THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATTION EXAMINATION

732/2A **CHEMISTRY 2A**

(PRACTICAL A)

Time: 3 Hours **ANSWERS** **Year: 2020**

Instructions.

1. This paper consists of **three (3)** questions.
2. Answer **all** questions
3. Question number 1 carries 20 marks and the rest carry 30 marks.
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

1. You are provided with a solution of 10.6 g anhydrous sodium carbonate in 2 litres, labelled SS and another solution of sulphuric acid of unknown concentration, labelled AA. You are also given Methyl orange (MO).

(a) Perform titrations procedure to determine the volume of sulphuric acid used for neutralisation.

Answer

Using a pipette, measure 25.0 cm^3 of SS (sodium carbonate solution) into a conical flask. Add 2–3 drops of methyl orange indicator. Fill a burette with the sulphuric acid solution (AA). Titrate by adding AA from the burette to the SS in the flask while swirling until the indicator changes colour from yellow to orange-pink, indicating the end point. Note the burette readings. Repeat the procedure to get at least two concordant results.

(b) Record your results in a suitable table of titration results.

Answer

Titration	**Final burette reading (cm^3)**	**Initial burette reading (cm^3)**	**Volume of AA used (cm^3)**
1	24.80	0.00	24.80
2	24.70	0.00	24.70
3	24.80	0.00	24.80

(c) Comment on the colour change.

Answer

The methyl orange indicator changes from yellow in alkaline solution to orange-pink at the end point when all carbonate has been neutralised by sulphuric acid.

(d) Write a balanced chemical equation for the reaction taking place in the experiment.

Answer

$Na_2CO_3(aq) + H_2SO_4(aq) \text{-----> } Na_2SO_4(aq) + CO_2(g) + H_2O(l)$

(e) State the mole ratio SS:

Answer

The mole ratio of sodium carbonate to sulphuric acid is 1:1.

(f) What mass in grams of sulphuric acid is present in one litre of the acid solution?

Answer

First, calculate molarity of sodium carbonate:

Molar mass of $Na_2CO_3 = (23\times2) + 12 + (16\times3) = 106$ g/mol
Given 10.6 g in 2 litres:

Molarity of SS = (10.6 g / 106 g/mol) ÷ 2 L = 0.05 M

From titration:

$M_1V_1 = M_2V_2$
$(0.05\ mol/dm^3 \times 25.0\ cm^3) = M_2 \times 24.80\ cm^3$
$M_2 = (0.05 \times 25.0) / 24.80$
$M_2 = 0.0504\ mol/dm^3$

Mass of H_2SO_4 in 1 litre = Molarity × Molar mass
= 0.0504 × 98
= 4.939 g

Therefore, 4.94 g of sulphuric acid is present in one litre.

(g) What volume of sulphuric acid is required to complete neutralization, if the concentration of acid is 0.05 moles/l?

Answer

From $M_1V_1 = M_2V_2$
$(0.05\ mol/dm^3 \times 25.0\ cm^3) = (0.05\ mol/dm^3) \times V_2$
$V_2 = 25.0\ cm^3$

Therefore, 25.0 cm^3 of 0.05 M sulphuric acid is required.

2. You are provided with solutions TT (0.22 M $Na_2S_2O_3$) and HH (0.15 M HCl). You are also given distilled water, stop watch/clock and a sheet of white A4 paper marked 'X'.

Table 1: Experimental data

Expt	**$S_2O_3^{2-}$ (cm^3)**	**H_2O (cm^3)**	**HCl (cm^3)**	**Time, t (sec)**	**1/t (sec^{-1})**
A	2	8	10	130	0.00769
B	4	6	10	70	0.01429
C	6	4	10	50	0.02000
D	8	2	10	38	0.02632

(a) Complete Table 1 with appropriate data.

(b) If the rate expression is
$R = k[S_2O_3^{2-}]^a\ [H^+]^b$,
calculate the value of a. Take volume of solution as its concentration.

Answer

Since total volume is constant (20 cm^3), the concentration is proportional to the volume of $Na_2S_2O_3$ used.

Choose two experiments (say A and B):

Rate ratio = $(R_2 / R_1) = ([S_2O_3^{2-}]_2 / [S_2O_3^{2-}]_1)^a$

0.01429 / 0.00769 = (4 / 2)^a
1.858 = 2^a
a = log(1.858) / log(2)
a ≈ 0.270 / 0.301
a ≈ 0.90

Therefore, a ≈ 1

(c) Given the value of b = 2, find the value of K.

Answer

Use experiment A:

$R = k[S_2O_3^{2-}]^a [H^+]^b$

$R = 0.00769\ s^{-1}$
$[S_2O_3^{2-}] = 2\ cm^3 / 20\ cm^3 = 0.1$
$[H^+] = 10\ cm^3 / 20\ cm^3 = 0.5$

Substitute:

$0.00769 = k \times (0.1)^1 \times (0.5)^2$
$0.00769 = k \times 0.1 \times 0.25$
$0.00769 = k \times 0.025$
$k = 0.00769 / 0.025$
$k = 0.3076\ s^{-1}$

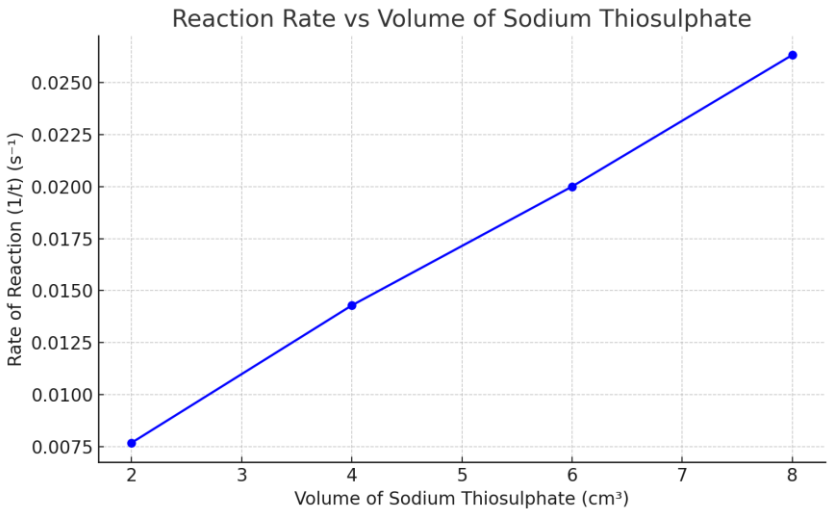
(d) Write the ionic equation for the reaction taking place in this experiment.

Answer

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

(e) Plot a graph of R (vertical axis) against the volume of sodium thiosulphate (horizontal axis).

Answer



(f) Based on the nature of the graph in (e), suggest the order of reaction with respect to sodium thiosulphate.

Answer

The graph is a straight line passing through the origin, indicating the reaction is first order with respect to sodium thiosulphate.

3. You are given sample Z which contains one cation and one anion. Carry out qualitative analysis to identify the cation and anion present in Z based on the tests given in Table 2.

Table 2: Experimental Observation and Inferences.

S/N	Experiment	Observation	Inference
(a)	Observe the appearance of sample Z.	White crystalline solid	Could be a soluble salt
(b)	Dissolve a spatula end full of sample Z in distilled water and shake well. Divide the solution into four portions.	Soluble, clear colourless solution formed	Soluble salt
(c)	To the first portion, add conc. H_2SO_4.	Effervescence with a gas that turns limewater milky	Presence of CO_3^{2-}
(d)	To the second portion, add $FeSO_4$ then conc. H_2SO_4 down the side.	Brown ring formed at the junction	Presence of NO_3^-
(e)	To the third portion, add dilute NaOH dropwise till in excess.	White precipitate, soluble in excess NaOH	Presence of Zn^{2+}
(f)	To the fourth portion, add dilute NH_4OH dropwise till in excess.	White precipitate, soluble in excess NH_4OH	Confirming Zn^{2+}

(a) Complete the table with appropriate information.

(b) Give the name and chemical formula of the cation in Z.

Answer

Cation: Zinc ion
Formula: Zn^{2+}

(c) Write down the chemical formula of Z.

Zinc nitrate
Formula: $Zn(NO_3)_2$