THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3A

CHEMISTRY 3A
ACTUAL PRACTICAL A
(For Both School and Private Candidates)

Time: 3 Hours **Wednesday, 13th February, 2013 a.m.**

Instructions

1. This paper consists of **four (4)** questions.
2. Answer **three (3)** questions including question number **one (1)**.
3. Question number **one (1)** carries 20 marks and the other **three (3)**, 15 marks each.
4. Mathematical tables and non programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. You may use the following constants:
   - Atomic masses: H = 1, C = 12, Mg = 24, O = 16, S = 32, Na = 23, K = 39, Mn = 55.
   - Molar gas constant = 8.314 $J K^{-1} mol^{-1}$.

1. You are provided with the following solutions:
   - **AA**: A solution made by dissolving 6.32g of pure potassium permanganate in distilled water and diluting the resulting solution to 2000 cm^3;
   - **BB**: Hydrogen peroxide solution made by diluting commercial sample of hydrogen peroxide 36 times;
   - **CC**: 2.0M sulphuric acid.

Theory

The concentrations of commercial samples of hydrogen peroxide are usually expressed in volume strengths. The volume strength of hydrogen peroxide is defined as the volume of oxygen in litres at S.T.P, which would be liberated if one litre of hydrogen peroxide decomposes. The equation for such decomposition is written as: $2H_2O_{2(aq)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$.

According to this equation, 2 moles or 68 g of hydrogen peroxide produce 22.4 dm^3 of oxygen at S.T.P. It follows that if 68 g of hydrogen peroxide are present in 1 dm^3 of hydrogen peroxide solution, the solution is 22.4 volume. Volume strengths can be converted to molarities and vice versa.

Hydrogen peroxide reacts with acidified potassium permanganate according to the following equation: $2MnO^-_{4(aq)} + 5H_2O_{2(aq)} + 6H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 5O_{2(g)}$. The unknown molarity of hydrogen peroxide may be determined by standardization of acidified potassium permanganate. The aim of this experiment is to determine the volume strength of commercial hydrogen peroxide.

Procedure

(i) Pipette 20 cm^3 or 25 cm^3 of **BB** into a clean conical flask; add 20 cm^3 or 25 cm^3 of **CC**.
(ii) Fill the burette with **AA** and fix it to a retort stand.
(iii) Titrate this mixture (**BB** and **CC**) in the flask against **AA** from the burette until there is a colour change. Record the volume of **AA** used.
(iv) Repeat procedure (i) to (iii) three times and record your results in a tabular form.

Summary

The volume of pipette used was _____ cm^3.
_____ cm^3 of acidified **BB** required _____ cm^3 of **AA** for complete oxidation.

Questions

(a) Write down half reaction equations for oxidation of hydrogen peroxide and reduction of potassium permanganate.

(b) Calculate the molarity of solution:
   (i) **AA**
   (ii) **BB**.

(c) Using the results obtained in (b), calculate the:
   (i) Concentration of commercial hydrogen peroxide in g/l.
   (ii) Volume strength of commercial hydrogen peroxide.

2. You are provided with the following:
   - A_1: Solution of 1 M hydrochloric acid;
   - A_2: 0.2 g of magnesium ribbon;
   - A_3: 1 g of magnesium carbonate;
   - Thermometer.

Procedure

Case A

(i) Measure 50 cm^3 of A_1 solution into a 100 cm^3 beaker or conical flask.
(ii) Determine the initial temperature T_1.
(iii) Add 0.2 g of A_2 in (i) above. Swirl the mixture and record the final temperature T_2.

Case B

(i) Measure 50 cm^3 of A_1 solution into a 100 cm^3 beaker or conical flask.
(ii) Determine the initial temperature T_3.
(iii) Add 1 g of A_3 in (i) above. Swirl the mixture and record the final temperature T_4.

Questions

(a) Calculate the heat evolved during the reaction in case **A** and **B**, given that specific heat capacity of the solution = 4.2 $Jg^{-1}K^{-1}$ and density of the solution = 1 gcm^{-3}. Neglect the heat absorbed by the container and assume no change in the volume of the solution.

(b) Calculate the enthalpy of formation of magnesium carbonate ($MgCO_3$), given that enthalpy of formation of CO_2 = -394 $kJmol^{-1}$ and enthalpy of formation of H_2O = −286$kJmol^{-1}$.

3. You are provided with the following:
   - C_1: A solution of 2 g sodium hydroxide in 1 dm^3 of water;
   - C_2: Isobutanol;
   - C_3: 0.01 M ethanoic acid;
   - **POP**: Phenolphthalein indicator.

Theory

The solubility of a solute in two immiscible liquids is governed by the distribution law and can be represented by the equation at equilibrium: $[solute]_o \rightleftharpoons [solute]_a$

hence $Kd = \frac{[solute]_o}{[solute]_a}$, where o = organic layer, a = aqueous layer and Kd = distribution constant.

Procedure

(i) Place 50 cm^3 of solution C_3 into a separating funnel, add into it 25 cm^3 of solution C_2.
(ii) Cork the separating funnel; shake vigorously for about 3 minutes. Leave to stand for 3 minutes.
(iii) Run the lower layer into a beaker and from it measure 10 cm^3 into a clean conical flask. Add 3 drops of **POP** and titrate it against solution C_1 until the end point is reached.

(iv) Only one accurate titration is enough.

Questions

(a) Write a balanced chemical equation for the titration reaction.
(b) Calculate the concentration of the solute in the
  (i) aqueous layer in g/cm^3.
  (ii) organic layer in g/cm^3.
(c) Calculate the value of the distribution constant.
(d) Conclude on the value of distribution constant.

4. Substance W contains two **cations** and **anions**. Use the information given in the experiment column in Table 2 to complete the observations and inferences and hence identify the two cations and anions.

Table 2

S/n	Experiments	Observations	Inferences
1	Put a spatulaful of sample W into a boiling tube and add distilled water. Boil the mixture for about 1 minute. Filter or centrifuge to obtain the residue and a clear solution. Divide the resulting clear solution into two portions. (i) In the first portion add sodium hydroxide solution till in excess. (ii) In the second portion add dil. HNO_3 followed by $AgNO_3$.		
2	To a little quantity of the residue in (1) above add hydrochloric acid and identify any resulting gas.		
3	Dilute the resulting solution in 2 above with distilled water and divide the solution into two portions. (i) To the first portion add dilute sodium hydroxide solution. (ii) To the second portion add dilute ammonia solution.		
4	Perform one confirmatory test for each ion.		

Conclusion

The two cations in the sample W are _____ and _____; the anions are _____ and _____.