THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2 **CHEMISTRY 2**

ALTERNATIVE TO PRACTICAL

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: January 1999**

Instructions

1. This paper consists of five questions. Answer all questions.

2. Each question carries 10 marks

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1. Give the name and one use of the following pieces of apparatus labeled A, B, C, D, E, F, G, H, I, and J.

A - Retort stand, used to hold apparatus in place during experiments.
B - Test tube, used to hold small amounts of liquids or solids for heating or reactions.
C - Burette, used in titration experiments to measure precise volumes of liquids.
D - Measuring cylinder, used to measure liquid volumes accurately.
E - Beaker, used to hold and mix chemicals.
F - Dropper, used to transfer small amounts of liquids.
G - Round-bottom flask, used for heating or boiling liquids.
H - Conical flask, used for titrations and mixing chemicals.
I - Flat-bottom flask, used for heating substances evenly.
J - Separating funnel, used to separate immiscible liquids.

2. In a titration experiment, 1M H_2SO_4 (sulphuric acid) and NaOH (sodium hydroxide) gave the following results:

Burette readings/cm^3	PILOT	1	2	3
Final reading	14.00	26.60	39.00	42.50
Initial reading	1.00	14.00	26.60	30.00
Titre volume	13.00	12.60	12.40	12.50

(a) Complete the table by filling in the third value in each column.
Table completed as shown.

(b) Calculate the mean titre of this experiment.
Mean titre = (12.60 + 12.40 + 12.50) / 3 = 12.50 cm^3

(c) Write a balanced chemical equation for the reaction which took place.
$H_2SO_4 + 2NaOH \text{ ----> } Na_2SO_4 + 2H_2O$

(d) What is the acid to base ratio?
From the reaction equation, the acid-to-base ratio is 1:2.

(e) Calculate the molarity of sodium hydroxide and its concentration in g/dm^3.
Moles of H_2SO_4 used = 1 × (12.50 / 1000) = 0.0125 moles
Since the ratio of H_2SO_4 to NaOH is 1:2,
Moles of NaOH = 0.0125 × 2 = 0.025 moles
Molarity of NaOH = moles/volume in dm^3
= 0.025 / (25 / 1000)
= 1M

Concentration in g/dm^3 = Molarity × Molar mass of NaOH

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$= 1 \times 40$
$= 40\ g/dm^3$

3. (a) What is a redox reaction?
A reaction where oxidation (loss of electrons) and reduction (gain of electrons) occur simultaneously.

(b) In a certain experiment when powdered zinc was added to copper(II) sulfate, the following happened: Copper ions were reduced to a red-brown deposit of copper, and zinc dissolved to form a solution.

(i) Write a simple equation for the reaction above.
$Zn + CuSO_4$ -----> $ZnSO_4 + Cu$

(ii) Write the half equation representing oxidation (LEO).
Zn --> $Zn^{2+} + 2e^-$

(iii) Write the half equation representing reduction (GER).
$Cu^{2+} + 2e^-$ ----> Cu

(iv) Write the overall ionic equation for the reaction.
$Zn + Cu^{2+}$ ----> $Zn^{2+} + Cu$

(c) Certain features of the element vanadium, V, are represented in the figure below. Study the diagram and then answer the questions which follow.

(i) What is the oxidation number of vanadium in compounds A, B, C, D, E, F, G, and H?
A (VO_2^+) = +5
B (VCl_4) = +4
C (K_2VCl_6) = +3
D (VBr_3) = +3
E ($V(NH_3)_6Br_3$) = +3
F (VF_5) = +5
G (V_2O_5) = +5
H (Na_3VO_4) = +5

(ii) What can you deduce about the oxidizing power of the halogens towards vanadium?
The higher oxidation states of vanadium (e.g., +5 in VF_5) indicate that fluorine is the strongest oxidizing agent, followed by chlorine and bromine. The halogens oxidize vanadium to lower oxidation states in the order: $F_2 > Cl_2 > Br_2$.

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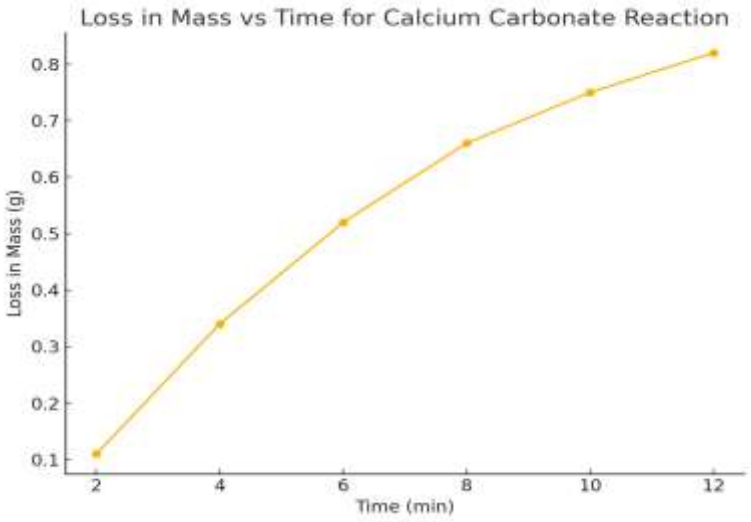
4. A sample of 2.0 g of calcium carbonate and 25 cm^3 (excess) of 2.0 M nitric acid were mixed, and the loss of mass recorded at various time intervals as follows.

Time (min)	2	4	6	8	10	12
Loss in mass (g)	0.11	0.34	0.52	0.66	0.75	0.82

The maximum loss was 0.87 g.

(a) Plot a suitable graph for this data, showing clearly that the rate of reaction was quickest during the 2nd up to the 4th minute interval.



(b) From the reaction equation, calculate the mass of carbon dioxide evolved.
Equation: $CaCO_3 + 2HNO_3 \dashrightarrow Ca(NO_3)_2 + CO_2 + H_2O$
Mass of CO_2 evolved = Maximum mass loss = 0.87 g

(c) The equation for the dissociation of calcium carbonate is
$CaCO_3 \rightleftharpoons CaO + CO_2$ $\Delta H = +175.5$ kJ/mol

(i) Increasing the temperature
Since the reaction is endothermic, increasing the temperature will shift equilibrium to the right, increasing the decomposition of calcium carbonate and decreasing its proportion in the mixture.

(ii) Increasing the pressure
Since the reaction produces a gas (CO_2), increasing pressure will shift equilibrium to the left, reducing decomposition and increasing the proportion of calcium carbonate.

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(d) What conditions would be suitable for manufacturing calcium oxide from calcium carbonate on a large scale?
High temperature and low pressure to favor decomposition.

5. An unknown sample N containing one anion and one cation was analyzed by performing the experiments illustrated in the table below. Complete the table and identify the cation, anion, and compound N.

Experiment	Observation	Inference
(a) Appearance of sample N held in air	White powder	The salt is a white solid.
(b) Sample N was heated	Odorless, colorless gas which turned blue litmus paper pale red was given off.	Presence of CO_2 gas, indicating a carbonate compound.
(c) Sample N was dissolved in distilled water, and in dilute HCl	Sample N was insoluble in water but dissolved in dilute HCl with strong effervescence of odorless, colorless acidic gas which turned lime water milky.	Confirms the presence of carbonate (CO_3^{2-}) ions.
(d) Sample N was dissolved in nitric acid to become an original solution (O.S.). To O.S., sodium hydroxide solution was added dropwise and then in excess.	White precipitate insoluble in excess NaOH (aq) was observed.	Indicates the presence of calcium (Ca^{2+}) ions.
(e) To O.S., ammonium chloride solution was added, followed by ammonium hydroxide solution drop by drop.	White precipitate	Confirms Ca^{2+} ions.
(f) To original solution, ammonium oxalate was added.	White precipitate	Confirms calcium ions.
(g) To O.S., dilute sulfuric acid was added.	White precipitate	Indicates sulfate or carbonate presence.
(h) Flame test on sample N	It burned with brick-red coloration.	Confirms calcium ions.

The cation is calcium (Ca^{2+}).
The anion is carbonate (CO_3^{2-}).
Compound N is calcium carbonate ($CaCO_3$).

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