ICSE Class 10 Chemistry Specimen Paper 2

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Maximum Marks: 80 | Time Allowed: Two hours | Reading Time: 15 minutes

Section A is compulsory. Attempt any four questions from Section B.

General Instructions

Write your answers on the separate answer paper provided. The first 15 minutes are for reading the paper, and you may not write during that time. Marks for each question, or part of a question, are shown in brackets. All working for numerical questions must be shown on the same sheet as the answer. Equations should be balanced. Take the molar volume of a gas at stp as 22.4 dm^3 and Avogadro's number as 6.022 x 10^{23}. Relative atomic masses are given where they are needed. Structures and electron dot diagrams should be drawn in pencil and labelled.

SECTION A (40 Marks)

Attempt all questions from this Section.

Question 1 [15]

Choose the correct answer for each part. Write only the option you choose.

(i) The element of Period 2 with the largest atomic size is:

(a) carbon (b) oxygen (c) lithium (d) fluorine

(ii) On moving down Group 2 from beryllium to barium, the metallic character:

(a) increases (b) decreases

(c) stays the same (d) rises and then falls

(iii) The number of shared pairs of electrons in a molecule of nitrogen is:

(a) one (b) three (c) two (d) four

(iv) A compound with a high melting point which conducts electricity only when molten or dissolved is held together by:

(a) covalent bonds (b) coordinate bonds

(c) weak intermolecular forces (d) ionic bonds

(v) The salt whose aqueous solution turns red litmus blue is:

(a) sodium carbonate (b) ammonium chloride

(c) sodium chloride (d) copper sulphate

(vi) A base that is soluble in water is called:

(a) an acid salt (b) a flux

(c) an alkali (d) an amphoteric oxide

(vii) A reddish brown precipitate that does not dissolve in excess sodium hydroxide solution is given by a solution containing:

(a) Fe^{2+} ions (b) Fe^{3+} ions

(c) Zn^{2+} ions (d) Pb^{2+} ions

(viii) The mass of 0.5 mole of carbon dioxide is:

(a) 11 g (b) 44 g (c) 88 g (d) 22 g

(ix) The vapour density of a gas is 22. Its relative molecular mass is:

(a) 11 (b) 22 (c) 44 (d) 66

(x) In the electrolysis of molten lead bromide, the product obtained at the cathode is:

(a) bromine (b) lead (c) oxygen (d) hydrogen

(xi) The strong electrolyte among the following is:

(a) dilute sulphuric acid (b) ethanoic acid

(c) carbonic acid (d) aqueous ammonia

(xii) Zinc oxide is reduced to zinc in a furnace by:

(a) hydrogen (b) aluminium (c) sodium (d) carbon

(xiii) Ammonia is not dried over concentrated sulphuric acid because the acid:

(a) is too costly (b) is a reducing agent

(c) reacts with ammonia (d) is not a drying agent

(xiv) Dilute nitric acid reacts with copper to give mainly:

(a) nitric oxide (b) hydrogen

(c) nitrogen dioxide (d) nitrogen

(xv) The general formula of an alkene is:

(a) C_nH_{2n+2} (b) C_nH_{2n-2}

(c) $C_nH_{2n+1}OH$ (d) C_nH_{2n}

Question 2 [10]

(i) State what is meant by the term electron affinity, and state how it changes on moving down a group. **[2]**

(ii) State what is seen when ammonium hydroxide solution is added, first a little and then in excess, to copper sulphate solution. **[2]**

(iii) Calculate the mass of 5.6 dm^3 of nitrogen measured at stp. (N = 14) **[2]**

(iv) Give a reason why hydrogen chloride gas is not collected over water, and name the liquid used to dry it. **[2]**

(v) Give the IUPAC name of $CH_3–CH_2–CHO$ and name the functional group present in it. **[2]**

Question 3 [15]

(i) Draw the electron dot structure of a molecule of water and of a molecule of nitrogen. State the number of lone pairs carried by the oxygen atom in water. (H = 1, O = 8, N = 7) **[3]**

(ii) Define each of the following terms: base, alkali, neutralisation. **[3]**

(iii) Acidified water is electrolysed using platinum electrodes. Name the product formed at each electrode, write the reaction at the cathode, and state why a little sulphuric acid is added to the water. **[3]**

(iv) Name the chief ore of iron, name the substance that reduces the ore in the blast furnace, and state the purpose of adding limestone to the charge. **[3]**

(v) Calculate the percentage by mass of nitrogen in ammonium nitrate. (N = 14, H = 1, O = 16) **[3]**

SECTION B (40 Marks)

Attempt any four questions from this Section.

Question 4 [10]

(a) State how electronegativity changes across Period 3 and how it changes down Group 17, giving a reason for each trend. **[3]**

(b) An element Y has 12 protons in its nucleus. Write its electronic configuration, state its group and period, and state whether it is a metal or a non-metal, giving a reason. **[3]**

(c) Explain, in terms of the transfer of electrons, how magnesium chloride is formed from magnesium and chlorine. State the charge carried by each ion formed and name the type of bond present in the compound. (Mg = 12, Cl = 17) **[4]**

Question 5 [10]

(a) Define a normal salt, an acid salt and a basic salt, and give one example of each. [3]

(b) State the method you would use to prepare each of the following salts, giving a reason in each case: barium sulphate, potassium nitrate, zinc sulphate. [3]

(c) Ammonium hydroxide solution is added, first a little and then in excess, to separate solutions of lead nitrate, zinc sulphate, copper sulphate and iron(III) chloride. State what is seen in each case. [4]

Question 6 [10]

(a) State Gay-Lussac's law of combining volumes. Calculate the volume of hydrogen that combines with 20 cm^3 of nitrogen to form ammonia, all volumes being measured at the same temperature and pressure. [3]

(b) A compound contains 26.5 per cent potassium, 35.4 per cent chromium and 38.1 per cent oxygen by mass. Calculate its empirical formula. (K = 39, Cr = 52, O = 16) [3]

(c) Calcium carbonate decomposes on heating as $CaCO_3 \rightarrow CaO + CO_2$. Calculate the mass of calcium oxide and the volume of carbon dioxide at stp obtained by heating 25 g of calcium carbonate. (Ca = 40, C = 12, O = 16) [4]

Question 7 [10]

(a) Define an electrolyte and a non-electrolyte, giving one example of each. State what is meant by a weak electrolyte. [3]

(b) Copper sulphate solution is electrolysed using platinum electrodes. Name the product formed at each electrode and state what happens to the colour of the solution as the electrolysis goes on. [3]

(c) Name the electrolyte and the material used for each electrode in the electro-refining of copper. Write the reaction at the anode and at the cathode, and state what collects below the anode. [4]

Question 8 [10]

(a) Define each of the following terms: mineral, ore, slag. [3]

(b) In the electrolytic extraction of aluminium, state why the alumina is dissolved in fused cryolite, name the material used for the anode, and state why the anode has to be replaced from time to time. [3]

(c) Name the three stages of the Ostwald process for the manufacture of nitric acid, write the equation for each stage, and name the catalyst used in the first stage. [4]

Question 9 [10]

(a) Give the IUPAC name of each of the following: (1) $CH_3–CH_2–OH$, (2) $CH_3–CO–CH_3$, (3) $CH{\equiv}CH$. [3]

(b) Name the products formed when ethanoic acid is warmed with ethanol in the presence of a little concentrated sulphuric acid. Write the equation and name the type of reaction. [3]

(c) State what is seen, name the products, and write the equation, when hydrogen chloride is (1) passed into silver nitrate solution and (2) brought into contact with ammonia gas. State one test by which hydrogen chloride can be distinguished from ammonia. [4]

ANSWER KEY AND MARKING SCHEME

Full working is given for every numerical. Marks shown in italics are the step marks an examiner would award. Accept any correct alternative method that reaches the same answer, and accept correctly balanced equations written in words or in symbols.

Question 1 [15]

(i) (c) lithium. Atomic size falls across a period, so the first member of the period is the largest.

(ii) (a) increases. The atoms get larger down the group and lose their outer electrons more readily.

(iii) (b) three. Each nitrogen atom has five outer electrons and shares three of them, giving a triple bond.

(iv) (d) ionic bonds. The ions are fixed in the solid lattice and move only when the lattice breaks down on melting or dissolving.

(v) (a) sodium carbonate. It is the salt of a strong base and a weak acid, so its solution is alkaline.

(vi) (c) an alkali.

(vii) (b) Fe^{3+} ions. Iron(III) hydroxide is reddish brown and is insoluble in excess alkali.

(viii) (d) 22 g. Molecular mass of CO_2 = 44, and 0.5 x 44 = 22 g.

(ix) (c) 44. Relative molecular mass = 2 x vapour density = 2 x 22.

(x) (b) lead.

(xi) (a) dilute sulphuric acid. It is almost completely ionised in solution, while the other three are only slightly ionised.

(xii) (d) carbon. Coke reduces the oxide in the furnace and is itself oxidised to carbon monoxide.

(xiii) (c) reacts with ammonia. Ammonia is basic and forms ammonium sulphate with the acid.

(xiv) (a) nitric oxide.

(xv) (d) C_nH_{2n}.

1 mark for each correct option. No marks are deducted for a wrong option.

Question 2 [10]

(i) Electron affinity is the energy given out when a neutral gaseous atom gains an electron to form a negative ion. On moving down a group the electron affinity falls, because the atom gets larger and the incoming electron is held less strongly by the nucleus.

Definition 1. Trend down the group 1.

(ii) A pale blue precipitate of copper hydroxide appears first. When the ammonium hydroxide is added in excess the precipitate dissolves and a deep blue solution is left.

Pale blue precipitate 1. Dissolves in excess to a deep blue solution 1.

(iii) Number of moles = 5.6/22.4 = 0.25 mol. Nitrogen exists as N_2, so its molecular mass is 28. Mass = 0.25 x 28 = 7 g.

Moles 0.25 1. Mass 7 g 1.

(iv) Hydrogen chloride is extremely soluble in water, so it would dissolve instead of collecting over it. The gas is dried by passing it through concentrated sulphuric acid.

Reason 1. Drying agent 1.

(v) Propanal. The functional group present is the aldehyde group, –CHO.

IUPAC name 1. Functional group 1.

Question 3 [15]

(i) In water the oxygen atom shares one electron with each of the two hydrogen atoms, giving two single covalent bonds, and the oxygen atom keeps two lone pairs. In nitrogen each atom shares three electrons with the other, giving a triple bond of three shared pairs, and each nitrogen atom keeps one lone pair. The oxygen atom in water carries two lone pairs.

Water structure 1. Nitrogen structure 1. Two lone pairs on oxygen 1.

(ii) Base: a substance, usually the oxide or hydroxide of a metal, that reacts with an acid to give a salt and water only. Alkali: a base that is soluble in water and gives hydroxide ions in solution. Neutralisation: the reaction between an acid and a base in which the two destroy each other's properties and give a salt and water only.

1 mark for each definition.

(iii) Hydrogen is set free at the cathode and oxygen at the anode, in the ratio of two volumes to one. Cathode: $2H^+ + 2e^- \rightarrow H_2$. The sulphuric acid is added because pure water is a very weak electrolyte with too few ions to carry the current, and the acid supplies the ions without being used up itself.

Products at the two electrodes 1. Cathode reaction 1. Reason for adding the acid 1.

(iv) The chief ore of iron is haematite, Fe_2O_3. The ore is reduced in the blast furnace by carbon monoxide, which is formed when coke burns in a limited supply of air. Limestone decomposes to calcium oxide, which combines with the silica impurity and carries it off as a fusible slag of calcium silicate.

Haematite 1. Carbon monoxide 1. Purpose of limestone 1.

(v) The formula of ammonium nitrate is NH_4NO_3. Molecular mass = 14 + 4 + 14 + 48 = 80. Mass of nitrogen in one mole = 2 x 14 = 28 g. Percentage of nitrogen = (28/80) x 100 = 35 per cent.

Molecular mass 80 1. Mass of nitrogen 28 1. Answer 35 per cent 1.

Question 4 [10]

(a) Across Period 3 the electronegativity rises, because the nuclear charge increases while the atoms get smaller, so the pull on a shared pair of electrons grows stronger. Down Group 17 the electronegativity falls, because each element has one more shell than the one above it, the bonding electrons lie further from the nucleus and are better screened, and the pull on them is weaker.

Trend across the period 1. Trend down the group 1. Reasons 1.

(b) Twelve protons means twelve electrons, so the configuration is 2, 8, 2. There are two electrons in the outermost shell, so the element is in Group 2, and there are three shells, so it is in Period 3. It is a metal, because it has only two electrons in its outermost shell and loses them easily to form a positive ion.

Configuration 2, 8, 2 1. Group 2 and Period 3 1. Metal with reason 1.

(c) A magnesium atom has the configuration 2, 8, 2 and a chlorine atom has 2, 8, 7. The magnesium atom gives away its two outermost electrons and takes the stable configuration 2, 8, forming Mg^{2+}. Each chlorine atom takes one of these electrons and completes its octet to give 2, 8, 8, forming Cl^-. Two chlorine atoms are needed for each magnesium atom, so the compound is $MgCl_2$. The magnesium ion carries a charge of 2+ and each chloride ion a charge of 1–, and the oppositely charged ions are held by strong electrostatic attraction, which is an ionic or electrovalent bond.

Transfer from magnesium 1. Gain by the two chlorine atoms 1. Charges on the ions 1. Ionic bond named 1.

Question 5 [10]

(a) Normal salt: a salt formed when all the replaceable hydrogen of an acid has been replaced by a metal, for example sodium chloride. Acid salt: a salt formed when only part of the replaceable hydrogen of a polybasic acid has been replaced, so a replaceable hydrogen atom is left, for example sodium hydrogen carbonate. Basic salt: a salt formed when only part of the hydroxide of a base has been replaced by an acid radical, so a hydroxide group is left, for example basic lead nitrate, $Pb(OH)NO_3$.

1 mark for each definition with its example.

(b) Barium sulphate: precipitation, because it is insoluble in water and is thrown down when barium chloride solution is added to dilute sulphuric acid or to a soluble sulphate. Potassium nitrate: neutralisation of potassium hydroxide solution by dilute nitric acid, because it is a soluble salt of a very reactive metal, which cannot be added to the acid directly. Zinc sulphate: the action of dilute sulphuric acid on zinc, because zinc is a moderately reactive metal that displaces hydrogen from the acid.

1 mark for each salt with a correct reason.

(c) Lead nitrate: a white precipitate of lead hydroxide forms, and it does not dissolve in excess ammonium hydroxide. Zinc sulphate: a white precipitate of zinc hydroxide forms, and it dissolves in excess to give a colourless solution. Copper sulphate: a pale blue precipitate of copper hydroxide forms, and it dissolves in

excess to give a deep blue solution. Iron(III) chloride: a reddish brown precipitate of iron(III) hydroxide forms, and it does not dissolve in excess.

1 mark for each solution, the colour and the behaviour in excess both being needed.

Question 6 [10]

(a) Gay-Lussac's law: when gases react they do so in volumes that bear a simple whole number ratio to one another and to the volumes of any gaseous products, all volumes being measured at the same temperature and pressure. From $N_2 + 3H_2 \rightarrow 2NH_3$, one volume of nitrogen needs three volumes of hydrogen, so 20 cm^3 of nitrogen needs 20 x 3 = 60 cm^3 of hydrogen.

Statement of the law 1. Use of the 1 : 3 ratio 1. Answer 60 cm^3 1.

(b) Potassium: 26.5/39 = 0.679. Chromium: 35.4/52 = 0.681. Oxygen: 38.1/16 = 2.381. Dividing each by the smallest, 0.679, gives K = 1, Cr = 1.00, O = 3.50. Multiplying throughout by 2 to clear the fraction gives K = 2, Cr = 2, O = 7. The empirical formula is $K_2Cr_2O_7$.

Division by atomic masses 1. Ratio 1 : 1 : 3.5 1. Formula $K_2Cr_2O_7$ after doubling 1.

(c) Molecular mass of $CaCO_3$ = 40 + 12 + 48 = 100, so 25 g is 25/100 = 0.25 mol. The equation shows that one mole of the carbonate gives one mole of calcium oxide and one mole of carbon dioxide. Mass of CaO = 0.25 x 56 = 14 g. Volume of CO_2 at stp = 0.25 x 22.4 = 5.6 dm^3.

Moles of carbonate 0.25 1. Mass of calcium oxide 14 g 1.5. Volume of carbon dioxide 5.6 dm^3 1.5.

Question 7 [10]

(a) An electrolyte is a substance that conducts electricity in the molten state or in aqueous solution and is broken down by it, for example dilute sulphuric acid. A non-electrolyte does not conduct in either state, because it has no ions, for example sugar solution or carbon tetrachloride. A weak electrolyte is one that is only slightly ionised in solution, so it conducts poorly, for example ethanoic acid.

Electrolyte with example 1. Non-electrolyte with example 1. Weak electrolyte 1.

(b) Copper is deposited as a pink brown layer on the cathode and oxygen is given off at the anode. The blue colour of the solution slowly fades, because copper ions leave the solution at the cathode and nothing replaces them, the platinum anode being unattacked. The solution gradually turns into dilute sulphuric acid.

Copper at the cathode 1. Oxygen at the anode 1. Blue colour fades with reason 1.

(c) Electrolyte: copper sulphate solution acidified with a little dilute sulphuric acid. Anode: a thick block of impure copper. Cathode: a thin sheet of pure copper. Anode: $Cu - 2e^- \rightarrow Cu^{2+}$, so the impure copper dissolves. Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$, so pure copper is deposited. The impurities that do not dissolve settle below the anode as anode mud, which contains the silver and gold present in the crude copper.

Electrolyte 1. Both electrodes 1. Both reactions 1. Anode mud 1.

Question 8 [10]

(a) Mineral: a naturally occurring substance, found in the earth, that contains a metal in the combined or free state. Ore: a mineral from which a metal can be extracted conveniently and at a profit, so every ore is a mineral but not every mineral is an ore. Slag: the fusible substance formed when the flux combines with the gangue, which floats on the molten metal and is run off.

1 mark for each definition.

(b) Alumina melts only above 2000 °C, which is far too high to work with. Dissolving it in fused cryolite brings the working temperature down to about 950 °C and makes the melt a much better conductor of electricity. The anode is made of graphite. The oxygen set free at the anode attacks the hot carbon and burns it away as carbon monoxide and carbon dioxide, so the anode wears down and has to be replaced from time to time.

Purpose of cryolite 1. Graphite anode 1. Oxygen burns the carbon away 1.

(c) Stage one, catalytic oxidation of ammonia: $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$. Stage two, oxidation of nitric oxide by air: $2NO + O_2 \rightarrow 2NO_2$. Stage three, absorption in water in the presence of excess air: $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$. The catalyst used in the first stage is platinum, in the form of a heated gauze.

Stage one with equation 1. Stage two with equation 1. Stage three with equation 1. Platinum catalyst 1.

Question 9 [10]

(a) (1) Ethanol. (2) Propanone. (3) Ethyne.

1 mark for each correct name.

(b) The products are ethyl ethanoate and water. $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$. The reaction is esterification, and the concentrated sulphuric acid acts as a dehydrating agent that drives the reaction forward.

Products named 1. Equation 1. Esterification named 1.

(c) (1) Hydrogen chloride passed into silver nitrate solution: a thick white precipitate of silver chloride appears, and it is insoluble in dilute nitric acid but dissolves in excess ammonium hydroxide. $AgNO_3 + HCl \rightarrow AgCl + HNO_3$. (2) Hydrogen chloride brought near ammonia gas: dense white fumes of ammonium chloride are formed in the air between them. $NH_3 + HCl \rightarrow NH_4Cl$. Test: hydrogen chloride turns moist blue litmus paper red, while ammonia turns moist red litmus paper blue.

Observation and equation in (1) 1.5. Observation and equation in (2) 1.5. Test 1.