ICSE Class 10 Chemistry Specimen Paper 1

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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) Across Period 3, from sodium to chlorine, the atomic size:

(a) increases (b) decreases

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

(ii) On moving down Group 1 from lithium to caesium, the ionisation potential:

(a) increases (b) stays the same

(c) falls and then rises (d) decreases

(iii) The substance that conducts electricity when molten but not when solid is:

(a) sodium chloride (b) hydrogen chloride

(c) carbon tetrachloride (d) methane

(iv) The bond formed when a molecule of ammonia joins a hydrogen ion is:

(a) ionic (b) covalent (c) coordinate (d) metallic

(v) Sodium hydrogen sulphate is an example of:

(a) a normal salt (b) an acid salt

(c) a basic salt (d) a complex salt

(vi) An aqueous solution of ammonium chloride has a pH:

(a) of exactly 7 (b) a little above 7

(c) a little below 7 (d) of 14

(vii) The solution that gives a white precipitate which dissolves in excess sodium hydroxide solution is:

(a) zinc sulphate (b) calcium nitrate

(c) iron(II) sulphate (d) copper sulphate

(viii) The number of molecules present in 8 g of oxygen gas is:

(a) 3.01 x 10^{22} (b) 3.01 x 10^{23}

(c) 6.02 x 10^{23} (d) 1.51 x 10^{23}

(ix) The volume occupied by 11 g of carbon dioxide at stp is:

(a) 2.8 dm^3 (b) 5.6 dm^3

(c) 11.2 dm^3 (d) 22.4 dm^3

(x) During the electrolysis of acidified water, the gas set free at the anode is:

(a) hydrogen (b) chlorine (c) carbon dioxide (d) oxygen

(xi) The electrolyte used in silver plating an article is:

(a) silver nitrate solution (b) silver chloride solution

(c) potassium argentocyanide solution (d) dilute sulphuric acid

(xii) A sulphide ore is concentrated by:

(a) froth flotation (b) hydraulic washing

(c) magnetic separation (d) calcination

(xiii) Ammonia gas is dried using:

(a) concentrated sulphuric acid (b) quicklime

(c) phosphorus pentoxide (d) anhydrous calcium chloride

(xiv) Concentrated sulphuric acid acts as a dehydrating agent when it is poured on:

(a) copper turnings (b) sodium chloride

(c) potassium nitrate (d) sugar

(xv) The functional group present in ethanoic acid is:

(a) –OH (b) –CHO (c) –COOH (d) >C=O

Question 2 [10]

(i) Explain why the size of an atom falls on moving from left to right across a period, although the nuclear charge is rising. **[2]**

(ii) Name the gas given off, and state what is seen, when sodium hydroxide solution is warmed with ammonium sulphate. **[2]**

(iii) Calculate the number of moles present in 7.1 g of chlorine gas. (Cl = 35.5) **[2]**

(iv) State why concentrated nitric acid is kept in dark coloured bottles, and name the gas that causes the acid to turn yellow. **[2]**

(v) Write the structural formula of ethyne and state the type of bond joining its two carbon atoms. **[2]**

Question 3 [15]

(i) Draw the electron dot structure of a molecule of carbon tetrachloride. State the number of shared pairs in the molecule and the number of lone pairs on each chlorine atom. (C = 6, Cl = 17) **[3]**

(ii) State the method you would choose to prepare each of the following salts, giving a reason in each case: lead chloride, sodium sulphate, anhydrous iron(III) chloride. **[3]**

(iii) Molten lead bromide is electrolysed using graphite electrodes. Write the reaction taking place at the cathode and at the anode, and name the product formed at each. **[3]**

(iv) Define each of the following terms used in metallurgy: ore, gangue, flux. **[3]**

(v) A sample of sulphur dioxide occupies 2.24 dm^3 at stp. Calculate its mass, the number of molecules it contains, and the vapour density of the gas. (S = 32, O = 16) **[3]**

SECTION B (40 Marks)

Attempt any four questions from this Section.

Question 4 [10]

(a) State how each of the following changes on moving down Group 17 from fluorine to iodine, giving a reason in each case: atomic size, ionisation potential, non-metallic character. **[3]**

(b) An element X has the electronic configuration 2, 8, 7. State its group and its period, give the symbol and charge of the ion it forms, and write the formula of the compound it forms with magnesium. **[3]**

(c) Compare an ionic compound and a covalent compound with respect to the way the bond is formed, the melting point, the conduction of electricity, and the solubility in water. Name one compound of each kind. **[4]**

Question 5 [10]

(a) Define an acid salt. Write the formula and the name of one acid salt of sulphuric acid and one acid salt of carbonic acid. **[3]**

(b) Three solutions A, B and C have pH values of 2, 7 and 11. State which of them is the most strongly acidic, give the colour each would turn universal indicator paper, and name one substance whose solution would have a pH close to that of C. **[3]**

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

Question 6 [10]

(a) Define the term molar volume. Calculate the volume occupied by 3.2 g of methane at stp. (C = 12, H = 1) **[3]**

(b) A compound contains 31.8 per cent potassium, 29.0 per cent chlorine and 39.2 per cent oxygen by mass. Calculate its empirical formula. (K = 39, Cl = 35.5, O = 16) **[3]**

(c) Ammonia burns in oxygen according to the equation $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$. Calculate the volume of oxygen needed to burn 60 cm^3 of ammonia and the volume of nitrogen formed, all volumes being measured at the same temperature and pressure. **[4]**

Question 7 [10]

(a) Define electrolysis. Explain why solid sodium chloride does not conduct electricity while molten sodium chloride does. **[3]**

(b) Copper sulphate solution is electrolysed using copper electrodes. State what is seen at the cathode and at the anode, and write the reaction taking place at each. **[3]**

(c) An iron spoon is to be electroplated with nickel. Name the electrolyte, the cathode and the anode, write the reaction at the cathode, and give one reason why articles are electroplated. **[4]**

Question 8 [10]

(a) Explain what is meant by calcination and by roasting, and name one ore that is treated by each process. **[3]**

(b) In the extraction of aluminium, name the ore used, state why cryolite is added to the fused alumina, and write the reaction taking place at the cathode. **[3]**

(c) Name the two gases used in the manufacture of ammonia by the Haber process, state the catalyst and the conditions of temperature and pressure, and write the balanced equation for the reaction. **[4]**

Question 9 [10]

(a) Define the terms homologous series and isomerism. Write the structural formulae of the two isomers having the molecular formula C_4H_{10}. **[3]**

(b) Name the product formed when ethanol is heated with concentrated sulphuric acid at 170 °C. Write the equation for the reaction and state the part played by the sulphuric acid. **[3]**

(c) State what is seen, name the products, and write the equation, when concentrated sulphuric acid is (1) heated with copper turnings and (2) warmed with sodium chloride crystals. **[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) (b) decreases. The nuclear charge rises across the period while the added electrons enter the same shell, so the nucleus holds them more tightly.

(ii) (d) decreases. Each element down the group has one more shell, so the outermost electron is further from the nucleus and is more easily removed.

(iii) (a) sodium chloride. Its ions are held in fixed positions in the solid lattice and become free to move only when the lattice breaks down on melting.

(iv) (c) coordinate. The nitrogen atom supplies both electrons of the shared pair, and the hydrogen ion supplies none.

(v) (b) an acid salt. Only one of the two replaceable hydrogen atoms of sulphuric acid has been replaced by sodium.

(vi) (c) a little below 7. Ammonium chloride is the salt of a weak base and a strong acid, so its solution is slightly acidic.

(vii) (a) zinc sulphate. The white zinc hydroxide first formed dissolves in excess alkali to give a colourless solution of sodium zincate.

(viii) (d) 1.51×10^{23}. 8/32 = 0.25 mol, and $0.25 \times 6.022 \times 10^{23} = 1.51 \times 10^{23}$.

(ix) (b) 5.6 dm^3. 11/44 = 0.25 mol, and $0.25 \times 22.4 = 5.6$ dm^3.

(x) (d) oxygen.

(xi) (c) potassium argentocyanide solution.

(xii) (a) froth flotation.

(xiii) (b) quicklime.

(xiv) (d) sugar. The acid removes hydrogen and oxygen from the sugar as water and leaves a black mass of carbon.

(xv) (c) –COOH.

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

Question 2 [10]

(i) Across a period the number of protons in the nucleus rises by one at each step, but every added electron goes into the same outermost shell, so the screening by the inner shells hardly changes. The stronger nuclear pull draws the shells closer in, and the atom gets smaller.

Electrons added to the same shell while nuclear charge rises 1. Stronger pull reduces the size 1.

(ii) Ammonia is given off. A colourless gas with a sharp choking smell comes out of the mixture, and it turns moist red litmus paper blue.

Gas named 1. Observation 1.

(iii) Chlorine exists as Cl_2, so its molecular mass is 2 x 35.5 = 71. Number of moles = 7.1/71 = 0.1 mol.

Molecular mass 71 1. Answer 0.1 mol 1.

(iv) Nitric acid breaks down in sunlight into nitrogen dioxide, oxygen and water. The brown nitrogen dioxide dissolves in the acid and turns it yellow, so a dark bottle is used to keep the light out. The gas responsible is nitrogen dioxide.

Decomposition in light 1. Nitrogen dioxide named 1.

(v) H–C≡C–H. The two carbon atoms are joined by a triple bond, which is three shared pairs of electrons.

Structure 1. Triple bond 1.

Question 3 [15]

(i) Carbon has four electrons in its outermost shell and each chlorine atom has seven. The carbon atom shares one electron with each of the four chlorine atoms, so four single covalent bonds are formed and every atom completes its octet. The molecule contains four shared pairs, and each chlorine atom carries three lone pairs.

Correct dot structure with all octets complete 1. Four shared pairs 1. Three lone pairs on each chlorine 1.

(ii) Lead chloride: precipitation, because it is insoluble in cold water and is thrown down when lead nitrate solution is mixed with dilute hydrochloric acid. Sodium sulphate: neutralisation of sodium hydroxide solution by dilute sulphuric acid, because it is a soluble salt of a very reactive metal, which cannot be added to the acid directly. Anhydrous iron(III) chloride: direct combination of heated iron with dry chlorine, because the anhydrous salt cannot be obtained by evaporating its solution.

1 mark for each salt with a correct reason.

(iii) Molten lead bromide contains free Pb^{2+} and Br^{-} ions. Cathode: $Pb^{2+} + 2e^{-} \rightarrow Pb$, and a grey bead of molten lead collects below the cathode. Anode: $2Br^{-} - 2e^{-} \rightarrow Br_2$, and reddish brown fumes of bromine are given off.

Ions named 1. Cathode reaction with lead 1. Anode reaction with bromine 1.

(iv) Ore: a mineral from which a metal can be extracted conveniently and at a profit. Gangue: the earthy or rocky impurity present with the metal compound in the ore. Flux: a substance added to the furnace charge to combine with the gangue and turn it into an easily fusible slag.

1 mark for each definition.

(v) Number of moles = 2.24/22.4 = 0.1 mol. Molecular mass of SO_2 = 32 + 32 = 64, so mass = 0.1 x 64 = 6.4 g. Number of molecules = 0.1 x 6.022 x 10^{23} = 6.022 x 10^{22}. Vapour density = 64/2 = 32.

Mass 6.4 g 1. Molecules 6.022 x 10^{22} 1. Vapour density 32 1.

Question 4 [10]

(a) Atomic size increases, because each element down the group has one more electron shell than the one above it. Ionisation potential decreases, because the outermost electron lies further from the nucleus and is better screened by the inner shells, so less energy is needed to pull it away. Non-metallic character decreases, because the larger atom holds an incoming electron less strongly and so gains an electron less readily.

1 mark for each trend stated with its reason.

(b) The configuration 2, 8, 7 accounts for 17 electrons, so the element belongs to Group 17 and Period 3. It gains one electron to complete its octet and forms the ion X^{-}. Magnesium loses two electrons to form Mg^{2+}, so the compound formed is MgX_2.

Group 17 and Period 3 1. Ion X^{-} 1. Formula MgX_2 1.

(c) An ionic bond is formed by the complete transfer of one or more electrons from a metal atom to a non-metal atom, and the oppositely charged ions produced are held together by strong electrostatic attraction. A covalent bond is formed when two non-metal atoms share one or more pairs of electrons, each atom contributing equally. Ionic compounds are hard crystalline solids with high melting points, because a great deal of energy is needed to break the lattice, while covalent compounds are usually gases, liquids or soft solids with low melting points. Ionic compounds conduct electricity when molten or dissolved in water, since the ions are then free to move, while covalent compounds do not conduct in any state. Ionic compounds are generally soluble in water and insoluble in organic solvents, and covalent compounds behave the other way round. Examples: sodium chloride is ionic and carbon tetrachloride is covalent.

Formation 1. Melting point 1. Conduction 1. Solubility with one example of each 1.

Question 5 [10]

(a) An acid salt is a salt formed when only part of the replaceable hydrogen of a polybasic acid has been replaced by a metal, so the salt still contains a replaceable hydrogen atom. From sulphuric acid: $NaHSO_4$, sodium hydrogen sulphate. From carbonic acid: $NaHCO_3$, sodium hydrogen carbonate.

Definition 1. Acid salt of sulphuric acid with its name 1. Acid salt of carbonic acid with its name 1.

(b) A, with a pH of 2, is the most strongly acidic. A turns universal indicator paper red, B turns it green and C turns it blue. A solution of pH close to 11 would be given by dilute ammonia solution, or by dilute sodium

carbonate solution.

A identified 1. Three colours 1. Substance for C 1.

(c) Copper sulphate: a pale blue precipitate of copper hydroxide forms, and it does not dissolve in excess. Iron(II) sulphate: a dirty green precipitate of iron(II) hydroxide forms, and it does not dissolve in excess. Lead nitrate: a white precipitate of lead hydroxide forms, and it dissolves in excess to give a colourless solution of sodium plumbite. Zinc nitrate: a white precipitate of zinc hydroxide forms, and it dissolves in excess to give a colourless solution of sodium zincate.

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

Question 6 [10]

(a) Molar volume is the volume occupied by one mole of any gas at stp, and it is 22.4 dm^3. Molecular mass of CH_4 = 12 + 4 = 16, so 3.2 g is 3.2/16 = 0.2 mol. Volume = 0.2 x 22.4 = 4.48 dm^3.

Definition 1. Moles 0.2 1. Volume 4.48 dm^3 1.

(b) Potassium: 31.8/39 = 0.815. Chlorine: 29.0/35.5 = 0.817. Oxygen: 39.2/16 = 2.450. Dividing each by the smallest, 0.815, gives K = 1, Cl = 1.00, O = 3.01, that is a whole number ratio of 1 : 1 : 3. The empirical formula is $KClO_3$.

Division by atomic masses 1. Simplest ratio 1 : 1 : 3 1. Formula $KClO_3$ 1.

(c) By Gay-Lussac's law the volumes of reacting gases are in the ratio of the coefficients in the equation, so 4 volumes of ammonia need 3 volumes of oxygen and give 2 volumes of nitrogen. Oxygen = 60 x 3/4 = 45 cm^3. Nitrogen = 60 x 2/4 = 30 cm^3.

Use of the volume ratio 1. Oxygen 45 cm^3 1.5. Nitrogen 30 cm^3 1.5. Water is not counted, as it is not a gas under these conditions.

Question 7 [10]

(a) Electrolysis is the breaking down of an electrolyte, in the molten state or in aqueous solution, by the passage of a direct current through it. In solid sodium chloride the ions are locked in fixed positions in the lattice and no charged particle can move, so no current flows. When the salt melts the lattice breaks down, the ions become free to move to the electrodes, and the melt conducts.

Definition 1. Ions fixed in the solid 1. Ions free in the melt 1.

(b) At the cathode a fresh pink brown layer of copper is deposited and the electrode grows heavier: $Cu^{2+} + 2e^- \rightarrow Cu$. At the anode the copper dissolves away and the electrode gets thinner: $Cu - 2e^- \rightarrow Cu^{2+}$. The blue colour of the solution does not fade, because copper goes into the solution at the same rate as it leaves it.

Cathode observation and reaction 1. Anode observation and reaction 1. Colour unchanged with reason 1.

(c) Electrolyte: nickel sulphate solution. Cathode: the iron spoon that is to be plated. Anode: a plate of pure nickel. Cathode reaction: $Ni^{2+} + 2e^- \rightarrow Ni$. Articles are electroplated to protect the metal underneath from rusting or corrosion, and to give it a better appearance.

Electrolyte 1. Cathode and anode 1. Cathode reaction 1. Reason 1.

Question 8 [10]

(a) Calcination is the heating of an ore strongly in a limited supply of air, below its melting point, so that moisture and carbon dioxide are driven off and the oxide is left. Zinc carbonate, the ore calamine, is treated in this way. Roasting is the heating of an ore strongly in a free supply of air, so that the ore is changed into its oxide. Zinc sulphide, the ore zinc blende, is treated in this way.

Calcination 1. Roasting 1. One correct ore for each 1.

(b) The ore is bauxite. Cryolite is added because it lowers the melting point of the alumina from well above 2000 °C to about 950 °C and makes the molten mixture a far better conductor, so the cell can be run at a workable temperature. Cathode reaction: $Al^{3+} + 3e^- \rightarrow Al$.

Bauxite 1. Purpose of cryolite 1. Cathode reaction 1.

(c) The gases are nitrogen and hydrogen. The catalyst is finely divided iron, with molybdenum as a promoter. The temperature is about 450 to 500 °C and the pressure about 200 atmospheres. The reaction is reversible: $N_2 + 3H_2 \rightarrow 2NH_3$.

Two gases 1. Catalyst 1. Temperature and pressure 1. Equation 1.

Question 9 [10]

(a) A homologous series is a family of organic compounds that have the same general formula and the same functional group, in which each member differs from the one before it by a CH_2 unit, and whose members show a steady gradation in physical properties and closely similar chemical properties. Isomerism is the existence of two or more compounds that have the same molecular formula but different structural formulae. The two isomers of C_4H_{10} are n-butane, $CH_3–CH_2–CH_2–CH_3$, and 2-methylpropane, in which a CH_3 group is attached to the middle carbon of a three carbon chain.

Homologous series 1. Isomerism 1. Both structures 1.

(b) The product is ethene. $C_2H_5OH \rightarrow C_2H_4 + H_2O$, the ethanol being heated with excess concentrated sulphuric acid at 170 °C. The sulphuric acid acts as a dehydrating agent, taking a molecule of water out of each molecule of ethanol.

Ethene named 1. Equation 1. Dehydrating agent 1.

(c) (1) Copper turnings heated with concentrated sulphuric acid: the turnings dissolve slowly, a colourless gas with a choking smell is given off, and the solution turns blue when it is poured into water. The products are copper sulphate, sulphur dioxide and water, and the acid acts here as an oxidising agent. $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$. (2) Sodium chloride warmed with concentrated sulphuric acid: steamy pungent fumes are given off which form a white cloud in moist air. The products are sodium hydrogen sulphate and hydrogen chloride, the less volatile acid driving out the more volatile one. $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$.

Observation and products in (1) 1. Equation in (1) 1. Observation and products in (2) 1. Equation in (2) 1.