

CHEMISTRY PAPER 2 (PRACTICAL)

Attempt *all* questions.

Question 1

[8]

You are provided with two solutions as follows:

- **C-10** is a solution prepared by dissolving 3.5 gms of **impure** sample of potassium manganate(VII), KMnO_4 per litre.
- **C-11** is a solution prepared by dissolving 6.5 gms of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ per litre.

PROCEDURE:

Rinse and fill the burette with potassium manganate(VII) solution **C-10** (KMnO_4).

Pipette out 20 ml or 25 ml of the oxalic acid solution **C-11** ($\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$) in a clean conical flask. To this, add 20 ml of dilute H_2SO_4 , **C-12**, specially provided for this purpose. Warm the contents of the flask to $60^\circ\text{C} - 70^\circ\text{C}$. The heating should be continued till the first bubble appears at the bottom of the flask.

Remove the conical flask from fire and titrate this solution by running solution **C-10** from the burette. Shake the solution constantly till a permanent pale pink colour is obtained. Ensure that the pink colour obtained does not disappear on shaking the contents of the conical flask.

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

Tabulate your readings.

State:

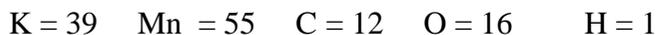
- (a) The capacity of the pipette used.
- (b) The titre value you intend to use in your calculations.

Show the titre value to the Visiting Examiner.

The equations for the above reactions are as follows:



Relative atomic masses:



Calculate the following:

- (i) The **molarity** of oxalic acid solution **C-11**.
- (ii) The **molarity** of potassium manganate (VII) solution **C-10**.
- (iii) The **strength** of potassium manganate(VII) solution in gms per litre.
- (iv) The **percentage purity** of the sample of potassium manganate (VII) solution.

Note: Molarity must be calculated upto at least 4 decimal places.

Comments of Examiners

- A number of candidates did not seem to be aware of the significance of tabulating the readings and giving the size of the pipette.
- Some candidates did not write the initial and final readings.
- Many candidates just gave one titre value - they had no concept of concordant values.
- Some candidates used average value with a difference between two readings of more than 0.2. They also calculated the average up to two decimal places.
- A few candidates did not read the question paper carefully and used wrong solutions in the burette and pipette.
- Overwriting in the titre value was observed in a number of cases. In some cases, the readings were recorded in pencil instead of ink.
- Many candidates used wrong formula to calculate molarity of potassium permanganate i.e. $M_1V_1/M_2V_2 = n_1/n_2$ instead of gms per litre / molecular weight.
- Some candidates rounded off the value of molarity in questions (i) and (ii) and used only two places after the decimal instead of four, although the question paper required molarity to be calculated upto at least four decimal places.
- In some cases, molecular weight of oxalic acid was calculated without water of crystallization.

Suggestions for teachers

- All students at a centre must be given pipettes of the same size.
- 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 that the average should not be taken and overwriting in the readings should be strictly avoided. Instruct students to complete all work in ink.
- Give sufficient practice in calculating molarity, percentage purity, water of crystallization for all oxidation/ reduction titrations in the syllabus.
- Tell students it is absolutely imperative to write up to at least four decimal places in the calculation of molarities, and at least two decimal places for molecular weight and percentage purity.
- Students should be told that water of crystallization must be a whole number.
- Instruct students to read the question paper carefully, refer to the formula of the substances, chemical equation and atomic weights, as given in the question paper.
- Explain that for only pure compounds with complete molecular formula given, students can use molarity = weight dissolved per liter/ molecular weight.

MARKING SCHEME

Question 1.

Let the titre value be 24.5 ml

- (i) Molarity of the solution C – 11(Oxalic Acid $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$)

$$\text{Molarity} = \frac{\text{wt. in gms per litre}}{\text{mol wt.}} = \frac{6.5}{126} = 0.0515 \text{ M}$$

- (ii) Molarity of the solution , **C-10** (KMnO_4)

$$\frac{M_1 \times V_1}{M_2 \times V_2} = \frac{n_1}{n_2}$$

M_1 – Molarity of C-10

V_1 – Volume of C-10

n_1 – Number of moles of C-10

M_2 – Molarity of C-11

V_2 – Volume of C-11

n_2 – Number of moles of C-11

$$\frac{M_1 \times V_1}{M_2 \times V_2} = \frac{2}{5}$$

Let the titre value be 24.5ml

$$\frac{M_1 \times 24.5}{0.0515 \times 25} = \frac{2}{5}$$

$$M_1 = 0.0210 \text{ M}$$

- (iii) Strength in grams per litre of KMnO_4

$$= \text{molarity} \times \text{mol. Wt.}$$

$$= 0.0210 \times 158 = 3.31 \text{ gms / lit. } \frac{M_1 \times V_1}{M_2 \times V_2}$$

- (iv) % purity of $\text{KMnO}_4 = \frac{3.31}{3.5} \times 100 = \frac{\text{pure}}{\text{impure}} \times 100$

$$= 94.57\%$$

Question 2

[5]

- (a) Substance **C-13** is an organic compound. Perform the experiments given below. Record the changes taking place at each step of the experiment.

Note the smell of the substance formed, the colour of the substance obtained, the colour of the precipitate produced, changes on heating and cooling and any other observations you may have. State the identity of the compound on the basis of the experiments and observational changes.

Substance C-13

PROCEDURE:

- (i) Take 2 ml of **C-13** in a test tube. To this, add 1 ml of Tollen's reagent. Warm the contents in a water bath.
 - (ii) Take 2 ml of **C-13** in a test tube and add 1 ml of freshly prepared pyrogallol solution. Shake the contents. Add 2 ml of concentrated hydrochloric acid and warm the contents in a water bath.
 - (iii) Take 2 ml of **C-13** in a test tube and add a few crystals of resorcinol, shake the contents. Slowly add 1 ml of concentrated sulphuric acid along the sides of the test tube.
- (b) Substance **C-14** is an unknown sample of either carbohydrate or protein. Carry out the following experiments and record all your observations. State the identity of the compound as carbohydrate or protein on the basis of the experiments and observational changes.

Substance C-14

PROCEDURE:

Take the sample **C-14** in a test tube. Dissolve it in 10 ml of distilled water in order to obtain saturated solution. Divide the solution into three parts.

- (i) To the first part of **C-14**, add 2 drops of alcoholic α -naphthol solution followed by 1 ml of concentrated H_2SO_4 carefully by the side of the test tube.
- (ii) To the second part of **C-14**, add 1 ml of lead acetate solution, heat to boil. Now, add 5 ml of ammonium hydroxide solution and heat to boil again.
- (iii) To the third part of **C-14**, add 1 ml of copper sulphate solution, followed by 3 ml of sodium hydroxide solution.

Comments of Examiners

- (a) Many candidates made mistakes in the observation of ring/mirror. Sequential observations were not listed in many cases. Though the question clearly stated "write down all changes, taking place at each step of the experiment", some candidates tended to give a summary. Common errors made by the candidates were as follows:
- (i) Instead of silver mirror, candidates reported black mass, precipitate and solution.
 - (ii) Incomplete observation was given i.e. changes to pink or red instead of white precipitate changes to pink and finally red.

Suggestions for teachers

- The chemistry of the organic tests, along with the physical properties of the organic substances should be taught to students. This is to ensure that they do not work mechanically.
- Emphasize upon the use of correct quantity of reagent and explain what can occur with use of excess. Also tell students why adding drop wise is very important, so that changes can be seen at every step.

- (iii) 'Red ring' was reported as colour/precipitate and the second part i.e. 'white precipitate is formed in the aqueous layer' was left out by many candidates.
- (b) Candidates did not seem to have adequate practice in performing food tests and recording the observations. They did not understand or read the question paper carefully and gave extra observations for glucose. Some reported 'glucose' instead of 'carbohydrate' when the question paper clearly stated 'carbohydrate' or 'protein'. Some common errors made by candidates were as follows:
- (i) Instead of violet ring precipitate/colour was mentioned.
- (ii) White solution was reported instead of white precipitate changes to salmon pink.
- (iii) Instead of no change or blue colouration, several candidates heated without being asked and gave incorrect observations.

- Advise students to write the experiment, observations and inferences in a tabular form, so that they may answer sequentially, instead of just reporting the final observation.
- Teach students to write complete observations with correct changes instead of incomplete and incorrect observations. They also need to know difference between precipitate /colouration or solid/liquid state.
- Emphasize the importance of indentifying correct colours and giving correct inferences.
- Practice the tests with proper instructions. Do not do things which are not asked for in the question paper.

MARKING SCHEME

Question 2.

Identification of organic compounds

(a) Substance C-13

- (i) Silver mirror/deposit/ coating is formed
- (ii) White precipitate/ residue/ solid which changes to pink or deep red
- (iii) A red ring/layer at the junction of the two liquids
and a white precipitate is formed in the aqueous layer

Deduction: Substance C-13 is formaldehyde

(Should be based on any two correct tests)

(b) Substance C-14:

A purple/ violet ring/layer/ band is formed at the junction of two liquids

A white ppt is formed on boiling, which turns to salmon pink on boiling with ammonium hydroxide

No change / blue colouration or precipitate

Deduction - Substance C-14 is a sample of carbohydrate (Glucose)

(Should be based on any two correct tests)

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:
- How the solution/soda extract was prepared.
 - How the gases were identified.
 - The confirmatory test for each anion.

Show the results as required to the Visiting Examiner.

- (b) While testing for **cations** you must mention:
- How the original solution for group analysis was prepared.
 - The formal group analysis with pertinent group reagents.
 - 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. Common errors made by candidates were as follows:
- For the acetate ion test, ferric chloride was used which is incorrect (neutral ferric chloride should have been used).
 - Alternate test for acetate ion using salt mixture, ethanol, concentrated sulphuric acid and heat was incorrectly done with salt solution dilute sulphuric acid and without heat. \
 - The sulphate ion test was performed with aqueous solution instead of neutralised sodium carbonate extract.
 - The white precipitate obtained in the barium chloride test, which should be insoluble in mineral acid to confirm the presence of sulphate ion was omitted by many candidates.

Suggestions for teachers

- Teach students the steps for preparing the original solution.
- Insist that the wet tests for the anion should 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. The concept of group separation and group analysis must be clearly explained.
- Practice mixture analysis and guide student on how to record formal group analysis correctly and meaningfully with pertinent group reagents.

(b) Preparation of original solution for cation detection was not done correctly by many candidates. Solubility of mixture was reported in dilute HCl instead of distilled water. Common errors made by candidates were as follows:

- Formal group reagents for zero group like, salt, NaOH and heat were not used. Instead, test for zero group was performed with original solution and without heat.
 - Nessler's reagent was added to ammonia gas instead of passing ammonia gas through Nessler's reagent.
 - Absence of group I & II was not reported.
 - Most of the candidates did not add concentrated nitric acid in group III and did not boil off H₂S gas.
 - The order of preparing the buffer medium in group III was incorrect.
 - Absence of group IV & V was not reported.
 - H₂S was not boiled off before group V reagents were added.
 - For separation of group VI, original solution was used instead of filtrate after group V.
- Ask students to use reagents and tests that are acceptable.
 - Explain to students the importance of adding concentrated nitric acid and boiling to convert ferrous to ferric.
 - Removal of H₂S before group III and V must be taught clearly.
 - Students do the test for the respective groups but forget to mention whether the group is present or absent. They must be cautioned against this.
 - Formal group separation must be adhered to even though Group I to V are absent.

MARKING SCHEME

Question 3.

Substance C-15

Mixture C-15 contains ammonium acetate and magnesium sulphate in the ratio (1:1) by mass.

Preparation of original solution

Acetate ion

Sulphate ion

Identification of Group Zero

Confirmation of ammonium ion

Presence of group VI

Confirmation of magnesium ion.

Details of tests:

Original solution is made in distilled water

Test for sulphate:

To the neutral Na₂CO₃ extract acidified with (dil HCl / acetic acid / HNO₃)

BaCl₂ solution is added – a white precipitate insoluble in all mineral acids – SO₄²⁻ ion confirmed

Acetate:

To the neutral Na_2CO_3 extract acidified with (dil. HCl / H_2SO_4 / HNO_3 ,) neutral FeCl_3 is added – a wine red colour is obtained. On heating it changes to reddish brown ppt. Confirms acetate ion.

OR

Salt mixture is heated with ethyl alcohol and concentrated H_2SO_4 – A fruity odour/ sweet smell of ethyl acetate is obtained. Confirms acetate ion.

Group Zero:

Salt Mixture + NaOH and heat – a pungent smelling gas evolved which turns red litmus blue / gives dense white fumes with a rod dipped in conc. HCl – Group 0 present.

Confirmatory test for NH_4^+ :

The gas is passed through Nessler's reagent/ paper dipped in Nessler's reagent – it turns brown – NH_4^+ confirmed.

Group VI:

Formal group separation must be carried out from Group I to Group V with pertinent reagents and written as being absent. Proceed with the solution of group V and show the presence of group VI.

OS + dilute HCl	no ppt	Group I absent
Solution after group I/filtrate Pass H_2S gas	no ppt	Group II absent
Solution after group II/ filtrate boil off H_2S gas (add conc. HNO_3 and boil). Cool add NH_4Cl solid NH_4OH solution	no ppt	Group III absent
Pass H_2S gas through the above solution/filtrate	no ppt	Group IV absent
Boil off H_2S gas add NH_4Cl solid NH_4OH solution and $(\text{NH}_4)_2\text{CO}_3$ solution to the above solution/ filtrate	no ppt	Group V absent
Solution after group V present add NH_4Cl solid NH_4OH solution and NaH_2PO_4 * solution	white ppt	Group VI

Confirmatory:

To the Group V solution, add a pinch of solid NH_4Cl , NH_4OH solution and excess of disodium hydrogen phosphate / *ammonium phosphate / sodium dihydrogen phosphate solution. Shake well and scratch the inner walls of the test tube with a glass rod – A white crystalline precipitate on standing – Confirms Mg^{2+}

GENERAL COMMENTS:

(a) Topics found difficult by candidates in the Question paper:

- Concepts of molarity based on (grams/liter)/ molecular weight for pure substances and molarity based on titer value.
- Principles of formal group analysis.

(b) Concepts between which candidates got confused:

- Confusion between precipitate/coloration/solution/ring/mirror while reporting organic compounds.
- Solubility of mixture/neutralized sodium carbonate extract.
- Distinguishing between carbohydrate and protein.

(c) Suggestions for candidates:

- 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.
- Learn all the tests and the observations for organic detection. Make sure that the correct amount of reagent is added and wait for the changes to take place.
- Plan before writing formal group analysis.
- Do not perform any additional test outside the question paper.
- Remember to tabulate your readings neatly, keeping in mind concordant readings and avoid overwriting in the tabular column and do not leave your tabulation in pencil.
- Do not round off molarity values, report to minimum four decimal places (check scope of syllabus).
- Follow the molecular formula given in the question paper, whether it is hydrated or anhydrous.
- Do not forget the use of concentrated nitric acid in group III. Also understand why it is being used.
- Group VI must be reported with the filtrate after group V is reported absent and not with the original solution.