ICSE Board
Class X Chemistry
Board Paper – 2015 Solution

SECTION I

1.

(a)

(i) Ammonia
(ii) Hydrogen chloride
(iii) Ethyne
(iv) Ethane
(v) Hydrogen sulphide

(b)

(i) **(A)** Lithium
Lithium is an element with the least electronegativity.
(ii) **(C)** They can undergo addition and substitution reactions.
Alkenes do not undergo substitution reaction.
(iii) **(C)** Solder
Solder is an alloy of lead and tin.
(iv) **(D)** Ammonium chloride
The bond formed between the nitrogen atom in ammonia and the chloride ion is a coordinate bond.
(v) **(A)** 2 gram atoms of Nitrogen.

(c)

(i) Given:
Mass of Sulphur = 3.2 gm
Solution:
32 g of S ≡ 6.022×10^{23} atoms
3.2 g of S ≡ ?

$$\text{3.2 g of S will contain} = \frac{6.022 \times 10^{23} \times 3.2}{32} = 6.022 \times 10^{22} \text{ atoms}$$

40 g of Ca ≡ 6.022×10^{23} atoms
? ≡ 6.022×10^{22} atoms

$$\text{Mass of Ca} \equiv \frac{6.022 \times 10^{22} \times 40}{6.022 \times 10^{23}} = 4\text{ g}$$

Mass of calcium = 4 g

(ii) 6 litres of hydrogen and 4 litres of chlorine are mixed which results in the formation of 8 litres of HCl gas. When water is added, it results in the formation of hydrochloric acid. So, the amount of gas left is only 2 litres of hydrogen as chlorine acts as a limiting reagent.
Therefore, the volume of the residual gas will be 2 litres.

(iii) Given:
Empirical formula = CH
Vapour density = 13
Molecular weight = 2 × Vapour density
= 2 × 13
= 26
∴ Empirical formula of a compound with molecular mass 26 is CH.

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula}} = \frac{26}{(12 + 1)} = \frac{26}{13} = 2$$

∴ Molecular formula of the given compound is 2 × (CH) = C_2H_2 = CH ≡ CH.

(d)
(i) Reddish brown nitrogen dioxide gas is released and the residue left behind is black copper oxide.
(ii) The reddish brown colour of bromine solution gets decolourised.
(iii) When hydrogen sulphide gas is passed through lead acetate solution, it forms a black precipitate of lead sulphide.
(iv) It burns in oxygen with a yellowish green flame.
(v) Copper anode itself ionises to give Cu^{2+} ions.
$Cu - 2e^- \rightarrow Cu^{2+}$

(e)
(i) Sulphuric acid
(**Note: Error in the question.** The question should be
The acid which is used in the preparation of a volatile acid.
Solution: Conc. sulphuric acid is a non-volatile acid and is therefore used in the preparation of volatile acids such as HCl and HNO_3)
(ii) Conc. sulphuric acid
(iii) Nitric acid
(iv) Conc. sulphuric acid
(v) Conc. hydrochloric acid

(f)

(i) The metals in the middle of the activity series like zinc are moderately reactive, and carbon is a good reducing agent because of which zinc oxide gets easily reduced by carbon. Oxides of highly active metals like aluminium have great affinity towards oxygen and so cannot be reduced by carbon.

(**Note: Error in the question.** Zinc oxide can be reduced to zinc metal by using carbon, but aluminium oxide cannot be reduced by a reducing agent.)

(ii) Carbon tetrachloride is made of individual covalently bonded molecules, CCl_4. In addition, the charged particles are absent in CCl_4 which could conduct electricity. So, CCl_4 does not conduct electricity.

(iii) During the electrolysis of molten lead bromide, a graphite anode is preferred because graphite remains unaffected by the reactive bromine vapours which are released at the anode.

(iv) Sulphuric acid is a strong acid compared to acetic acid. A strong acid has more ions than a weak one, and so, its solution will be a better electrical conductor than a weak acid. So, electrical conductivity of acetic acid is less in comparison of electric conductivity of sulphuric acid.

(v) In the electrolysis of molten lead bromide, the following reactions take place:

At the cathode: $Pb^{2+} (l) + 2e^- \rightarrow Pb(l)$

At the anode: $2Br^- (l) \rightarrow Br_2 (g) + 2e^-$

Lead (II) ions (Pb^{2+}) are attracted to the negative electrode, and the Pb^{2+} ions are forced to accept two electrons. Pb^{2+} ions are reduced. Bromide ions (Br^-) are attracted to the positive electrode and the bromide ions are forced to give away their extra electron to form bromine atoms. Thus, bromide ions are oxidised. So, electrolysis of molten lead bromide is a redox reaction.

(g)

(i) A: $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

B: $2FeCl_3 + 3Zn \rightarrow 3ZnCl_2 + 2Fe$

$Fe + H_2CO_3 \rightarrow FeCO_3 + H_2\uparrow$

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

(ii)

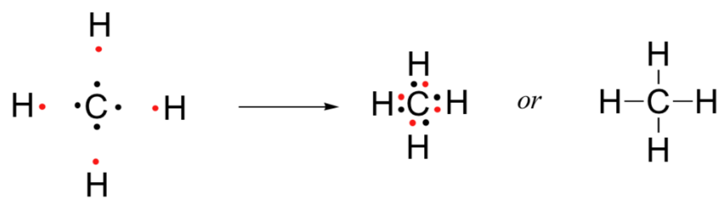
Strong Electrolytes	**Weak Electrolytes**
Electrolytes which allow a large amount of electricity to flow through them.	Electrolytes which allow a small amount of electricity to flow through them.
The solution of a strong electrolyte contains only free mobile ions.	The solution of a weak electrolyte contains ions and molecules.

(h)

(i) **Formation of methane molecule – Non-polar covalent compound:**

Atom	Electronic configuration	Nearest noble gas	To attain stable electronic configuration of nearest noble gas
Carbon	$^{12}_{6}C$ [2,4]	Neon [2,8]	Carbon needs four electrons to complete the octet
Hydrogen	$^{1}_{1}H$ [1]	Helium [2]	Hydrogen needs one electron to complete the duplet

One atom of carbon shares four electron pairs, one with each of the four atoms of hydrogen.



Before combination (4 [H] and 1 [C] atom)	After combination (CH_4 – Methane molecule)

(ii)

(1) In group 2, the atomic size increases down the group. As the atomic size increases, the nuclear charge decreases. Due to this, electrons of the outermost shell lie further away from the nucleus making the removal of electrons easy. So, Ba will form ions readily.

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

SECTION II

2.

(a)

(i) Li < Na < K < Rb < Cs

(ii) Na > Mg > Si > S > Cl

(iii) Na < Si < S < Cl

(iv) I < Br < Cl < F

(b)

(i) Na_2O

(ii) SO_2

(iii) Al_2O_3

(iv) SiO_2

(c)

(i) Y will form an anion by gaining 3 electrons.

The equation is given as $Y + 3e^- \rightarrow Y^{3-}$

(ii) The equation for the direct combination of X and Y to form a compound is

$3X + Y_2 \rightarrow X_3Y_2$

3.

(a)

(i) Ethanoic acid to ethyl ethanoate

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

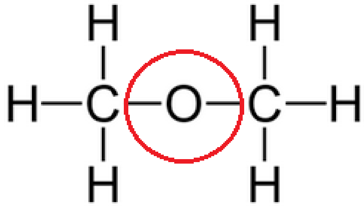
(ii) $CaC_2 + 2\,H_2O \rightarrow Ca(OH)_2 + CH \equiv CH$

Calcium carbide — Calcium hydroxide

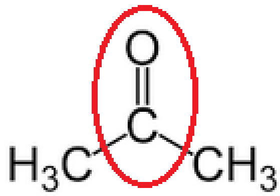
(iii) $CH_3COONa + NaOH \xrightarrow[300^\circ C]{CaO} Na_2CO_3 + CH_4$

(b)

(i) Dimethyl ether



(ii) Propanone



(c)

(i) Hydrogenation
(ii) Methane
(iii) Esterification
(iv) Catenation
(v) Dehydrohalogenation

4.

(a)

(i) Chloride ion (Cl^-)
(ii) Carbonate (CO_3^{2-})
(iii) Sulphate (SO_4^{2-})

(b)

(i) Zn^{2+}
(ii) Cu^{2+}
(iii) Ca^{2+}
(iv) NH_4^+

(c)

(i) Ammonia is prepared in the laboratory by suing ammonium chloride.

$$\underset{\text{Ammonium chloride}}{2NH_4Cl} + Ca(OH)_2 \rightarrow \underset{\text{Calcium chloride}}{CaCl_2} + 2H_2O + \underset{\text{Ammonia gas}}{2NH_3}$$

(ii) When ammonia reacts with excess of chlorine, it forms nitrogen trichloride and HCl.

$$NH_3 + 3Cl_2 \longrightarrow \underset{\text{(Nitrogen trichloride)}}{NCl_3} + 3HCl$$

(iii) Ammonia reacts with sulphuric acid to form ammonium sulphate.

$$2NH_3 + H_2SO_4 \longrightarrow \underset{\text{Ammonium sulphate}}{(NH_4)_2SO_4}$$

5.

(a) The given reaction is as follows:

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

(i) Given:
Weight of $(NH_4)_2Cr_2O_7$ = 63 gm
Molar mass of $(NH_4)_2Cr_2O_7$
= $(2 \times 14) + (8 \times 1) + (2 \times 52) + (7 \times 16)$
= 28 + 8 + 104 + 112
= 252 gm
1 mole $(NH_4)_2Cr_2O_7$ = 252 gm
Hence, 63 gm of $(NH_4)_2Cr_2O_7$ = 0.25 moles
The quantity of moles of $(NH_4)_2Cr_2O_7$ if 63 gm of $(NH_4)_2Cr_2O_7$ is heated is **0.25** moles.

(ii) From the given chemical equation, 1 mole of $(NH_4)_2Cr_2O_7$ produces 1 mole of nitrogen gas.
Hence, 0.25 moles of $(NH_4)_2Cr_2O_7$ can produce 0.25 moles of nitrogen gas.
The quantity in moles of nitrogen formed is **0.25** moles.

(iii) One mole of an ideal gas at S.T.P. occupies 22.4 litres or dm^3.
Hence, 0.25 moles of $(NH_4)_2Cr_2O_7$ will occupy $0.25 \times 22.4 = 5.6$ litres or dm^3.
The volume in litres or dm^3 of N_2 evolved at S.T.P. is **5.6** litres or dm^3.

(iv) From the given chemical equation, 1 mole of $(NH_4)_2Cr_2O_7$ produces 1 mole of Cr_2O_3.
Hence, 0.25 moles of $(NH_4)_2Cr_2O_7$ will produce 0.25 moles of Cr_2O_3.
Molar mass of Cr_2O_3
= $(2 \times 52) + (3 \times 16)$
= 104 + 48
= 152 gm
1 mole Cr_2O_3 = 152 gm
Hence, 0.25 moles of Cr_2O_3 = 0.25×152 = 38 gm
The mass in grams of Cr_2O_3 formed at the same time is **38** gm.

(b)

(i) In the extraction of aluminium, the given compounds play the following roles:

(1) Cryolite: It lowers the fusion temperature from 2050°C to 950°C and enhances conductivity.

(2) Sodium hydroxide:
Two roles are played by sodium hydroxide in the extraction of aluminium.
First, finely grinded bauxite (ore of aluminium) is heated under pressure with conc. caustic soda solution (NaOH solution) for 2–8 hours at 140°C to 150°C to produce sodium aluminate. The chemical equation is as follows:
$Al_2O_3.2H_2O + 2NaOH \rightarrow 2NaAlO_2 + 3H_2O$

Second, on diluting sodium aluminate with water and cooling to 50°C, sodium aluminate is hydrolysed to give aluminium hydroxide as precipitate. Here, the impurities dissolve in sodium hydroxide.

(3) Graphite: Thick rods of graphite are suspended into the fused electrolyte. They act as an anode where oxygen gas is discharged.

(ii)

(1) In the electrolysis of alumina using the Hall–Héroult process, the electrolyte is covered with powdered coke as it

- reduces heat loss by radiation
- prevents the burning of the anode

(2) Iron sheets are coated with zinc during galvanisation to prevent them from rusting.

6.

(a)

(i)

(1) Action of sulphuric acid on potassium hydrogen carbonate

$2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + 2CO_2\uparrow$

(2) Action of sulphuric acid on sulphur

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

(ii) In the contact process for the manufacture of sulphuric acid, the equations for the conversion of sulphur trioxide to sulphuric acid are

$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (oleum or pyrosulphuric acid)

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

(b)

(i)

	Anode	Electrolyte
Purification of copper	Impure copper	Solution of copper sulphate and dilute sulphuric acid

(ii) Equation at the anode:

$Cu - 2e^- \rightarrow Cu^{2+}$

(c)

(i) Dilute nitric acid is generally considered a typical acid but not in its reaction with metals because the action of nitric acid on metals depends on the temperature and concentration of nitric acid. These conditions are not required in case of hydrochloric acid or sulphuric acid.

(ii) Although pure concentrated nitric acid is colourless, it appears yellow when left standing in a glass bottle due to the dissolution of reddish brown nitrogen dioxide gas in the acid. Nitrogen dioxide is produced because of the thermal decomposition of a portion of nitric acid.

$4HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$

(iii) An all-glass apparatus is used in the laboratory preparation of nitric acid because nitric acid vapours corrode rubber and cork.

7.

(a)

(i) The equation for the laboratory preparation of hydrogen chloride gas:

$NaCl + H_2SO_4 \xrightarrow{<200°C} NaHSO_4 + HCl\uparrow$

Although it is a reversible reaction, it goes to completion as hydrogen chloride continuously escapes as a gas.

The reaction can occur up to the stage of the formation of sodium sulphate on heating above 200°C.

$NaHSO_4 + NaCl \xrightarrow{\text{above } 200°C} Na_2SO_4 + HCl\uparrow$

(ii) The drying agent used in the laboratory preparation of hydrochloric acid is conc. sulphuric acid.

The other drying agents such as phosphorus pentoxide (P_2O_5) and quick lime (CaO) cannot be used because they react with hydrogen chloride.

$2P_2O_5 + 3HCl \rightarrow POCl_3 + 3HPO_3$

$CaO + 2HCl \rightarrow POCl_3 + 3HPO_3$

(iii) A safety precaution which should be taken during the preparation of hydrochloric acid:

Always wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron in the laboratory during the preparation of hydrochloric acid.

(b)

(i) Covalent bonding is observed in atoms which are similar. Hence, covalent bonding is present in the particles which make up element L.

(ii) When L is heated with iron metal, it forms a compound FeL.

Here, oxidation of Fe and reduction of L occur as follows:

$Fe \rightarrow Fe^{2+} + 2e^-$

(c)

(i) A deliquescent salt = $MgCl_2$

(ii) An insoluble chloride = AgCl

(iii) On heating, this salt gives a yellow residue when hot and a white residue when cold = $ZnCO_3$

(iv) On heating this salt, a brown-coloured gas is evolved = $Ca(NO_3)_2$