SCIENCE

Paper 2 (Chemistry) — 2015 (SOLVED)

(Two hours)

Answers to this Paper must be written on the paper provided separately.

*You will not be allowed to write during the first **15** minutes.*

This time is to be spent in reading the Question Paper.

The time given at the head of this paper is the time allowed for writing the answers.

***Section I** is compulsory. Attempt **any four** questions from **Section II**.*

The intended marks for questions or parts of questions are given in brackets [ ].

SECTION I (40 Marks)

*Attempt **all** questions from this Section.*

Question 1

(a) Select from the list ***the gas*** that matches the description given in each case : **[5]**

[*ammonia, ethane, hydrogen chloride, hydrogen sulphide, ethyne*]

(i) This gas is used as a reducing agent in reducing copper oxide to copper.

Ans. Ammonia

(ii) This gas produces dense white fumes with ammonia gas.

Ans. Hydrogen chloride

(iii) This gas is used for welding purposes.

Ans. Ethyne

(iv) This gas is also a saturated hydrocarbon.

Ans. Ethane

(v) This gas has a characteristic rotten egg smell.

Ans. Hydrogen sulphide

(b) Choose the *most appropriate* answer for each of the following : **[5]**

(i) Among the elements given below, the element with the least electronegativity is :

(a) Lithium (b) Carbon (c) Boron (d) Fluorine

Ans. (a) Lithium

(ii) Identify the statement which does **not** describe the property of alkenes :

(a) They are unsaturated hydrocarbons

(b) They decolourise bromine water

(c) They can undergo addition as well as substitution reactions

(d) They undergo combustion with oxygen forming carbon dioxide and water.

Ans. (c) They can undergo addition as well as substitution reactions.

(iii) This is **not** an alloy of copper :

(a) Brass (b) Bronze (c) Solder (d) Duralumin

Ans. (c) Solder

(iv) Bonding in this molecule can be understood to involve coordinate bonding.

(a) Carbon tetrachloride (b) Hydrogen

(c) Hydrogen chloride (d) Ammonium chloride

Ans. (d) Ammonium chloride

(v) Which of the following would weigh the least ?

(a) 2 gram atoms of Nitrogen (b) 1 mole of Silver

(c) 22·4 litres of oxygen gas at 1 atmospheric pressure and 273 K (d) $6{\cdot}02 \times 10^{23}$ atoms of carbon.

[Atomic masses : Ag = 108, N = 14, O = 16, C = 12]

Ans. (d) $6{\cdot}02 \times 10^{23}$ atoms of carbon.

(c) Complete the following calculations. Show working for complete credit :

(i) Calculate the mass of Calcium that will contain the same number of atoms as are present in 3·2 gm of Sulphur. [Atomic masses : S = 32, Ca = 40]. **[2]**

Ans. Atomic weight of element contains Avogadro number of atoms

$\therefore$ 32 g of sulphur contains $6{\cdot}02 \times 10^{23}$ atoms

3·2 g of sulphur contain $\frac{6{\cdot}02 \times 10^{23}}{32} \times 3{\cdot}2 = \mathbf{6{\cdot}02 \times 10^{22}}$ **atoms**

$6{\cdot}02 \times 10^{23}$ atoms of calcium weighs 40 g

$6{\cdot}02 \times 10^{22}$ atoms of calcium weigh $\frac{40}{6{\cdot}02 \times 10^{23}} \times 6{\cdot}02 \times 10^{22} = \mathbf{4\ g}$

(ii) If 6 litres of hydrogen and 4 litres of chlorine are mixed and exploded and if water is added to the gases formed, find the volume of the residual gas. **[2]**

Ans. $H_2 + Cl_2 \rightarrow 2HCl$

1 volume of chlorine reacts with 1 volume of hydrogen

$\therefore$ 4 litres of chlorine reacts with $\frac{1}{1} \times 4\ l$ of hydrogen

$\therefore$ Hydrogen used is 4 litres

Remaining hydrogen = 6 – 4 = 2 litres

1 volume of chlorine forms 2 volume of HCl

4 litres of chlorine forms $\frac{2}{1} \times 4 = 8\ l$ of HCl

Hence gases after reaction, 8 *l* HCl and 2 *l* hydrogen *i.e.*, 10 litres

When water is added to the gases formed HCl dissolves and residual gas is 2 litres of hydrogen

(iii) If the empirical formula of a compound is CH and it has a vapour density of 13, find the molecular formula of the compound. **[1]**

Ans. Vapour density is 13

$\therefore$ Molecular mass is $13 \times 2 = 26$

Molecular mass = n (empirical formula mass)

$26 = n(13)$

$2 = n$

$\therefore$ Molecular formula = C_2H_2

(d) State ***one relevant observation*** for each of the following : **[5]**

(i) When crystals of copper nitrate are heated in a test tube.

Ans. Brown gas is evolved and residue is black in colour or Bluish green colour of copper nitrate which changes to black.

(ii) When the gaseous product obtained by dehydration of ethyl alcohol is passed through bromine water.

Ans. Brown colour fades.

(iii) When hydrogen sulphide gas is passed through lead acetate solution.

Ans. Black precipitate of lead sulphide is formed.

(iv) When ammonia gas is burnt in an atmosphere of excess oxygen.

Ans. Yellowish green flame is seen.

(v) At the Anode when aqueous copper sulphate solution is electrolysed using copper electrodes.

Ans. Blue Cu^{2+} ions formed.

(e) Identify ***the acid*** which matches the following description (i) to (v) : **[5]**

(i) The acid which is used in the preparation of a non-volatile acid.

Ans. Nitric acid (conc.).

(ii) The acid which produces sugar charcoal from sugar.

Ans. Sulphuric acid (conc.).

(iii) The acid which is prepared by catalytic oxidation of ammonia.

Ans. Nitric acid.

(iv) The acid on mixing with lead nitrate solution produces a white precipitate which is insoluble even on heating.

Ans. Sulphuric acid.

(v) The acid on mixing with silver nitrate solution produces a white precipitate which is soluble in excess ammonium hydroxide.

Ans. Hydrochloric acid.

(f) Give ***appropriate scientific reasons*** for the following statements : **[5]**

(i) Zinc oxide can be reduced to zinc by using carbon monoxide, but aluminium oxide cannot be reduced by a reducing agent.

Ans. Aluminium has great affinity towards oxygen.

(ii) Carbon tetrachloride does not conduct electricity.

Ans. Carbon tetrachloride is a covalent molecule so do not form ions.

(iii) During electrolysis of molten lead bromide graphite anode is preferred to other electrodes.

Ans. Graphite anode is unaffected by bromine.

(iv) The electrical conductivity of acetic acid is less in comparison to the electrical conductivity of dilute sulphuric acid at a given concentration.

Ans. Acetic acid is an organic acid contains ions as well as molecules while sulphuric acid contains only ions when dilute.

(v) Electrolysis of molten lead bromide is considered to be a redox reaction.

Ans.

$$PbBr_2 \rightarrow Pb^{2+} + 2Br^-$$

$$Pb^{2+} + 2e^- \rightarrow Pb \qquad \text{(Reduction)}$$

$$2Br^- - 2e^- \rightarrow Br_2 \qquad \text{(Oxidation)}$$

Since oxidation and reduction occurs so it is a redox reaction.

(g) (i) Give ***balanced <u>chemical</u> equations*** for the following conversions A, B and C :

$$Fe \xrightarrow{A} FeCl_2 \xrightarrow{B} FeCO_3 \xrightarrow{C} Fe(NO_3)_2$$ **[3]**

Ans. A $Fe + 2HCl \rightarrow FeCl_2 + H_2$

B $FeCl_2 + Na_2CO_3 \rightarrow FeCO_3 + 2NaCl$

C $FeCO_3 + 2HNO_3 \rightarrow Fe(NO_3)_2 + H_2O + CO_2$

(ii) Differentiate between the terms ***strong electrolyte*** and ***weak electrolyte***. **[2]**
(stating any two differences)

Ans.

Strong electrolyte	*Weak electrolyte*
(a) Contain only ions	(a) Contain ions as well as molecules
(b) Ionise completely	(b) Ionise feebly

(h) Answer the following questions :

(i) Explain the bonding in methane molecule using electron dot structure. **[3]**

Ans. Methane (CH_4)

It has 4 shared pair of electrons so it has 4 single covalent bond.

(ii) The metals of Group 2 from top to bottom are Be, Mg, Ca, Sr and Ba. **[3]**

(1) Which one of these elements will form ions most readily and why ?

(2) State the common feature in the electronic configuration of all these elements.

Ans. (1) Ba (Barium) Tendency to loose electron increases top to bottom in a group, so Ba will form ion most readily.

(2) All these elements have 2 electrons in their valence shell.

SECTION II (40 Marks)

*Attempt any **four** questions from this Section*

Question 2

(a) Arrange the following as per the ***instructions*** given in the brackets : **[4]**

(i) Cs, Na, Li, K Rb (increasing order of metallic character).

Ans. Li, Na, K, Rb, Cs.

(ii) Mg, Cl, Na, S, Si (decreasing order of atomic size).

Ans. Na, Mg, Si, S, Cl.

(iii) Na, K, Cl, S, Si (increasing order of ionization energy).

Ans. K, Na, Si, S, Cl.

(iv) Cl, F, Br, I (increasing order of electron affinity).

Ans. According to the trend in E.A. — I, Br, Cl, F

According to actual E.A. values — I, Br, F, Cl

(Both answers are acceptable)

(b) Choose the most appropriate answer from the following list of oxides which fit the ***description***. Each answer may be used only once : **[4]**

[SO_2, SiO_2, Al_2O_3, MgO, CO, Na_2O]

(i) A basic oxide.

Ans. MgO

(ii) An oxide which dissolves in water forming an acid.

Ans. SO_2

(iii) An amphoteric oxide.

Ans. Al_2O_3

(iv) A covalent oxide of a metalloid.

Ans. SiO_2

(c) Element X is a metal with a valency 2, Y is a non-metal with a valency 3. **[2]**

(i) Write an equation to show how Y forms an ion.

Ans. $Y + 3e^- \rightarrow Y^{3-}$

(ii) If Y is a diatomic gas, write an equation for the direct combination of X and Y to form a compound.

Ans. $3X + Y_2 \rightarrow X_3Y_2$

Question 3

(a) Give balanced ***chemical equations*** for the following ***conversions*** : **[3]**

(i) Ethanoic acid to ethyl ethanoate.

Ans. $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$

(ii) Calcium carbide to ethyne.

Ans. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

(iii) Sodium ethanoate to methane.

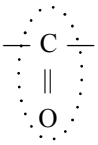
Ans. $CH_3COONa + NaOH \rightarrow CH_4 + Na_2CO_3$

(b) Using their structural formula identify the functional group by circling them : **[2]**

(i) Dimethyl ether.

Ans. $CH_3 - \ddot{O} - CH_3$ Ether group

(ii) Propanone.

Ans.  Ketonic group

(c) Name the following : **[5]**

(i) Process by which ethane is obtained from ethene.

Ans. Hydrogenation (addition of hydrogen).

(ii) A hydrocarbon which contributes towards the ***greenhouse*** effect.

Ans. Methane.

(iii) Distinctive reaction that takes place when ethanol is treated with acetic acid.

Ans. Esterification.

(iv) The property of elements by virtue of which atoms of the element can link to each other in the form of a long chain or ring structure.

Ans. Catenation.

(v) Reaction when an alkyl halide is treated with alcoholic potassium hydroxide.

Ans. Dehydrohalogenation.

***Question* 4**

(a) Identify the ***anion*** present in each of the following compounds : **[3]**

(i) A salt **M** on treatment with concentrated sulphuric acid produces a gas which fumes in moist air and gives dense fumes with ammonia.

Ans. Chloride ion [Cl^-]

(ii) A salt **D** on treatment with dilute sulphuric acid produces a gas which turns lime water milky but has no effect on acidified potassium dichromate solution.

Ans. Carbonate ion [CO_3^{2-}]

(iii) When barium chloride solution is added to salt solution **E** a white precipitate insoluble in dilute hydrochloric acid is obtained.

Ans. Sulphate ion [SO_4^{2-}]

(b) The following table shows the tests a student performed on four different aqueous solutions which are X, Y, Z and W. Based on the observation provided, identify the cation present. **[4]**

Chemical test	**Observation**	**Conclusion**
To solution X, ammonium hydroxide is added in minimum quantity first and then in excess.	A dirty white precipitate is formed which dissolves in excess to form a clear solution.	(i)
To solution Y ammonium hydroxide is added in minimum quantity first and then in excess.	A pale blue precipitate is formed which dissolves in excess to form a clear inky blue solution.	(ii)
To solution W a small quantity of sodium hydroxide solution is added and then in excess.	A white precipitate is formed which remains insoluble.	(iii)
To a salt Z calcium hydroxide solution is added and then heated.	A pungent smelling gas turning moist red litmus paper blue is obtained.	(iv)

Ans. (i) Zinc ion [Zn^{2+}]

(ii) Copper ion [Cu^{2+}]

(iii) Calcium ion [Ca^{2+}]

(iv) Ammonium ion [NH_4^+]

(c) Give balanced chemical equations for each of the following : **[3]**

(i) Lab preparation of ammonia using an ammonium salt.

Ans. $2NH_4Cl + Ca(OH)_2 \xrightarrow{\Delta} CaCl_2 + 2H_2O + 2NH_3$

(ii) Reaction of ammonia with excess chlorine.

Ans. $NH_3 + 3Cl_2 \longrightarrow NCl_3 + 3HCl$

(iii) Reaction of ammonia with sulphuric acid.

Ans. $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$

***Question* 5**

(a) Consider the following reaction and based on the reaction answer the questions that follow :

$$(NH_4)_2Cr_2O_7 \xrightarrow{\text{Heat}} N_2(g) + 4H_2O(g) + Cr_2O_3$$

Calculate :

(i) the quantity in moles of $(NH_4)_2Cr_2O_7$ if 63 gm of $(NH_4)_2Cr_2O_7$ is heated. **[1]**

Ans. Molecular mass of $(NH_4)_2Cr_2O_7 = 14 \times 2 + 8 \times 1 + 2 \times 52 + 16 \times 7 =$ **252**

No. of moles $= \dfrac{\text{wt}}{\text{m.wt.}} = \dfrac{63}{252} =$ **0·25 moles**.

(ii) the quantity in moles of nitrogen formed. **[1]**

Ans. 1 mole of $(NH_4)_2Cr_2O_7$ produces 1 mole of nitrogen

$\therefore$ 0·25 mole of $(NH_4)_2Cr_2O_7$ produces **0·25 mole of nitrogen**

(iii) the volume in litres of dm^3 of N_2 evolved at S.T.P. **[1]**

Ans. 1 mole of nitrogen = 22·4 *l* at S.T.P.

$$0{\cdot}25 \text{ mole} = \frac{\overset{5{\cdot}6}{\cancel{22{\cdot}4}}}{1} \times \frac{0{\cdot}\cancel{25}}{\underset{4}{\cancel{100}}} = \textbf{5·6 litres}$$

(iv) the mass in grams of Cr_2O_3 formed at the same time. **[2]**

[Atomic masses : H = 1, Cr = 52, N = 14]

Ans. 252 g of $(NH_4)_2Cr_2O_7$ produces 152 g of Cr_2O_3

63 g of $(NH_4)_2Cr_2O_7$ produces $\dfrac{152}{252} \times 63 =$ **38 g of Cr_2O_3**

(b) (i) For each of the substance listed below, describe the role played in the extraction of aluminium. **[3]**

(1) Cryolite (2) Sodium hydroxide (3) Graphite

Ans. (1) Cryolite : Lowers melting point of Alumina and enhance conductivity.

(2) Sodium hydroxide : Dissolves bauxite to form soluble sodium meta aluminate.

(3) Graphite : Act as anode in the extraction where oxygen reacts with it. Anode is burnt and has to be replaced. $C + O_2 \rightarrow CO_2$

(ii) Explain why : **[2]**

(1) In the electrolysis of alumina using the Hall Heroult's Process the electrolyte is covered with powdered coke.

(2) Iron sheets are coated with zinc during galvanization.

Ans. (1) Coke is used to prevent oxidation of anode.

(2) To prevent rusting.

***Question* 6**

(a) (i) Give balanced chemical equations for the action of sulphuric acid on each of the following : **[2]**

(1) Potassium hydrogen carbonate.

(2) Sulphur.

Ans. $KHCO_3 + H_2SO_4 \rightarrow KHSO_4 + H_2O + CO_2$

$S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

(ii) In the contact process for the manufacture of sulphuric acid give the equations for the conversion of sulphur trioxide to sulphuric acid. **[2]**

Ans. $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

(b) (i) Copy and complete the following table : **[2]**

	Anode	Electrolyte
Purification of copper		

Ans. Anode — Impure copper
Electrolyte — Aqueous copper sulphate solution

(ii) Write the equation taking place at the anode. **[1]**

Ans. $Cu - 2e^- \rightarrow Cu^{2+}$ (Anode)

(c) Explain the following : **[3]**

(i) Dilute nitric acid is generally considered a typical acid but not so in its reaction with metals.

Ans. Nitric acid acts an oxidising agent so hydrogen gas is not liberated, instead oxide of nitrogen and water are formed.

(ii) Concentrated nitric acid appears yellow when it is left standing in a glass bottle.

Ans. Conc. HNO_3 decomposes to give reddish brown gas NO_2 which dissolves and yellow colour is seen.

(iii) An all glass apparatus is used in the laboratory preparation of nitric acid.

Ans. Nitric acid attacks cork made of wood and rubber.

***Question* 7**

(a) The following questions are pertaining to the laboratory preparation of hydrogen chloride gas :

(i) Write the equation for its preparation mentioning the condition required. **[1]**

Ans. $NaCl + H_2SO_4 \xrightarrow{\text{below } 200°C} NaHSO_4 + HCl$

(ii) Name the drying agent used and justify your choice. **[2]**

Ans. Conc. H_2SO_4

(iii) State a safety precaution you would take during the preparation of hydrochloric acid.

Ans. Thistle funnel and delivery tube should dip in conc. H_2SO_4.

Temperature to be maintained below 200°C as at higher temperature hard crust of sodium sulphate is formed.

(b) An element **L** consists of molecules. **[2]**

(i) What type of bonding is present in the particles that make up **L**?

Ans. Covalent bonding

(ii) When **L** is heated with iron metal, it forms a compound **FeL**. What chemical term would you use to describe the change undergone by **L**?

Ans. Direct combination or synthesis

(c) From the list of the following salts choose the salt that most appropriately fits the description given in the following :
[AgCl, $MgCl_2$, $NaHSO_4$, $PbCO_3$, $ZnCO_3$, KNO_3, $Ca(NO_3)_2$] **[4]**

(i) A deliquescent salt.

Ans. $MgCl_2$

(ii) An insoluble chloride.

Ans. AgCl

(iii) On heating, this salt gives a yellow residue when hot and white when cold.

Ans. $ZnCO_3$

(iv) On heating this salt, a brown coloured gas is evolved.

Ans. $Ca(NO_3)_2$