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ISC 2009
CHEMISTRY
PAPER-2 (PRACTICAL)

- **SOLUTION OF 2009**
- **COMMENTS OF COUNCIL EXAMINERS**
- **SUGGESTIONS FOR TEACHERS**

Dedicated to all my lovely students. May God help you always.

This small booklet contains solution of ISC 2009 Chemistry Paper-2 (Practical).

The comments from the council examiners under solution of every question makes this a very handy guide for students to understand what the council expects as answer from the students.

I hope that the students will find this to be useful.

- *Md. Zeeshan Akhtar*

01st February, 2018.

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CHEMISTRY PAPER 2 (PRACTICAL)

Question 1 [8]

You are provided with two solutions as follows:

(a) **C-10** is a solution prepared by dissolving 16.7 gms of Copper sulphate crystals, $CuSO_4.5H_2O$ per litre.

(b) **C-11** is a solution prepared by dissolving 17 gms of impure Sodium thiosulphate crystals, $Na_2S_2O_3.5H_2O$ per litre.

PROCEDURE:-

Rinse and fill the burette with sodium thiosulphate solution **C-11.** Pipette out 20 ml or 25 ml of the copper sulphate solution **C-10** into a clean conical flask. To this, add sodium carbonate solution, **C-12** dropwise until a slight precipitate or turbidity is formed. Now add acetic acid solution **C-13** dropwise till the precipitate or turbidity disappears on shaking.

Then add 20 ml of potassium iodide solution, **C-14.** Shake the contents of the conical flask thoroughly and allow it to stand for three minutes, covering with a watch glass.

Titrate the liberated iodine with sodium thiosulphate solution **C-11** with constant stirring, until the reddish brown colour of the solution changes to light yellow. Add 2 ml of starch solution, **C-15.** Continue the addition of sodium thiosulphate solution until the blue colour starts to fade. At this stage, add 10 ml of ammonium thiocyanate solution, **C-16.** Continue the titration till the blue colour just disappears.

Repeat the experiment to get at least two concordant readings.

Tabulate your readings.

State:

(i) the capacity of the pipette used,

(ii) 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:

$$2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$$

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

OR

$$2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$$

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

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Relative atomic masses:

Cu = 64 Na = 23 S =32 O = 16 H = 1

Calculate the following:

(a) The **molarity** of copper sulphate solution, **C-10**.

(b) The **molarity** of sodium thiosulphate solution **C-11**.

(c) The **strength** of sodium thiosulphate solution in grams per litre.

(d) The **percentage purity** of the sample of sodium thiosulphate that was used in the preparation of **C-11.**

Comments of Examiners

A number of candidates did not seem to be aware of the significance of tabulating the readings. They did not write the initial and the final burette readings. Candidates were also not aware of the importance of concordant reading.

(a) The molecular weight of copper sulphate penta hydrate was taken as 249.5 instead of 250 because the students did not read the question paper where atomic mass of copper was given as '64' instead they used '63.5'.

(b) Wrong formula used for calculating molarity of sodium thiosulphate due to lack of awareness of theoretical concepts $\frac{V_1M_1}{V_2M_2}=\frac{n_1}{n_2}$.

(c) Since candidates rounded off the value of molarity in (a) and (b) and used only two places after the decimal instead of four places, they lost marks due to arithmetical error.

(d) Some candidates calculated the water of crystallization of copper sulphate instead of the percentage purity of sodium thiosulphate, since they did not read the question carefully.

Suggestions for teachers

- The basic concept of volumetric analysis should be explained and revised with the students.
- Give sufficient practice in calculating percentage purity and water of crystallization for all oxidation-reduction titrations in the syllabus.
- Insist that students tabulate the titre value correctly. Teach them how to titrate accurately, drop-wise, so that they get the correct value and do not manipulate the readings. Insist on one trial run and two concordant readings. Tell them that the average should not be taken for titre value and overwriting should be strictly discouraged in the table.
- Insist that the students write upto four decimal places, at least in the calculation of molarities and two decimal places in percentage purity.
- Explain that only for pure compounds, students can use molarity as equal to weight dissolved per litre / molecular weight. For impure substances, students must use titre value and the required formula for molarity.
- Importance of reading the question paper and following the instructions given there must be emphasized.

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MARKING SCHEME

Question 1.

Calculations (4 marks)

(i) Molarity of Copper sulphate solution (C-10)

$$\text{Molarity} = \frac{\text{Strentth in gl}^{-1}}{\text{Molecular weight}}$$

$$= \frac{16.7}{250}$$

$$= 0.0668$$

(ii) Molarity of solution C-11 of Sodium thiosulphate.

Let the titre value be = 21 cm^3 (or ml)

and volume of pipette = 20 cm^3

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

M_1 = Molarity of Copper sulphate

V_1 = Volume of Copper sulphate

n_1 = No of moles of Copper sulphate

M_2 = Molarity of Sodium thiosulphate

V_2 = Volume of Sodium thio-sulphate (Volume of pipette)

n_2 = No. of moles of Sodium thiosulphate.

$$\frac{0.0668 \times 20}{M_2 \times 21} = \frac{2}{2}$$

$\therefore M_2 = 0.0636$

(iii) Strength of Sodium thiosulphate solution in grams per litre.

Strength in gm l^{-1} = Molarity × Molecular weight

= 0.0636 × 248

= 15.7728

(iv) Percentage purity of $Na_2S_2O_3.5H_2O$

% purity = (pure weight/impure weight) x 100

$$= \frac{15.7728}{17} \times 100 = 92.78\%$$

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Question 2 [5]

You are provided with two organic compounds, **C-17** and **C-18**.

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

(a) Substance **C-17**

(i) Take few drops of **C-17** in a clean test tube. Add a few drops of saturated solution of sodium bisulphite and shake the mixture well.

(ii) Take about 1 ml of **C-17** in a test tube and add a few crystals of iodine (or a solution of iodine in KI). Now add 10% NaOH solution carefully till no further change takes place. Heat the contents on a water bath for a few minutes and then allow to cool.

(iii) Take about 0.5 ml of **C-17** in a test tube and to this add about 1 ml of sodium nitroprusside solution. Mix the contents of the test tube well. Now add 2 ml of NH_4OH and shake the mixture. Warm the mixture on a water bath and allow it to cool.

(iv) Take about 0.5 ml of mercuric chloride solution in a test tube. Add a few drops of dilute NaOH carefully till no further change occurs. To the above, add substance **C-17** drop-wise till the additional drop has no effect on the contents.

(b) <u>Substance **C-18**</u>

(i) Take 3 - 4 drops of **C-18** in a test tube. Add about 0.5 g of potassium hydrogen sulphate and heat strongly.

(ii) Add about 5 ml of water to about 0.2 gm of borax in a test tube and shake well to get a clear solution. To the above solution, add 1–2 drops of phenolphthalein. Now add 2–3 drops of compound **C-18**. Shake well again. Warm and cool.

(iii) Take about 4–5 drops of compound **C-18** in a test tube. Add about 1 ml of copper sulphate solution followed by a few drops of sodium hydroxide solution.

Show the results as required to the Visiting Examiner.

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Comments of Examiners

Candidates made mistakes in the observation of precipitate / solution / colouration. Sequential observations were not listed. Though the question clearly stated write down all changes taking place at each step of the experiment, candidates tended to give a summary. As a result, observations did not tally with the order of the experiment. Some of the errors made by candidates are as follows:

(a)(i) White colour, white crystalline solution etc. was given instead of white precipitate.

(ii) Yellow iodoform was mentioned instead of 'yellow precipitate'.

(iii) Wine red colouration was mentioned instead of 'violet colouration'.

(iv) Dissolution of precipitate was not mentioned since many students did not add the required quantity of reagent.

(b)(i) Offensive/obnoxious/poisonous gas was mentioned instead of 'pungent irritating odour'.

(ii) Sequential observations were not recorded in many cases, therefore, the observations lost their meaning.

(iii) Candidates observed 'blue precipitate' instead of 'blue colouration'.

Candidates did not seem to have adequate practice in identification of organic compounds and recording the observations. As a result, they did not use the exact amounts of chemicals specified, nor maintained the exact conditions of the experiment.

Suggestions for teachers

- The chemistry of the organic tests along with the physical properties of organic substances should be taught to the students so that they understand the changes and do not work mechanically.
- Emphasize upon the use of correct quantity of reagents and explain what can occur with excess.
- Advise students to write the experiment, observations and inference in tabular form so that they may answer sequentially instead of just reporting final observation.
- Explain to the students the difference between precipitate/ solution / colouration.
- Emphasize the importance of identifying correct colours as slight variation can be incorrect.

MARKING SCHEME

Question 2.

Organic analysis

(a) **Substance C-17**

(i) White crystalline precipitate.

(ii) Yellow precipitate with characteristic odour of iodoform

(iii) Wine red colouration changes to violet

(iv) Yellow precipitate formed which dissolves/disappears on adding C-17

Deduction – substance **C -17** is acetone based on 2 correct tests

(b) **Substance C-18.**

(i) Pungent / irritating smell of acrolein.

(ii) Pink colour disappears on adding **C-18,** reappear on warming and disappears on cooling. *(any two right)*

(iii) Blue colouration

Deduction – substance C-18 is glycerol based on 2 correct tests.

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Question 3

[7]

Analyse qualitatively the substance **C-19** 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.

(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.

Comments of Examiners

Majority of candidates appeared to have not understood the principle of group separation and group analysis. They used either the solid mixture in the first group and the original solution in all subsequent groups, and not the filtrate of the previous group.

The formal group reagents for the respective groups were not used by many candidates. Common errors were: boiling of H_2S in group III and V, concentrated nitric acid in group III and order of reagents in group V.

(a) Wet test for anions was done using either the aqueous solution or soda extract instead of neutralized soda extract.
- The solubility of the white precipitate obtained for the sulphate test in mineral acid was not mentioned.
- Many centres used lead acetate solution instead of barium chloride solution for sulphate ion.
- Neutral sodium carbonate extract and neutral solution of ferric chloride was not used for the acetate test; instead, aqueous solution and ferric chloride was used.
- Ester test was done using aqueous solution instead of the salt mixture.

(b) Preparation of original solution for cation detection was not done correctly.
- Most of the candidates did not use concentrated nitric acid in group III.
- The order of preparing the buffer medium in group III was incorrect.
- The precipitate of group III was not dissolved in minimum amount of dilute HCl.
- Identification of group VI was done with original solution instead of the filtrate of group V.

Suggestions for teachers
- Teach students the steps for preparing the original solution.
- Insist that the wet test for anions should be performed with neutralized sodium carbonate extract.
- 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 students on how to record formal group analysis correctly and meaningfully with pertinent group reagents.
- Instruct students on how to differentiate between sulphite and sulphate ion and teach them the use of correct group reagents regularly used, instead of reagents which are not acceptable.

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MARKING SCHEME

Question 3.

Mixture **C-19** contains aluminium acetate and magnesium sulphate in the ratio 1 : 1 by mass.

Mark distribution:

Preparation of original solution

Presence of acetate

Presence of sulphate

Presence of group III after reporting absence of group I and II

Confirmation of Al^{3+}

Presence of group VI after reporting absence of group IV and V

Confirmation of Mg^{2+}

Details of Test

Original solution is made in aqueous solution/dilute HCl or dilute HNO_3.

Acetate ion

Mixture - salt/C_{18} when heated with a little concentrated H_2SO_4 and ethanol gives strong fruity odour of ethyl acetate.

OR

The Na_2CO_3 extract of the mixture is neutralized with dilute mineral acid (not acetic acid). Neutral $FeCl_3$ solution is added and heated. A wine red colouration is obtained which turns into a reddish brown precipitate on heating. Acetate confirmed.

- Sulphate ion:

  Soda extract neutralised with dilute HCl/dilute HNO_3 , $BaCl_2$ solution is added. White precipitate insoluble in all mineral acids. SO_4^{2-} confirmed.

- After reporting absence of Group I and II, with appropriate reagents/test for Group III, boil off H_2S from the solution after group II. Test with lead acetate paper. Add a few drops of concentrated nitric acid, boil (to convert ferrous to ferric). Cool, add ammonium chloride solid and ammonium hydroxide solution till ammoniacal. White gelatinous precipitate obtained. Group III test could be done with O.S. also.

Group III present.

- Test for Al^{3+}

  White gelatinous precipitate is dissolved in minimum quantity of HCl and to the solution add blue litmus solution and ammonium hydroxide till alkaline. Blue floating precipitate is obtained (Lake Test).

  OR

  White precipitate is dissolved in minimum quantity of dilute HCl. Then add NaOH. First a little then in excess, a white precipitate is obtained which dissolves in excess. Al^{3+} is confirmed.

  After showing absence of Group IV and V systematically, test for Group VI.

Group VI present.

Concentrate the filterate after group V to half its quantity. Add a pinch of ammonium chloride solid, ammonium hydroxide solution and saturated solution of di sodium hydrogen phosphate. White precipitates group VI

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present.

OR

Test for Mg^{++}:

To the filterate of Group V, add excess of dilute sodium hydrogen phosphate and few drops of NH_4OH. Shake well and scratch the walls of the test tube with a glass rod.

White crystalline precipitate on standing confirms Mg^{++}.

Topics found Difficult/confusing:-

- Concepts of molarity based on gm/l and molecular weight for pure substances; molarity based on titre value.
- Confusion between precipitate / colouration / solution while reporting organic compounds.
- Principles of formal group analysis.

Suggestions for Candidates

- Listen to the teachers' instructions carefully. Read the experiment thoroughly and then perform them.
- Develop a habit of observation and write the observations correctly and to the point.
- Practice makes perfect. Therefore, practice as many unknown salt mixtures as possible.
- Remember to tabulate your readings neatly keeping in mind concordant reading and avoid overwriting in titration.
- Do not round off molarity values. Report to minimum four decimal places.
- Learn all the tests and 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 forget the use of concentrated nitric acid in group III.

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