CHEMISTRY PAPER 2 (PRACTICAL)

Question 1

You are provided with two solutions as follows:

- **C-10** is a solution prepared by dissolving 1·85 gms of potassium manganate (VII) $KMnO_4$ per litre.
- **C-11** is a solution prepared by dissolving 22 gms of hydrated ammonium iron (II) sulphate crystals, $(NH_4)_2SO_4.FeSO_4.xH_2O$ per litre.

PROCEDURE:

Rinse and fill the burette with the given solution **C-10** of potassium manganate (VII). Pipette out 20 ml or 25 ml of the solution **C-11** of ammonium iron(II) sulphate solution into a clean conical flask. To this, add 20 ml of **C-12** solution of dilute H_2SO_4 specially provided for titration.

Titrate the solution by running solution **C-10** from the burette till one drop of this solution gives a permanent light pink colour to the solution **C-11** in the conical flask. Ensure that the pink colour obtained does not disappear on shaking the contents of the conical flask.

Repeat the above procedure of the titration to get at least two concordant readings.

Tabulate your readings.

State:

(a) The capacity of the pipette used.

(b) The titre value you intend to use in your calculations.

Show the titre value to the Visiting Examiner.

The equations for the above reactions are as follows:

$2KMnO_4 + 8H_2SO_4 + 10(NH_4)_2SO_4.FeSO_4.xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + 10(NH_4)_2SO_4 + 5Fe_2(SO_4)_3 + 8H_2O + 10\,x\,H_2O$

OR

$2MnO_4^- + 10\,Fe^{2+} + 16H^+ \rightarrow 2Mn^{2+} + 10Fe^{3+} + 8H_2O$

Relative atomic masses:

K = 39 Fe = 56 S = 32 N = 14 H = 1 Mn = 55 O = 16

Calculate the following:

(i) The **molarity** of potassium manganate(VII) solution **C-10**.

(ii) The **molarity** of the hydrated ammonium iron(II) sulphate solution **C-11**.

(iii) The **molecular mass** of hydrated ammonium iron (II) sulphate, deduced from the experimental data.

(iv) The **numerical value** of *x*, i.e. the number of molecule of water of crystallization in $(NH_4)_2\,SO_4.FeSO_4.x\,H_2O$

Comments of Examiners

A number of candidates did not seem to be aware of the significance of tabulating the readings. They did not write initial and final readings. Many just gave one titre value. These candidates had no concept of concordant readings. Some used average value with a difference between two readings of more than 0.2. Several candidates did not read the question paper carefully and used wrong solutions in the burette and pipette. Overwriting in the titre value was also observed.

- Many candidates used wrong formula to calculate molarity of hydrated ferrous ammonium sulphate i.e. gms per litre/molecular weight instead of $M_1\ V_1/\ M_2\ V_2 = n_1/n_2 = 1/5$.
- Some candidates rounded off the value of molarity in questions (i) and (ii) and used only two places after the decimal instead of four.
- Molecular weight of hydrated ferrous ammonium sulphate was incorrectly calculated by many candidates as the question was not read carefully i.e. theoretical value of x was substituted and molecular weight determined.
- In some cases, the numerical value of (x) water of crystallization was reported in fraction and it was not rounded off to the closest whole number.

Suggestions for teachers

– Insist that students tabulate the titre value correctly. Teach them the tabular form and explain the significance of each column. Insist on one trial run and two concordant readings. Tell them the average should not be taken and overwriting in the readings should be strictly avoided.

– Give sufficient practice in calculating molarity, percentage purity, water of crystallization for all oxidation/-reduction titration in the syllabus. Students must do the experiments throughout the year under the supervision of the teacher.

– Tell students that it is absolutely imperative to write upto at least four decimal places in the calculation of molarities, and at least two decimal places for molecular weight and percentage purity. They must also round off the value of water of crystallization to the nearest whole number.

- Ask students to read the question paper carefully, refer to the formula of the substances and atomic weights as given in the question paper. They must follow the chemical equation given in the question paper and apply that for the number of moles.
- Explain that for only pure compounds students can use molarity = weight dissolved per liter/ molecular weight.

MARKING SCHEME

Question 1.

(i) Molarity of C – 10 ($KMnO_4$)

$$\text{Molarity} = \frac{\text{wt. in gms per litre}}{\text{mol. wt.}} = \frac{1{\cdot}85}{158} = 0.0117089\text{M}$$

(ii) Molarity of C-11 (Hydrated ammonium iron(II) sulphate)

$$\frac{M_1V_1}{M_2V_2} = \frac{n_1}{n_2}$$

M_1 – Molarity of **C -10**

V_1 – Volume of **C-10 (Titre value)**

M_2 = Molarity of **C-11**

V_2 = Volume of **C-11**

n_1 – number of moles of **C-10**

n_2 – Number of moles of **C-11**.

Let the titre value be 25·5 ml

$$\frac{0{\cdot}0117089 \times 25.5}{M_2 \times 25} = \frac{2}{10}$$

M_2 = 0·0597 M

(iii) Mol. Wt. of C-11

$$\text{Mol wt} = \frac{\text{wt. in gms per litre}}{\text{Molarity}(M_2)} = \frac{22}{0.0597} = 368.5$$

(iv) Value of x: $(NH_4)_2SO_4FeSO_4.xH_2O = 368.5$

$368{\cdot}5 = 284 + 18x$

$x = 4{\cdot}69 \approx 5$

$x = 5$

Question 2 **[5]**

This experiment is designed to find out the effect of concentration of the reactants on the rate of a chemical reaction.

You are provided with two solutions:

(a) **C-13** is a solution prepared by dissolving 60gms of sodium thiosulphate crystals ($Na_2S_2O_3.5H_2O$) per litre.

(b) **C-14** is a solution of 1M hydrochloric acid.

PROCEDURE:

Measure out 50 ml of the solution **C-13** ($Na_2S_2O_3.5H_2O$) in a beaker. Place the beaker over a piece of paper with a cross mark on it. Now add 10 ml of the solution **C-14** (HCl) to this solution and start the stop watch at the same time. Look down vertically on to the cross and note the time when the cross becomes invisible. This is due to the formation of colloidal sulphur in the reaction. The reaction is given as:

$Na_2S_2O_3(aq) + 2HCl\ (aq) \rightarrow 2NaCl(aq) + SO_2(g) + H_2O(aq) + S\ (collidal)$.

Repeat the experiment using 40ml, 30ml, 20ml and 10ml of **C-13** solution made upto 50 ml with distilled water in each case and 10 ml of **C-14** according to the following table:

Expt. no	Volume of the solution **C-13**	Volume of distilled water	Time in seconds
1.	50 ml.	0 ml.	
2.	40 ml.	10 ml.	
3.	30 ml.	20 ml.	
4.	20 ml.	30 ml.	
5.	10 ml.	40 ml.	

Tabulate your results. From your results:

(i) Plot a graph of the concentration of sodium thiosulphate solution (in terms of the volume of sodium thiosulphate taken) against time.

(ii) From the graph find out the time taken for the reaction when 15 ml of the solution **C-13** is used.

(iii) Predict the effect of change in concentration of sodium thiosulphate on the rate of the above reaction from the nature of your graph.

Show the results as required to the Visiting Examiner.

Comments of Examiners

A tabular column was provided in the question paper which many candidates did not follow and complete by filling up the time in seconds.

(i) The question said 'plot a graph of the concentration of sodium thiosulphate solution (in terms of the volume) against time'. Several candidates first calculated the molarity of sodium thiosulphate (concentration) which was not required. Only volume was to be used.
Many candidates did not mention what was taken on which axis and units like ml & sec were also missing.
In some cases, the scale for x and y axis was incorrect and haphazard.
In several answer scripts the curve was not hyperbolic. It should have been drawn free-hand, but instead, it was drawn using a ruler by some candidates.

(ii) The time for the reaction when 15 ml of C-13 is used was not interpreted correctly from the graph. Instead, a vague value was reported

(iii) Many candidates used vague, incomplete, and inappropriate language for prediction of the effect of change in concentration of sodium thiosulphate on the rate of reaction.

Suggestions for teachers

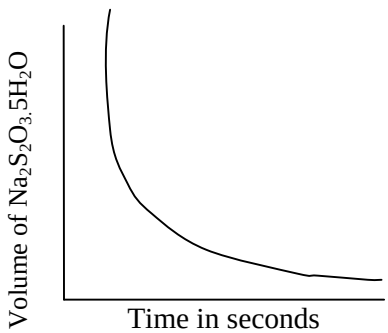
- Insist on reading the experiment carefully. Tabulation must be done correctly in the given format with correct units.
- Give more practice to students in experiments based on rate of reaction.
- Explain to students the selection of axis, choosing an appropriate scale, how and when to join points on a graph, free-hand /use a ruler, depending on the shape of the curve.
- Tell students that interpretation from the graph must be shown on the graph paper, and reported on the answer script as well.

MARKING SCHEME

Question 2.

Tabulation of time in ascending order.

(i) Graph



Time in seconds along x axis. Volume in ml or concentration in moles per litre/ relative concentration of strength along y axis. Shape of curve (rectangular hyperbole).

(ii) Time required when 15 ml of $Na_2S_2O_3.5H_2O$ solution was taken.

(iii) The rate of reaction decreases with decrease in concentration of sodium thiosulphate or rate of reaction is directly proportional to concentration of sodium thiosulphate.

Question 3 **[7]**

Analyse qualitatively the substance **C-15** which contains *two* anions and *two* cations. Identify these ions.

(a) While testing for **anions** you must mention:

(i) How the solution/soda extract was prepared.

(ii) How the gases were identified.

(iii) The confirmatory test for each anion.

Show the results as required to the Visiting Examiner.

(b) While testing for **cations** you must mention:

(i) How the original solution for group analysis was prepared.

(ii) The formal group analysis with pertinent group reagents.

(iii) The confirmatory test for each cation.

Show the results as required to the Visiting Examiner.

Note: *Use of qualitative analysis booklet/table is not allowed*.

Comments of Examiners

(a) Wet tests for anions were performed by many candidates using either the aqueous solution or soda extract, instead of neutralized soda extract.
- For the nitrate ion, ferrous sulphate was used which is incorrect. Instead, freshly prepared ferrous sulphate should have been used.
- Alternative test for nitrate ion using salt mixture, concentrated sulphuric acid, copper turning and heat was incorrectly done with salt solution, dilute acid and without heat.
- For the acetate ion, ferric chloride solution was used which is incorrect. Instead, neutral ferric chloride should have been used.
- Alternative test for acetate using salt mixture, ethanol, concentrated sulphuric acid and heat was incorrectly done with salt solution and dilute sulphuric acid.

(b) Preparation for original solution for cation detection was not done correctly by many candidates.
- Most of the candidates did not add concentrated nitric acid in group III.
- The order of preparing the buffer medium in group III was incorrect.

Suggestions for teachers
- Teach students the steps for preparing the original solution.
- Insist that the wet tests for the anion be performed with neutralized sodium carbonate extract, even if the salt mixture is more or less soluble in water.
- Concepts of formal group analysis like, common ion, buffer and solubility product must be taught thoroughly before doing salt analysis.
- Practice mixture analysis and guide the student on how to record formal group analysis correctly and meaningfully with pertinent group reagents.
- Explain to the students the importance of adding concentrated nitric acid and boiling to convert ferrous to ferric.

- Absence of group III, IV and V was not reported by several candidates.
- H_2S was not boiled off before group III and V reagents were added.
- The filtrate after group V was not used for detection of group VI. Instead, candidates incorrectly used original solution.
- The precipitate of Group I / Group II was not dissolved correctly in hot water/ concentrated nitric acid respectively.
- In some cases, the reagent for magnesium test was written with a wrong formula.

- Removal of H_2S before Group III and V must be taught clearly.
- Tell students that while reporting the groups which are present, it is equally important to mention groups which are absent so that the analysis is systematic.

MARKING SCHEME

Question 3.

(a) C-15 is a mixture of Lead acetate and Magnesium nitrate.

Test for NO_3^-:

Neutralise the Na_2CO_3 extract with dil. H_2SO_4 and add equal volume of freshly prepared solution of ferrous sulphate followed by conc. H_2SO_4 from the side of the test tube → Brown Ring forms at the junction of two liquids.

Nitrate confirmed.

OR

Salt mixture + concentrated H_2SO_4, heat and add copper turnings or paper balls. Dense brown fumes are observed. Nitrate confirmed.

CH_3COO^-

Neutralise the Na_2CO_3 extract with dil HNO_3. Add neutral $FeCl_3$ solution - a blood red colouration is obtained on heating turns reddish brown ppt. Acetate confirmed.

OR

Salt mixture + concentrated sulphuric acid add ethanol and heat, pleasant fruity odour of ester is obtained. Acetate confirmed.

OS. The salt solution is made in dil. HNO_3/ water/ hot dil HCl.

Group I present:

Add dil. HCl to OS - a white ppt. Group I present/Group II may also be accepted. Pass H_2S gas through the filtrate of Group I.

Confirmatory test for Pb^{2+}.

If the white precipitate from Group I is taken, dissolve it in hot water. If the black precipitate is taken from Group II, dissolve it in 33 % nitric acid and heat.

Add potassium chromate solution/ KI solution.

A yellow ppt. Pb^{2+} confirmed.

Group VI:

After reporting the absence of III, IV and V groups with pertinent group reagents, the filtrate of group V is taken, add NH_4OH solution and then add Disodium hydrogen phosphate/ Sodium hydrogen phosphate solution. A fine crystalline white precipitate is formed.

Group VI present and Mg^{++} is confirmed.

GENERAL COMMENTS:

(a) Topics found difficult:

- Concepts of molarity based on (grams/litre)/ molecular weight for pure substances and molarity based on titre value.
- Plotting of graphs in chemical kinetics.
- Principles of formal group analysis.

(b) Concepts found confusing:

- Choice of axis, correct scale, joining of points, shape of curve etc. in the graph of chemical kinetic.
- Solubility of mixture/neutralized sodium carbonate extract and carrying out a systemic analysis from Group 0 to Group 6.

(c) Suggestions for students:

- Listen to the teacher's instructions carefully, read the experiment thoroughly and then perform them.
- Develop a habit of observation and note them down correctly and to the point.
- Practice makes perfect, hence practice as many salt mixtures as possible.
- Remember to tabulate your readings neatly, keeping in mind concordant readings and avoid overwriting in the tabular column.
- Do not round off molarity values, report to minimum four decimal places.
- Do follow the molecular formula given in the question paper, whether it is hydrated or anhydrous.
- Perform experiments on chemical kinetics carefully after understanding the theoretical concepts. Also practice plotting graphs for these experiments.
- Plan before writing formal group analysis.
- Do not forget the use of concentrated nitric acid in Group III. Also understand why it is being used.
- Test for Group V cations in the order barium, strontium, calcium and show absence of barium before reporting presence of strontium.
- Group VI must be reported with the filtrate after group V is reported absent and not with the original solution.