration\ of\ hydrogen\ peroxide\ (moldm^{-3})$	0.05	0.10	0.15	0.20	0.25
$Time, t\ (s)$	53	26	17	13	10.5
$\frac{1}{t}(s^{-1})$					

  (i). Copy and complete the table above by computing and filling in the values of $\frac{1}{t}$
  (ii). Plot a graph of $\frac{1}{t}$ against concentration of hydrogen peroxide
  (iii). Using your graph, deduce how the rate of reaction varies with the concentration of hydrogen peroxide
  (iv). Determine the slope of the graph
  (v). State **two** ways by which the rate of the reaction in (b) could be made faster.

END