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 25 gms of sodium thiosulphate crystals ($Na_2S_2O_3 . xH_2O$) per litre.
- **C-11** is a solution prepared by dissolving 5 gms of potassium dichromate ($K_2Cr_2O_7$) per litre.

PROCEDURE:

Rinse and fill the burette with the given solution **C-10** ($Na_2S_2O_3.xH_2O$). Pipette out 20 ml or 25 ml of solution **C-11** ($K_2Cr_2O_7$) in a clean conical flask. To this, add 20 ml of **C-12** (dilute sulphuric acid) and about 20 ml of **C-13** (10% solution of potassium iodide). Now add about 20 ml of distilled water, followed by a pinch of sodium hydrogen carbonate (**C-14**). Shake the contents of the flask and cover it with a watch glass. Allow the solution to stand for about 5 minutes till the solution becomes dark reddish brown.

Titrate the solution by running **C-10** from the burette till the solution turns yellowish green. Add about 2 to 3 ml freshly prepared starch (**C-15**). The colour of the solution changes to dark blue. Continue adding **C-10** drop-wise till addition of one drop of **C-10** changes the colour of the solution from blue to light green.

Repeat the above procedure of 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:

$K_2Cr_2O_7 + 7H_2SO_4 + 6KI \rightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3I_2$

$6Na_2S_2O_3 + 3I_2 \rightarrow 3Na_2S_4O_6 + 6NaI.$

$Cr_2O_7^{2-} + 14H^+ + 6\,I^- \rightarrow 2Cr^{3+} + 7H_2O + 3I_2$

$6S_2O_3^{2-} + 3I_2 \rightarrow 3S_4O_6^{2-} + 6\,I^-$

Relative atomic masses:

K =39 Cr = 52 Na = 23 S = 32 O = 16 H = 1

Calculate the following:

(i) The **molarity** of potassium dichromate ($K_2Cr_2O_7$) solution **C-11.**

(ii) The **molarity** of sodium thiosulphate ($Na_2S_2O_3.xH_2O$) solution **C-10.**

(iii) The **molecular mass** of sodium thiosulphate ($Na_2S_2O_3.xH_2O$) .

(iv) The **numerical value of** x.

Note: Molarity must be calculated upto 4 decimal places at least, in order to avoid error.

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. They had no understanding of the concept of concordant readings. 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. Several candidates did not read the question paper carefully and used wrong solutions in the burette and pipette. Overwriting in the titre value continued to appear. In several cases, readings were recorded in pencil instead of ink.

(i) In several cases, molarity was not calculated up to four decimal places, despite the instructions in the question paper.

(ii) Many candidates used wrong formula to calculate molarity of sodium thiosulphate i.e. gms per litre / molecular weight, instead of $M_1V_1/M_2V_2 = n_1/n_2 = 6/1$.

Some candidates rounded off the value of molarity in questions (i) and (ii) and used only two places after the decimal instead of four.

(iii) Molecular weight of sodium thiosulphate was calculated by using theoretical value of x and atomic weights, instead of molecular weight = gms per litre / molarity.

(iv) Many candidates did not round off the value obtained for 'x' and water of crystallization was reported in decimal.

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 that the average should not be taken and overwriting in the readings should be strictly avoided. Encourage students to complete all work in ink.
- Give sufficient practice in calculating molarity, percentage purity and water of crystallization for all oxidation /-reduction titrations in the syllabus. Students must do the experiments throughout the year under the supervision of the teacher.
- 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 to round off the value of water of crystallization to the nearest whole number.
- Students should be asked 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.
- All students at a centre must be given pipettes of the same size.

MARKING SCHEME

Question 1.

Let the titre value be 25·5 ml

(i) Molarity of the solution C – 11 ($K_2Cr_2O_7$)

$$\text{Molarity} = \frac{\text{gl}}{\text{mol.wt.}} = \frac{5}{294} = 0.0170\text{M}$$

(ii) Molarity of the solution , C-10

$$\frac{\text{Molarity}_{\ Na_2S_2O_3} \times \text{Volume}_{\ Na_2S_2O_3}}{\text{Molarity}_{\ K_2Cr_2O_7} \times \text{Volume}_{\ K_2Cr_2O_7}} = \frac{6}{1}$$

OR

$$\frac{M_{C\text{-}10} \times 25.5}{0.0170 \times 25} = \frac{6}{1}$$

. . Molarity of C – 10 = $\frac{6 \times 0.0170 \times 25}{25.5} = 0.1000\text{M}$

(iii) The molar mass of $Na_2S_2O_3 . x H_2O$ = $\frac{\text{gl}^{-}}{\text{molarity}} = \frac{25}{0.1000} = 250$

(iv) Value of *x*:

$158 + 18x = 250$

or $x = 5 \cdot 11 \approx 5$

Question 2 **[5]**

You are provided with two organic compounds, **C-16** and **C-17**.

Perform the experiments given below on each of the two compounds. Record the changes taking place at every step of the experiment.

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

PROCEDURE:

(a) **Substance C – 16**

(i) Take 1 ml of **C-16** in a test tube and add 1 ml of Fehling's solution. Warm the contents.

(ii) Take 2 ml of **C-16** in a test tube and add 1 ml of lead acetate solution followed by 1 ml of ammonium hydroxide solution. Boil the contents.

(iii) Take 2 ml of **C-16** in a test tube and add 2 to 3 drops of alcoholic ~ -napthol solution. Pour conc. sulphuric acid slowly along the side of the test-tube.

Show the results as required to the Visiting Examiner.

(b) **Substance C-17**

(i) Take 1 ml of **C-17** in a test-tube and add a few drops of water. Now add about 1 ml of sodium hypochlorite solution; Shake the contents.

(ii) Take 1 ml of **C-17** in a test-tube and add a few drops of dilute sulphuric acid. Now add 1 ml of potassium dichromate solution. Shake and warm the contents.

(iii) Take 1 ml of **C-17** in a test-tube and add 1 ml of conc. hydrochloric acid to it. Now, add a few drops of neutral ferric chloride solution and dilute the contents with water.

(iv) Take 2 ml of **C-17** and dilute it with water. To this, add a few drops of bleaching powder solution and shake. Now, add a few drops of ammonium sulphide solution and shake.

Show the results as required to the Visiting Examiner.

Comments of Examiners

(a) Many candidates made mistakes in the observation of precipitate/solution/coloration. In a number of cases, sequential observations were not listed. Though the question clearly stated "record changes, taking place at each step of the experiment", some candidates tended to give a summary.

Some of the errors made by the candidates are as follows:

(i) Brown /yellow green precipitate was reported instead of brick red precipitate of cuprous oxide.

(ii) White or pink coloration was reported instead of white or pink precipitate.

(iii) Pink or red precipitate was reported instead of violet/purple ring at the junction of the two liquids.

(b) Candidates did not seem to have adequate practice in identification of organic compounds and in recording the observations. As a result, they did not understand the significance of adding reagents drop-wise so that changes at every step could be noted.

(i) Some candidates reported red/violet precipitate instead of coloration or solution.

(ii) Several candidates wrote - red precipitate turns blue green and finally black.

(iii) Green precipitate was written instead of green coloration.

(iv) Many candidates wrote that Violet precipitate changes to green/brown and with ammonium sulphide turns into red precipitate instead of violet colour changes to red colour.

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.
- Stress upon the use of correct quantity of reagent and explain what can occur with use of excess. Also tell students that adding drop wise is very important in order to see changes at every step.
- Advise students to write the experiment, observations and inferences in tabular form so that they may answer sequentially, instead of just reporting the final observation.
- Explain to the students the difference between precipitate/ solution/ coloration/ ring/ mirror/ layer.
- Emphasize the importance of identifying correct colours.
- Teachers must verify all coloration and precipitates before teaching the students.

MARKING SCHEME

Question 2.

(a) Substance **C-16**

(i) A brick red precipitate of cuprous oxide

(ii) White precipitate turns pink

(iii) A violet /purple layer -ring at the junction of two liquids.

Deduction: Substance C-16 is Glucose

(based on any two correct tests)

(b) **Substance C-17**:

(i) A violet / purple colouration solution

(ii) A deep red colour turns blue/green and or finally black solution

(iii) Pale green colouration

(iv) Violet colouration appears which fades to brown and then green, with ammonium sulphide turns intense red

Deduction: Substance C-17 is Aniline

(based on any two correct tests)

Question 3 **[7]**

Analyse qualitatively the substance **C-18** 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 carbonate ion, heat was used, which is incorrect.
- Lime water was added to the test tube which is incorrect; instead, carbon dioxide gas should have been passed into lime water
- Alternative test for chloride using salt mixture, concentrated sulphuric acid, manganese dioxide and heat was incorrectly done with solution, dilute acid and without heat.

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 wet test for chloride was performed with aqueous solution instead of neutralized soda extract; also, the white precipitate of silver chloride was not dissolved in excess of ammonium hydroxide, so distinction between carbonate and chloride was not confirmed.

(b) Preparation for original solution for cation detection was not done correctly by many candidates. Salt mixture or if residue of sodium carbonate extract was used, should have been dissolved in dilute HCl (hot or cold).

- Absence of group I was not reported by many candidates
- In some cases, group II precipitate was dissolved in dilute nitric acid without heating.
- Most of the candidates did not add concentrated nitric acid in group III and did not boil off H_2S gas.
- The order of preparing the buffer medium in group III was incorrect in a few cases.
- Some candidates did not report the absence of group IV.
- H_2S was not boiled off before group V reagents were added.
- The group V precipitate was not dissolved in hot acetic acid by some candidates.
- The order of barium, strontium, calcium was not observed. Only the presence of barium was to be reported instead, absence of strontium and calcium was mentioned by candidates.

– Practice mixture analysis and guide student on how to record formal group analysis correctly and meaningfully with pertinent group reagents.
– 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 H_2S before group III and V must be taught clearly.
– The BSC rule for group V must be explained.
– The solvent for the precipitate obtained in each group must be clearly understood otherwise the confirmatory test cannot be performed.

MARKING SCHEME

Question 3.

Substance **C-18**

Is a mixture of copper carbonate and barium chloride.

(O.S) Salt soluble in dil. HCl

CO_3^{2-}

Cl

O.S.

Gr.II

Gr.V

Cu^{+2}

Ba^{+2}

Carbonate : Salt + dil. H_2SO_4 – brisk effervescence gas evolved which turns lime water milky - CO_3^{2-} confirmed

Chloride: To the salt add concentrated H_2SO_4, heat and add a pinch of MnO_2. A dirty

Green gas is evolved which turns moist blue litmus red and then bleaches it. Also starch iodide paper turns blue.

OR

Chloride: Na_2CO_3 extract neutralise with dil. HNO_3, and add $AgNO_3$ solution – a white precipitate soluble in NH_4OH solution – Cl^{-1} confirmed.

O.S. – The solution is made in dil. HCl. (hot or cold)

Gr. I is absent.

Gr.II –Pass H_2S gas through the solution of Group I. A black ppt. – Gr. II present.

With the filtrate of Group II absence of Group III & IV to be shown with pertinent Group reagents.

Gr.III

Boil off H_2S(g). Add NH_4Cl(s) and NH_4OH solution Group III absent.

Gr. IV

Pass H_2S(g) Group IV absent

Gr. V – With the solution of Gr. IV, boil of H_2S test with lead acetate paper, then add NH_4Cl solid NH_4OH solution and $(NH_4)_2CO_3$ solution in excess. A white (bluish) precipitate – Group V confirmed.

Cu^{+2} – Dissolve the black precipitate obtained in Group II in hot dil. HNO_3 (conc. HNO_3 or 33% HNO_3). Add NH_4OH in excess – a deep blue colour - Cu^{+2} confirmed.

OR

Add potassium ferrocyanide solution – a brown precipitate - Cu^{+2} confirmed.

Ba^{+2} – dissolve the white precipitate obtained in Group V in hot dil. Acetic acid and add a few drops of potassium chromate solution – yellow precipitate - Ba^{+2} confirmed.

Question 4

Show the following to the Visiting Examiner for assessment:

(a) Project **[7]**

(b) Chemistry Practical File. **[3]**

GENERAL COMMENTS:

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

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

(b) Concepts in which candidates got confused:

- Confusion between precipitate/coloration/solution/ring/mirror while reporting organic compounds and use of excess of reagent.
- Solubility of mixture/neutralized sodium carbonate extract and the BSC rule for group V cations.

(c) Suggestions for students:

- Listen to the teachers instructions carefully, read the experiment thoroughly and then perform them.
- Develop a habit of observation and note down your observations 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.
- Remember to tabulate your readings neatly, keeping in mind concordant readings and avoid overwriting in the tabular column. Do not leave your tabulation in pencil.
- Do not round off molarity values, report to a minimum four decimal places (refer to the syllabus).
- Follow the molecular formula given in the question paper, whether it is hydrated or anhydrous.
- 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 if barium is present only report barium.
- Group VI must be reported with the filtrate after group V is reported absent and not with the original solution.