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

**132/3C**

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

**Time: 3 Hours** **Tuesday, 26th February, 2013 a.m.**

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**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, N = 14, O = 16, S = 32, Na = 23, K = 39, Mn = 55, Fe = 56, I = 127, Cu = 64.
   - Molar gas constant = 8.314 $J K^{-1} mol^{-1}$.

1. You are provided with the following:
   - $T_1$: A solution containing 0.65 g of impure potassium dichromate ($K_2Cr_2O_7$) in 0.10 $dm^3$ of distilled water;
   - $T_2$: A solution made by dissolving 0.04 moles of sodium thiosulphate pentahydrate ($Na_2S_2O_3.5H_2O$) in 0.4 $dm^3$ of distilled water;
   - $T_3$: 10% potassium iodide solution;
   - $T_4$: 1M sulphuric acid;
   - $T_5$: Starch solution.

**Theory**

Acidified potassium dichromate reacts quantitatively with potassium iodide solution liberating iodine according to the equation:

$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6I^-_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 3I_{2(g)} + 7H_2O$.....(1).

The liberated iodine can be titrated against sodium thiosulphate and the reaction taking place during the titration can be represented by the equation:

$2S_2O^{2-}_{3(aq)} + I_{2(g)} \longrightarrow S_4O^{2-}_{6(aq)} + 2I^-_{(aq)}$ .....(2).

**Procedure**

(i) Pipette 20 $cm^3$ or 25 $cm^3$ of solution $T_1$ into a clean conical flask.
(ii) Add 20 $cm^3$ or 25 $cm^3$ of solution $T_4$ followed by 20 $cm^3$ or 25 $cm^3$ of solution $T_3$ and shake the mixture.
(iii) Immediately titrate the mixture against solution $T_2$ from the burette until the solution becomes pale yellow.
(iv) Add about 2 $cm^3$ of solution $T_5$ and continue titrating until a green colour appears.
(v) Repeat procedures (i) to (iv) three times and record your data in a tabular form.

**Questions**

(a) Calculate the concentration of $T_2$ in $moldm^{-3}$.
(b) Calculate the concentration of pure potassium dichromate in
   (i) $moldm^{-3}$
   (ii) $gdm^{-3}$.
(c) Find the percentage purity of potassium dichromate.
(d) Write down the half reactions for the reaction equations (1) and (2) above.

2. You are provided with the following:
   - $A_1$: Distilled water;
   - $A_2$: 4 g anhydrous copper (II) sulphate ($CuSO_4$);
   - $A_3$: 6 g copper (II) sulphate pentahydrate ($CuSO_4.5H_2O$);
   - Thermometer and Stirrer;
   - Cotton wool.

**Procedure**

(i) Take 100 ml beaker and put it into a 250 $cm^3$ beaker. Fill the space between using cotton wool as an insulator.
(ii) Pour 50 $cm^3$ of $A_1$ into a 100 $cm^3$ beaker in (i).
(iii) Stir the water and record the temperature, $T_1$.
(iv) Add $A_2$ into a beaker containing water. Stir gently until dissolution is complete.
(v) Record the final temperature of the solution, $T_2$.
(vi) Clean and dry the beaker, stirrer and thermometer. Then repeat steps (i) to (v) using $A_3$.
(vii) Record your results in a tabular form as indicated in Table 1.

Table 1

| Salt | Volume of water ($cm^3$) | Mass of salt (g) | Initial temp. of water $T_1$ (°C) | Final temp. of solution $T_2$ (°C) | Tempe. Change $T = T_2 - T_1$ (°C) | Molecular weight of salt (Mr) |
|---|---|---|---|---|---|---|
| $A_2$ | | | | | | |
| $A_3$ | | | | | | |

**Questions**

(a) Find the temperature change $T = T_2 - T_1$ in each experiment.

(b) Calculate the enthalpy of solution of each salt, given that the specific heat of water is $4.18\ Jg^{-1}K^{-1}$ and the density of salt water is $1\ g\ cm^{-3}$.

(c) Accepted values for these two experiments are : $\Delta H^{\theta}_{solution}(CuSO_4) = -66.10\ kJmol^{-1}$ and $\Delta H^{\theta}_{solution}(CuSO_4.5H_2O) = +11.30\ kJmol^{-1}$. How the calculated enthalpies of each salt differ from the expected values? Give reasons.

3. You are provided with the following:

**JJ**: A solution of succinic acid in water;
**PP**: 0.2 M sodium hydroxide;
**SS**: Phenolphthalein indicator;
**OO**: Diethyl ether.

**Theory**

Ether and water are immiscible, when succinic acid is dissolved, it will distribute itself in the two liquids in such a way that $\frac{\text{concentration of succinic acid in water}}{\text{concentration of succinic acid in ether}} = \text{constant}$.

In this experiment you are required to determine the partition coefficient of succinic acid between water and diethyl ether at room temperature.

**Procedure**

**Part 1**

(i) Pipette 20 $cm^3$ or 25 $cm^3$ of **JJ** into a clean conical flask and add two drops of **SS**.
(ii) Put **PP** into the burette and titrate it against **JJ** until colour change is observed. A single accurate titration is enough.

**Summary**

_____ $cm^3$ of solution **JJ** required _____ $cm^3$ of **PP** for complete reaction.

**Part 2**

(i) Using a measuring cylinder measure 50 $cm^3$ of **OO** and transfer it into a separating funnel.
(ii) Measure 50 $cm^3$ of **JJ** and transfer it into a separating funnel containing **OO** and then shake well. Leave the mixture to stand for about 3 minutes.
(iii) Run the lower layer (aqueous layer) into a clean beaker. Measure 20 $cm^3$ or 25 $cm^3$ of the aqueous layer into a conical flask. Add to it two drops of **SS**.
(iv) Put **PP** into a burette and titrate it against the aqueous layer in a conical flask until there is a colour change. Record the volume of **PP** used. A single accurate titration is enough.

**Summary**

_____ $cm^3$ of **JJ** required _____ $cm^3$ of **PP** for complete reaction.

**Questions**

(a) The colour of the solution during titration changed from _____ to _____.

(b) Write down the equation for the reaction between **JJ** and **PP**.

(c) Calculate the
- (i) concentration of **JJ** before it was mixed with **OO** in $g/dm^3$.
- (ii) concentration of **JJ** in water after mixed with **OO** in $g/dm^3$.
- (iii) concentration of **JJ** in ether in $g/dm^3$.
- (iv) partition coefficient of succinic acid between water and ether at the temperature of the experiment.

4. Substance **M** contains a common **cation** and **two anions**. Use the information given in the experiment column in Table 2 to complete the observations and inferences and hence identify the common cation and the two anions.

Table 2

| S/n | Experiment | Observations | Inferences |
|---|---|---|---|
| 1 | Appearance. | | |
| 2 | Perform flame test. | | |
| 3 | To a little sample **M**, add Conc. $H_2SO_4$ and warm gently. | | |
| 4 | Prepare a solution of **M** and divide it into four portions. | | |
| | (i) In the first portion add $AgNO_3$ solution to excess. | | |
| | (ii) In the second portion add fresh $FeSO_4$ solution followed by concentrated sulphuric acid added slowly through the side of the test tube. | | |
| | (iii) In the third portion add $BaCl_2$ solution. | | |
| | (iv) In the last portion add aqueous ammonia till excess. | | |
| 5 | Perform two confirmatory tests for the cation. | | |

**Conclusion**

The cation in the sample **M** is _____ and the anions are _____ and _____.