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: 2015**

Instructions

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

2. Each question carries 10 marks

1. The following diagram represents the experimental set up for demonstrating the preparation and burning of hydrogen in air. Study the diagram and then answer the questions that follow:

(a) What do the letters A, B, C, D, E, F, G and H represent?

A – Thistle funnel
B – Round-bottom flask containing the acid and metal
C – U-tube containing drying agent (e.g., calcium chloride)
D – Delivery tube
E – Water trough
F – Gas jar collecting hydrogen gas
G – Burning splint
H – Source of hydrogen gas (reaction of acid with metal)

(b) What is the function of compound C?

Compound C is a drying agent used to remove moisture from the hydrogen gas before it is collected in the gas jar.

(c) With state symbols, write a balanced chemical equation which represents the reaction which leads to the production of hydrogen.

$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

(d) Write a balanced chemical equation for the combustion reaction.

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$

2. In a volumetric analysis practical class, solution MM of H_2Q acid was made by dissolving 11.25 g of the acid in 1.00 dm^3 and solution NN of sodium hydroxide containing 4.92 g/dm^3 were used. The results of the experiment were recorded as follows:

The volume of the pipette used was 25 cm^3 and solution MM was in the burette.

(a) Complete Table 1 by filling in the blanks.

The completed table is as follows:

Titration	Pilot	1	2	3
Final reading (cm^3)	13.00	25.50	12.50	12.50
Initial reading (cm^3)	0.00	13.00	25.50	0.00
Volume used (cm^3)	13.00	12.50	12.50	12.50

(b) Write the balanced chemical equation for the reaction between solution MM and NN.

$H_2Q + 2NaOH \text{ ----> } Na_2Q + 2H_2O$

(c) Showing your procedures clearly, determine the molar mass of H_2Q.

Given that 11.25 g of H_2Q was dissolved in 1.00 dm^3 of solution, the concentration of H_2Q is:
Concentration of H_2Q = 11.25 g / 1.00 dm^3 = 11.25 g/dm^3

Since 25.0 cm^3 of sodium hydroxide (NN) was used, its number of moles is:
Moles of NaOH = (4.92 g/dm^3 × 25.0 cm^3) / (40 g/mol × 1000 cm^3)
= (4.92 × 0.025) / 40
= 0.003075 moles

From the balanced equation, 2 moles of NaOH react with 1 mole of H_2Q, so:

Moles of H_2Q = 0.003075 / 2
= 0.0015375 moles

Since the volume of H_2Q used is 25 cm^3, the concentration of H_2Q is:

Concentration of H_2Q = 0.0015375 moles / 0.0125 dm^3
= 0.123 $moles/dm^3$

Since the given concentration of H_2Q in the full solution is 11.25 g/dm^3, the molar mass of H_2Q is:

Molar mass = 11.25 g/dm^3 / 0.123 $moles/dm^3$
= 91.46 g/mol

3. The following results were obtained by a student during the electrolysis of 450 cm^3 aqueous solution of copper (II) sulphate using carbon electrodes.

Table 2

Volume of oxygen gas liberated at STP (dm^3)	Number of coulombs passed
0.92	2,000
1.84	4,000
2.76	6,000
3.68	8,000
4.60	10,000
5.52	12,000

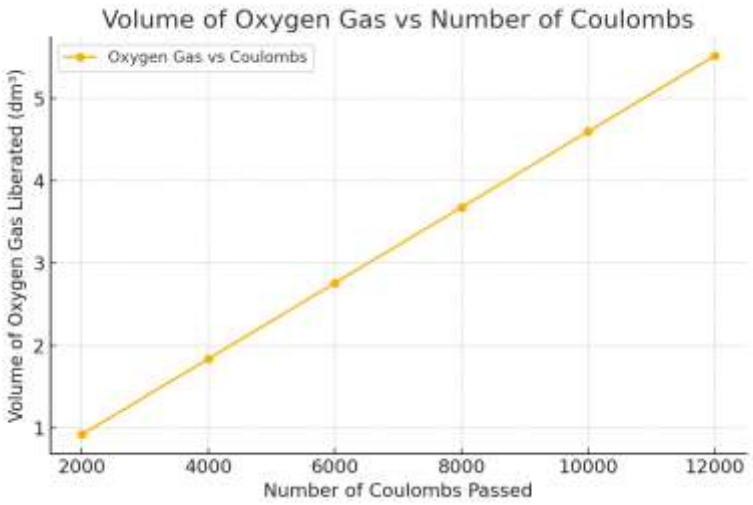
Questions:
(a) Write the ionic equation to represent the reaction at the electrodes.

At the anode:
$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

At the cathode:
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(b)

(i) Plot the graph of volume of oxygen gas (y-axis) against the number of coulombs passed (x-axis).



(ii) Explain the shape of the graph obtained in 3 (b) (i).
The graph is a straight line passing through the origin, showing a direct proportionality between the volume of oxygen gas liberated and the number of coulombs passed. This is expected because, according to Faraday's laws of electrolysis, the amount of substance liberated at an electrode is directly proportional to the quantity of electricity passed.
(iii) From the graph deduce the volume of oxygen gas liberated by 500 coulombs.

From the graph equation, the ratio is:
Volume of O_2 / Number of coulombs = 0.92 dm^3 / 2000 C = 0.00046 dm^3 per coulomb

For 500 C:
Volume = 500 × 0.00046 = 0.23 dm^3

(c) Suggest two ways for checking the reliability of the experimental results.

The experiment can be repeated several times and the average results taken to minimize errors. Using more precise measuring instruments such as a gas syringe instead of a measuring cylinder can improve accuracy.

4. The set apparatus below shows the experimental determination of the loss in mass during the reaction between 20.0 g of marble ($CaCO_3$) pieces (in excess) and 30.0 cm^3 of 1.2 M hydrochloric acid.

Table 3

Time/s	Experiment 1 Mass/g	Total loss in mass/g	Experiment 2 Mass/g	Total loss in mass/g
0	90.90	0.00	90.90	0.00
30	90.62	0.28	90.42	0.48
60	90.42	0.48	90.23	0.67
90	90.27	0.63	90.14	0.76
120	90.17	0.73	90.10	0.80
150	90.10	0.80	90.10	0.80
180	90.10	0.80	90.10	0.80

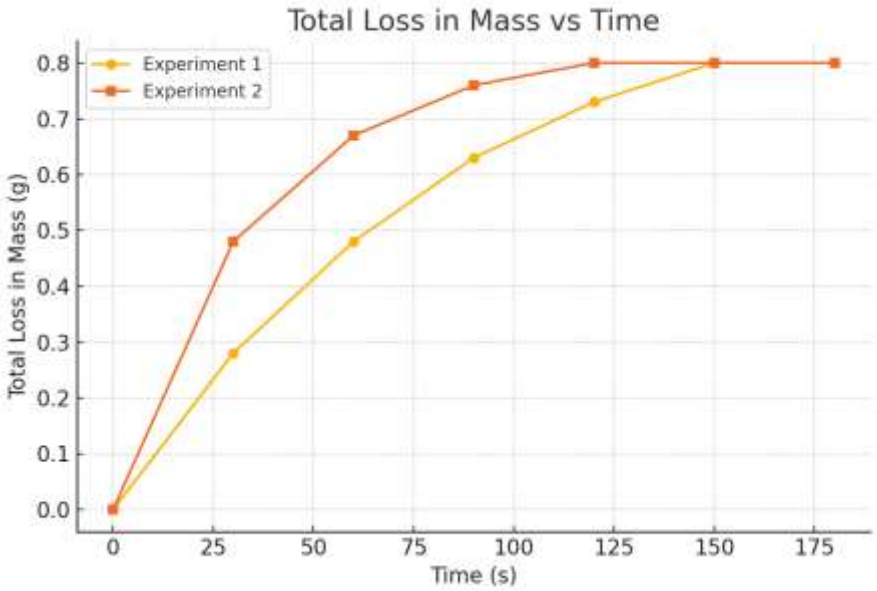
Questions:
(a) Complete Table 3 by calculating the total loss in mass for both experiments.

(b)(i) Explain why the decrease in mass of the contents in the flask occurs during the reaction.

The decrease in mass occurs due to the release of carbon dioxide gas (CO_2) as calcium carbonate reacts with hydrochloric acid according to the reaction:
$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$
As CO_2 escapes, the total mass of the system decreases.

(ii) Explain why the last two results in the first experiment and the last three in the second experiment were the same.
In both experiments, the reaction reached completion, meaning all the available hydrochloric acid reacted, leaving only the unreacted excess marble. At this point, no more CO_2 was produced, and the mass remained constant.

(c) On the same axes, plot the graphs of total loss in mass against time for the two experiments.



(d)(i) Use your graphs to determine the loss in mass in the first experiment after 75 seconds.

From the graph, the loss in mass in the first experiment at 75 seconds is approximately 0.55 g.

(ii) Use your graphs to determine the mass left in the second experiment after 45 seconds.
From the graph, the mass left in the second experiment at 45 seconds is approximately 90.32 g.

(e) Compare the two curves and deduce the effect of using powdered marble in the second experiment.
The second experiment shows a steeper curve, indicating a faster rate of reaction. This suggests that using powdered marble increases the surface area, allowing more frequent collisions between acid molecules and marble particles, leading to a faster reaction rate.
5. Table 4 shows the tests a student did on compound P. Complete the table by adding the inference for test (a), the observations for (b) (i), (b) (ii), (c), and the test and observation for (d).

Table 4

S/n	Experiment	Observations	Inferences
(a)	P was dissolved in water and the resulting solution was divided into three parts.	A colourless solution was formed.	P is a soluble salt.
(b) (i)	To the first part, aqueous sodium hydroxide was added until a change was seen.	A white precipitate was formed.	Ca^{2+}, Zn^{2+}, and Pb^{2+} may be present.
(b) (ii)	An excess of aqueous sodium hydroxide was added to the mixture from (b) (i).	The white precipitate remained insoluble.	Ca^{2+} may be present.

| (c) | To the second part, aqueous ammonia was added followed by ammonium oxalate. | A white precipitate was formed. | Ca^{2+} confirmed. |
| (d) | To the third part, silver nitrate solution was added followed by dilute nitric acid. | A white precipitate was formed, which remained insoluble in nitric acid. | Cl^- present and confirmed. |

Conclusion:
(i) The chemical name of sample P is calcium chloride.
(ii) The chemical formula of compound P is $CaCl_2$.
(iii) With state symbols, write a balanced chemical equation taking place at (b) (i) and the corresponding ionic equation.

Reaction at (b) (i):
$CaCl_2(aq) + 2NaOH(aq) \text{----> } Ca(OH)_2(s) + 2NaCl(aq)$

Ionic equation:
$Ca^{2+}(aq) + 2OH^-(aq) \text{----> } Ca(OH)_2(s)$