REACTION RATES & REVERSIBLE REACTIONS

KCSE QUICK REVISION

Compilation of Possible Questions in Chemistry Likely to be Examined in KCSE.

A Special Analysis of Prediction Questions that may be Tested in KCSE from this Topic in Form 4.

CHEMISTRY

SERIES 1

For Marking Schemes

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REACTION RATES & REVERSIBLE REACTIONS

1. Study the following equilibrium reaction and answer the questions that follow:-

$HL_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+(aq)\ L^-(aq)$

Given that in an acid solution, $H_3O^+_{(aq)}$ act in place of hydrogen ions, H^+, according to the equation.

$H_3O_{(aq)} + OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$

Explain what would be observed when potassium hydroxide solution is added to the above equilibrium mixture

2. The scheme below shows the energy changes that take place between ice, water and steam.Study it and answer the questions that follow:-

$$H_2O_{(s)} \underset{\Delta H_4}{\overset{\Delta H_1}{\rightleftharpoons}} H_2O_{(l)} \underset{\Delta H_3}{\overset{\Delta H_2}{\rightleftharpoons}} H_2O_{(g)}$$

(a) What name is given to the energy change ⍰H_4?

(b) What is the sign ⍰H_3, give a reason

3. The table below gives bond energies for three covalent bonds

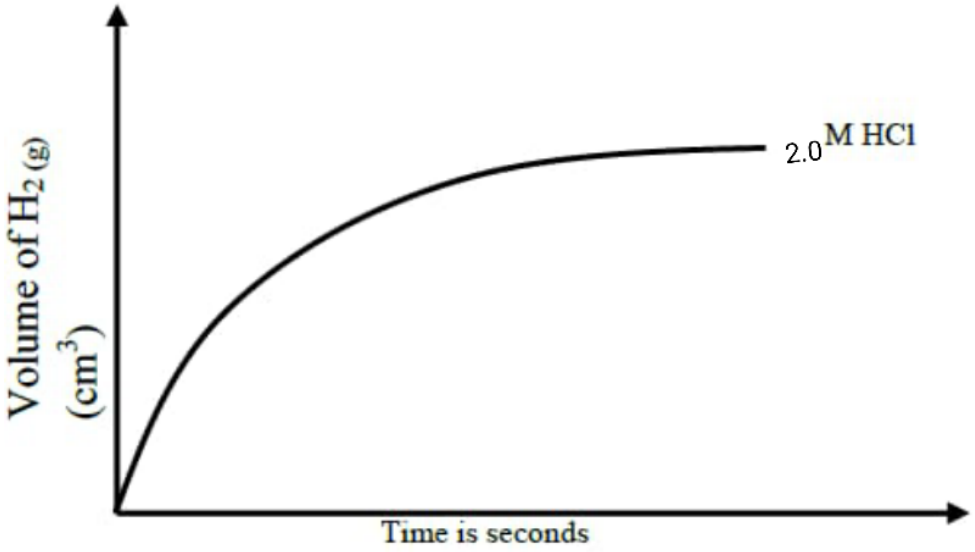
Bond	**Bond energy (KJmol-1)**
H –H	435
Cl – Cl	240
H – Cl	430

(a) Calculate the energy change for the following reaction:

$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

(b) Sketch an energy level diagram for the reaction in **(a)** above

4. The sketch below was obtained when 2g of magnesium was reacted with excess of 2M hydrochloric acid. The volume of hydrogen evolved was then plotted against time as shown below:



(a) On the same axis plot the graph that would be obtained if 1M hydrochloric acid was used instead of 2M hydrochloric acid. Explain

(b) Explain the significance of the flat portion **BC** of the curve

5. In a closed system an equilibrium exists between Nitrogen (IV) Oxide and dinitrogen tetraoxide as shown in the equation below:

$$N_2O_{4\,(g)} \rightarrow 2NO_{2\,(g)};\ \Delta H = +27.5KJ$$

(a) State and explain the observation when a glass syringe containing the equilibrium mixture is immersed in ice-cold water

[b] If the piston of the syringe is pushed, state the effect on the position of the equilibrium

6. The table below gives the volumes of the gas produced when different volumes of 2M hydrochloric acid were reacted with 1.0g of a lump of an alloy of Magnessium and copper at room temperature

Volume of 2M hydrochloric acid (cm^3)	**Volume of gas (cm^3)**
0	0
10	240
20	480
30	600
40	600
50	600

(a) Write an equation for the reaction that occurred

(b) On the grid provided below, plot a graph of the volume of the gas produced (verticalaxis) against the volume of acid added (Note that before the reaction comes to completion, the volume of the gas produced is directly proportional to the volume of the acid added)

(c) From the graph, determine:

(i) The volume of the gas produced if 13.0cm^3 of 2M hydrochloric acid had been used

(ii) The volume of 2M hydrochloric acid required for the reaction to go to completion

(d) State and explain the effect on the rate of production of the gas if:

(i) 1.0g of the lump of the alloy were replaced by 1.0g powder of the alloy

(ii) The reaction was carried out at 35^oC.

7. In a series of experiments in which magnesium ribbon of uniform width reacted with 2.0M .ydrochloric acid, the rates of evolution of hydrogen gas were found to be as follows:-

Length of ribbon (cm	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Rate of Evolution of hydrogen (cm^3/min)	1.1	1.8	2.7	3.6	4.6	5.4	6.1

(I) (a) Draw a graph of rate of evolution of hydrogen gas against length of ribbon

(b) What conclusion can you make from this graph? *

(c) Determine the rate of evolution of hydrogen gas from a piece of magnesium ribbon 12cm long under the same conditions

(d) With dotted line, sketch on the same axis the graph that would be obtained if all the ribbons were ground into powder *

8. A typical electrolysis cell uses a current of 40,000 amperes. Calculate the mass (in Kg of aluminium produced in one hour). (Al = 27) (Faraday = 96500Coloumbs)

9. The table below shows the volumes of nitrogen (IV) oxide gas produced when different volumes of 1M nitric acid were each reacted with 0.635g of copper at room temperature.

Volume of 1M nitric acid (cm^3)	**Volume of Nitrogen (IV) oxide gas(cm^3)**
5	60
15	180
25	300
35	420
45	480
55	480

a) Give a reason why hydrochloric acid can not be used instead of nitric acid

b) Explain how the rate of the reaction between copper and nitric acid would be affecte if the temperature of the reaction mixture was raised

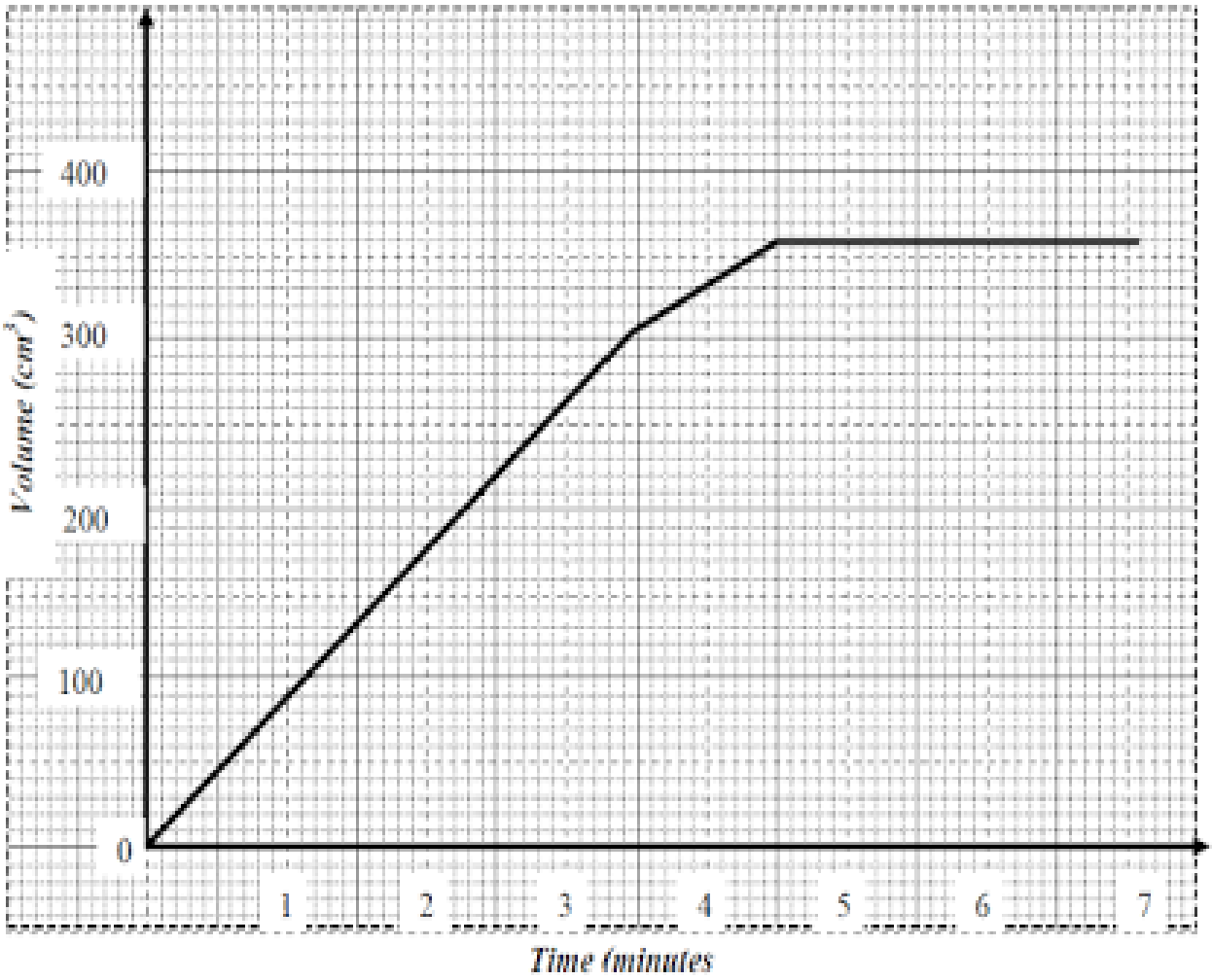
On the grid provided below, plot a graph of the volume of the gas produced (vertical axis)against volume of acid

d) Using the graph, determine the volume of:

(i) Nitrogen (IV) oxide produced when $30cm^3$ of 1M nitric acid were reacted with 0.635g of copper

(ii) 1M nitric acid which would react completely with 0.635g of copper

10. The graph below represents the volume of gas collected against time when dilute sulphuric acid is reacted with Zinc granules:-



(a) Determine the rate of reaction between the 1st and 3rd minute

(b) When did the reaction stop?

(c) Give a possible reason for the reaction to stop

11. The equation below represents a reaction that takes place in an industrial process

$4NH_{3(g)} + 5O_{2(g)} \rightarrow 6H_2O_{(g)} + 4NO_{(g)}$

(a) Name the catalyst used

(b) What are the other conditions for the reaction?

(c) Why are the products cooled before being oxidised?

12. Nitrogen reacts with hydrogen according to the equation below:-

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ ⍰H = -92KJ

(a) How would the yield of ammonia be affected by increase in :-

(i) Pressure

(ii) temperature

(b) The ammonia produced is isolated form the other gases from time to time. How does this affect the equilibrium?

13. Explain how you would obtain an insoluble salt XSO_4 when you are provided with the following :-

(i) Distilled water

(ii) Solid YSO_4 which is soluble in water

(iii) Solid salt $X(NO_3)_2$

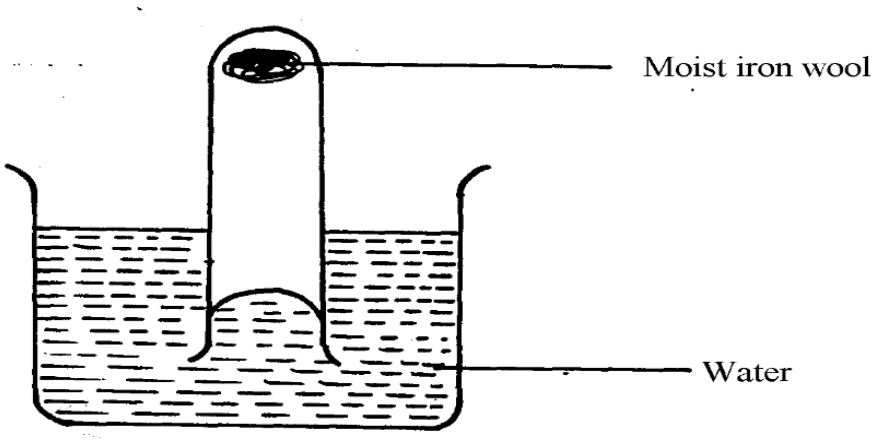
14. Metal **R** and **S** were used to form a cell. The following half equations show the standard electrode potentials of the half cells. (**R** and **S** are not actual symbols of the element)

$R^{2+} + 2e^- \rightarrow R_{(s)}$ $\quad E^\ominus = -2.04V$

$S^{2+}_{(aq)} + 2e^- \rightarrow S_{(s)}$ $\quad E^\ominus = -0.47V$

Write the full equation for the cell and calculate the e.m.f

15. The apparatus below were used to study the properties of air



(a) State **two** observations made at the end of the experiment

(b) Give **one** simple method that can be used to prevent rusting

16. Equal volumes of 1M monobasic acids **K** and **L** were each reacted with excess zinc granules.The table below shows the volumes of the gas produced after two minutes

Acid	Volume of gas (cm^3)
K	40
L	100

(a) Explain the difference in the volumes of the gas produced

(b) How can the production of the gas be increased?

17. The following is a thermochemical equation for the reaction between hydrogen and oxygen

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$ $\Delta H = -287kJmol^{-1}$

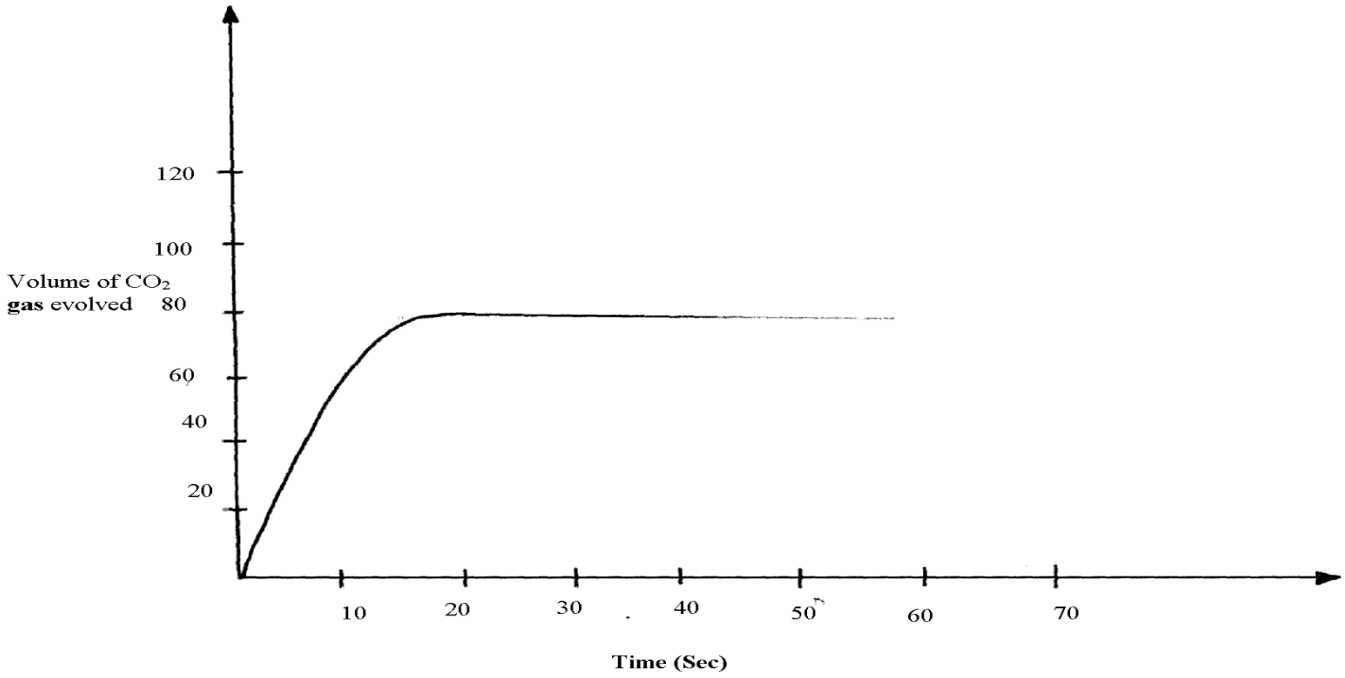
Calculate the bond energy between the elements in water given that:

O = O = $+496kJmol^{-1}$ H-H = $+ 435kJmol^{-1}$

18. $AgClO_{2(s)} \rightarrow Ag_{(s)} + ½ Cl_{2(g)} + O_{2(g)}$ $\Delta H = 0.00KJ/mol$

What is the effect on the position of equilibrium of the above system if temperature is decreased? Give a reason

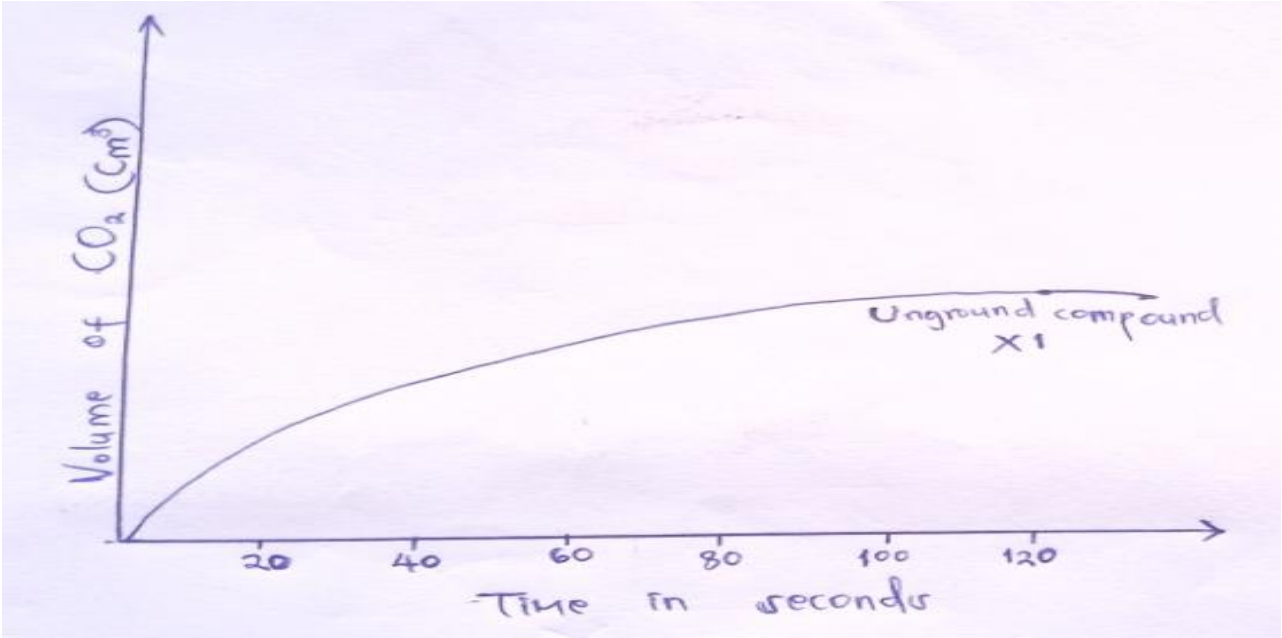
19. Sodium carbonate was reacted with dilute sulphuric (VI) acid at 25°C. The volume of carbon (IV) Oxide gas liberated was recorded at 10seconds interval. Below is a graph of the volume of carbon (IV) Oxide gas evolved against time.



(a) On the same axes, sketch the curve labelled **V** that would be obtained if Barium carbonate was used instead of sodium carbonate. (All conditions remain constant)

20. (a) What is meant by activation energy?

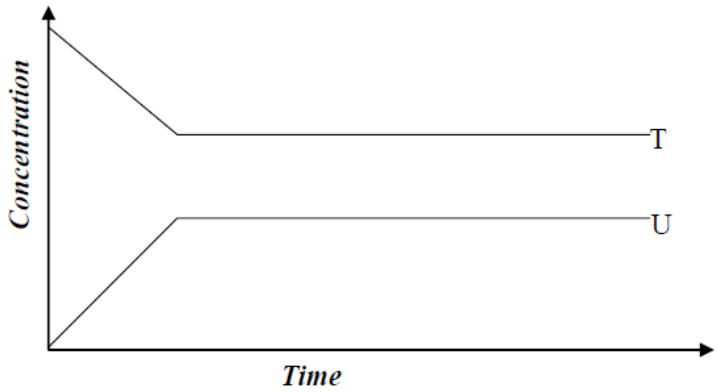
(b) A certain mass of unground compound X1 reacted with excess dilute hydrochloric acid. The volume of carbon (IV) oxide gas liberated was measured after every 20 seconds. The results were presented as shown in the graph below:-



(i) On the same axis, sketch the curve that would be obtained if the experiment was repeated using ground compound X1

(ii) Explain the shape of your curve in **(b) (i)** above

22. The sketch below shows the rate at which substance T is converted into U. Study it and answer the questions that follows:-



When the equilibrium has been established the two curves become horizontal after sometime. Explain the effect of the amount of the two reactants and products

23. Elements **A, B, C**, and **D** are not actual symbols, have atomic numbers **19, 9, 12** and **10** respectively.

(a) Which **two** elements represent non-metals

(b) Write the formula of the compound formed between elements **B** and **C** and identify the bond present in the compound

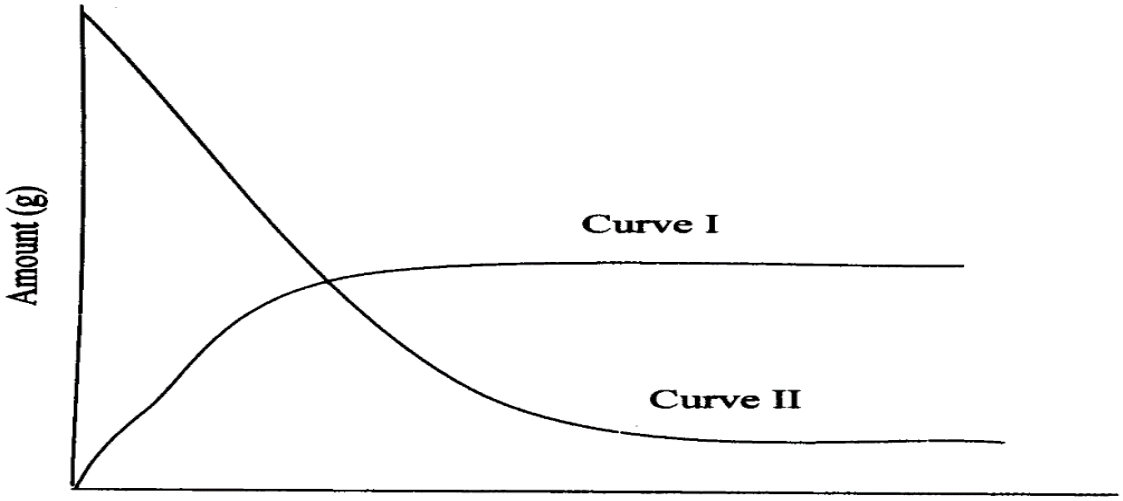
24. An equilibrium is established between nitrogen tetra -oxide and nitrogen (IV) oxide as shown below:State and explain what happens when temperature is increased

$N_2O_{4(l)} \rightarrow 2NO_{2(g)}$

Pale yellow Red-brown fumes

25. The graph below shows the amount of calcium carbonate and calcium chloride varying with time in the reactions:

$CaCO_{3\,(s)} + 2HCl_{\,(aq)} \rightarrow CaCl_{2\,(aq)} + H_2O_{\,(g)} + CO_{2\,(g)}$



(a) Which curve shows the amount of calcium chloride varying with time? (lmk)

(b) Explain why the two curves become horizontal after a given period of time. (lmk)

(c) Sketch on the graph how curve II would appear if the experiment was repeated using a more dilute hydrochloric acid solution

26 State the effect on the equilibrium when;

a) Pressure is increased

b) Oxygen gas is added

An equilibrium is established between CrO_4 and H^+ ions as shown below:

$2CrO_{4\,(aq)}^{2-} + 2H^+_{(aq)} \rightarrow Cr_2O_{7(aq)}^{2-} + H_2O_{(l)}$

(Yellow) (Orange)

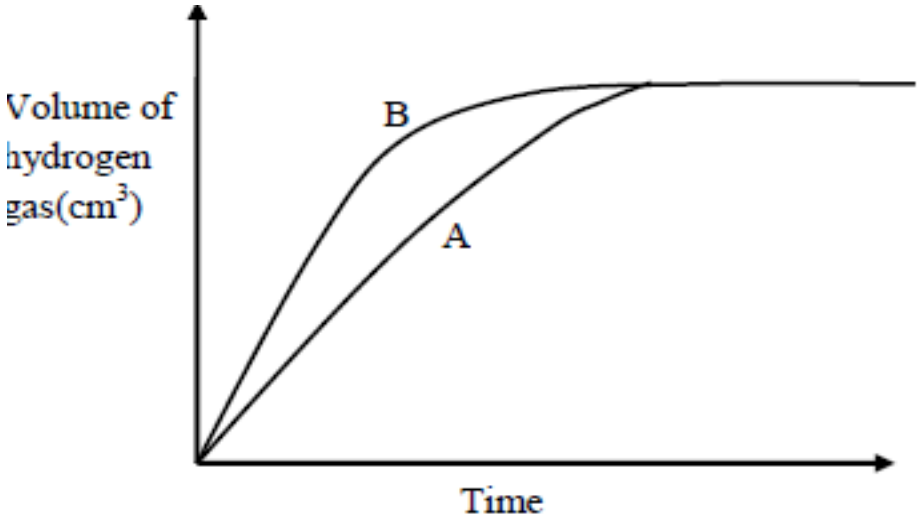
27. State and explain and explain the observation made when aqueous sodium hydroxide is added to the equilibrium mixture

28. Two experiments were carried out as follows and the volume of hydrogen gas evolved measured at intervals of 10seconds for 100seconds.

(i) 8cm of magnesium ribbon was added to 1M hydrochloric acid

(ii) 8cm of magnesium ribbon was added to 0.5M hydrochloric acid

Graphs of volume of hydrogen evolved against time were plotted



(a) Which of the graph was obtained for reaction (i) above? Explain

(b) Explain the general shape of the graph

29. Bromine dissolves in water forming a brown solution, according to the dynamic equation below.

$Br_{2\,(aq)} + H_2O_{\,(l)} \rightarrow 2H^+_{\,(aq)} + Br^-_{(aq)} + OBr^-_{(aq)}$

State and explain the observation that could be made if a solution of sodium hydroxide is added to the system

For Marking Schemes/Answers

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