2018

CHEMISTRY

SCIENCE Paper – 2

(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) *Choose the correct answer from the options given below .* **[5]**

(i) The salt solution which does not react with ammonium hydroxide is :

(A) Calcium nitrate (B) Zinc nitrate

(C) Lead nitrate (D) Copper nitrate

(ii) The organic compound which undergoes substitution reaction is :

(A) C_2H_2 (B) C_2H_4

(C) $C_{10}H_{18}$ (D) C_2H_6

(iii) The electrolysis of acidified water is an example of :

(A) Reduction (B) Oxidation

(C) Redox reaction (D) Synthesis

(iv) The IUPAC name of dimethyl ether is :

(A) Ethoxy methane (B) Methoxy methane

(C) Methoxy ethane (D) Ethoxy ethane

(v) The catalyst used in the Contact Process is :

(A) Copper (B) Iron

(C) Vanadium pentoxide (D) Manganese dioxide

(b) *Give **one word** or a **phrase** for the following statements :* **[5]**

(i) The energy released when an electron is added to a neutral gaseous isolated atom to form a negatively charged ion.

(ii) Process of formation of ions from molecules which are not in ionic state.

(iii) The tendency of an element to form chains of identical atoms.

(iv) The property by which certain hydrated salts, when left exposed to atmosphere, lose their water of crystallization and crumble into powder.

(v) The process by which sulphide ore is concentrated.

(c) *Write a balanced chemical equation for each of the following .* **[5]**

(i) Action of concentrated sulphuric acid on carbon.

(ii) Reaction of sodium hydroxide solution with iron (III) chloride solution.

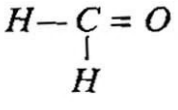
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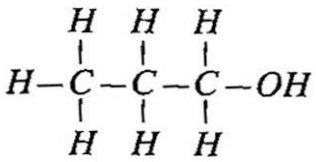
(iii) *Action of heat on aluminium hydroxide.*

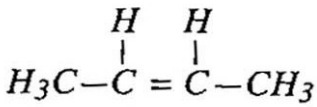
(iv) *Reaction of zinc with potassium hydroxide solution.*

(v) *Action of dilute hydrochloric acid on magnesium sulphite.*

(d) (i) *Give the IUPAC name for each of the following :* **[5]**

(1)


(2)


(3)


(ii) *Write the structural formula of the two isomers of butane.*

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

(i) *Lead nitrate solution is treated with sodium hydroxide solution drop wise till it is in excess.*

(ii) *At the anode, when molten lead bromide is electrolyzed using graphite electrodes.*

(iii) *Lead nitrate solution is mixed with dilute hydrochloric acid and heated.*

(iv) *Anhydrous calcium chloride is exposed to air for some time.*

(v) *Barium chloride solution is slowly added to sodium sulphate solution.*

(f) *Give a reason for each of the following :* **[5]**

(i) *Ionic compounds have a high melting point.*

(ii) *Inert gases do not form ions.*

(iii) *Ionisation potential increases across a period, from left to right.*

(iv) *Alkali metals are good reducing agents.*

(v) *Conductivity of dilute hydrochloric acid is greater than that of acetic acid.*

(g) *Name the gas that is produced in each of the following cases :* **[5]**

(i) *Sulphur is oxidized by concentrated nitric acid.*

(ii) *Action of dilute hydrochloric acid on sodium sulphide.*

(iii) *Action of cold and dilute nitric acid on copper.*

(iv) *At the anode during the electrolysis of acidified water.*

(v) *Reaction of ethanol and sodium.*

(h) *Fill up the blanks with the correct choice given in brackets :* **[5]**

(i) *Ionic or electrovalent compounds do not conduct electricity in their _____ state.* *(fused/solid)*

(ii) *Electrolysis of aqueous sodium chloride solution will form _____ at the cathode.* *(hydrogen gas/sodium metal)*

(iii) *Dry hydrogen chloride gas can be collected by_____ displacement of air.* *(downward/upward)*

(iv) *The most common ore of iron is_____* *(calamine/haematite)*

(v) *The salt prepared by the method of direct combination is _____ (iron (II) chloride/iron (III) chloride).*

Answers :

(a) **(i)** (A) Calcium nitrate

(ii) (A) C_2H_2

(iii) (C) Redox reaction

(iv) (B) Methoxy methane

(v) (C) Vanadium pentoxide

(b) **(i)** Electron affinity

(ii) Ionization

(iii) Catenation

(iv) Efflorescence

(v) Froth floatation

(c) **(i)** $C + 2H_2SO_4$ (Conc.) $\rightarrow CO_2 + 2SO_2 + 2H_2O$

(ii) $FeCl_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaCl$

(iii) Aluminium hydroxide on heating decomposes into aluminium oxide along with water.

$$Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$$

(iv) Elemental zinc reacts with strong bases to give zinc hydroxide, which on availability of extra OH^- ions get dissolved in solution due to formation of zincate :

$$Zn(s) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$$
$$Zn(OH)_2(s) + OH^- \rightarrow [Zn(OH)_4]^{2-}(aq)$$

(v) Magnesium sulphite reacts with dilute hydrochloric acid to give magnesium chloride :

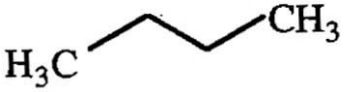
$$MgSO_3 + 2HCl \rightarrow MgCl_2 + H_2O + SO_2$$

(d) **(i)** (1) Methanal

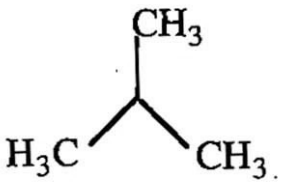
(2) Propan-1-ol

(3) But-2-ene

(ii)



n-Butane



Iso-Butane

(e) **(i)** On dropwise addition of sodium hydroxide solution to lead nitrate solution it first gives a white precipitate and then on adding excess of sodium hydroxide solution, a clear solution is obtained due to formation of sodium plumbate (Na_2PbO_2) which is colourless and soluble.

$$Pb(NO_3)_2 + 2NaOH \rightarrow Pb(OH)_2 (\downarrow) + 2NaNO_3$$
$$Pb(OH)_2 + 2NaOH \text{ (Excess)} \rightarrow Na_2PbO_2$$

(ii) At the anode, when lead bromide is electrolyzed using graphite electrodes following reaction occurs at the anode during electrolysis :

$$2Br^- + 2e^- \rightarrow Br_2(\uparrow)$$

(iii) Lead nitrate solution is mixed with dilute hydrochloric acid and heated to give lead chloride and nitric acid :

$$Pb(NO_3)_2 + 2HCl \rightarrow PbCl_2 + 2HNO_3$$

(iv) Anhydrous calcium chloride is exposed to air for some time and it absorbs moisture from air as it has a strong affinity for water :

$$CaCl_2 + 2H_2O \rightarrow Ca(OH)_2 + 2HCl$$

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(v) Barium chloride solution is slowly added to sodium sulphate solution to obtain barium sulphate :

$$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$$

(f) **(i)** Ionic compounds have high melting points because the ionic bonds that hold the compounds together are very strong and require a great deal of energy to break the bond.

(ii) Inert gases do not form ions because their outermost orbital is complete and they have a stable electronic configuration.

(iii) Ionisation potential increases across a period from left to right because size of atom decreases and effective nuclear charge increases per electron, hence making it difficult to remove electron.

(iv) Alkali metals are good reducing agents because alkali metals have ns^1 outer electron configuration and they achieve the nearest stable configuration by losing one electron, hence they have a great tendency to loose electrons or get oxidized therefore, they are good reducing agents.

(v) Conductivity of dilute hydrochloric acid is greater than that of acetic acid because hydrochloric acid is a strong acid and it dissociates completely in aqueous solution to form H^+ and Cl^- ions (a higher concentration of ions). Acetic acid, on the other hand, is a weak acid and it partially dissociates forming H^+ and CH_3COO^- ions (concentration of ions is lower).

(g) **(i)** SO_2 and NO_2 are produced when sulphur reacts with conc. HNO_3.

$$8S + 32HNO_3 \rightarrow 8SO_2 + 32NO_2 + 16H_2O$$

(ii) Hydrogen sulphide (H_2S) gas is produced when dilute hydrochloric acid reacts with sodium sulphide.

$$Na_2S(aq) + 2HCl(aq) \rightarrow H_2S(g) + 2NaCl(aq)$$

(iii) NO_2 gas is evolved when cold and dilute nitric acid reacts with copper.

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

(iv) Hydrogen gas is evolved at the anode during the electrolysis of acidified water.

$$2H_3O^+(aq) + 2e^- \rightarrow H_2(g) + 2H_2O(l)$$

(v) Hydrogen gas is produced during the reaction of ethanol and sodium.

$$C_2H_5OH + Na \rightarrow C_2H_5ONa + \frac{1}{2}H_2(g)$$

(h) **(i)** solid

(ii) hydrogen gas

(iii) downward (HCl gas is heavy than air)

(iv) haematite

(v) iron (III) chloride

SECTION II—(40 Marks)

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

Question 2.

(a) *(i) What do you understand by a lone pair of electrons ?* **[3]**

(ii) Draw the electron dot diagram of hydronium ion. (H = 1; O = 8)

(b) *In Period 3 of the Periodic Table, element **B** is placed to the left of element **A**. On the basis of this information, choose the correct word from the brackets to complete the following statements :* **[3]**

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(i) *The element* ***B*** *would have (lower/higher) metallic character than* ***A***.

(ii) *The element* ***A*** *would probably have (lesser/higher) electron affinity than* ***B***.

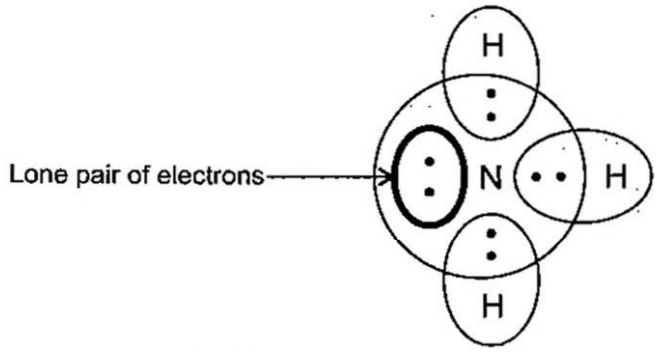
(iii) *The element* ***A*** *would have (greater/smaller) atomic size than* ***B***.

(c) *Copy and complete the following table which refers to the conversion of ions to neutral particles.* **[4]**

Conversion	*Ionic Equation*	*Oxidation/Reduction*
Chloride ion to chlorine molecule	*(i)* _____	*(ii)* _____
Lead (II) ion to lead	*(iii)* _____	*(iv)* _____

Answers :

(a) **(i)** A lone pair is an electron pair in the outermost shell of an atom that is not shared or bonded to another atom. Below is the example of lone pair on nitrogen atom of ammonia molecule.



(ii) Electron dot diagram of hydronium ion :



(b) **(i)** The element **B** would have *higher* metallic character than element **A.**

(ii) The element **A** would have probably *higher* electron affinity than element **B**.

(iii) The element **A** would have *smaller* atomic size than element **B.**

(c)

Conversion	Ionic Equation	Oxidation/Reduction
Chloride ion to chlorine molecule	(i) $Cl^- + e^- \rightarrow \frac{1}{2} Cl_2(g)$	(ii) Reduction
Lead(II) ion to lead	(iii) $Pb^{2+} + 2e^- \rightarrow Pb(s)$	(iv) Reduction

Question 3.

(a) *(i) Write the balanced chemical equation to prepare ammonia gas in the laboratory by using an alkali.* **[3]**

(ii) State why concentrated sulphuric acid is not used for drying ammonia gas.

(iii) Why is ammonia gas not collected over water ?

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(b) *(i) Name the acid used for the preparation of hydrogen chloride gas in the laboratory. Why is this particular acid preferred to other acids ?* [3]

(ii) Write the balanced chemical equation for the laboratory preparation of hydrogen chloride gas.

(c) *For the preparation of hydrochloric acid in the laboratory :* [2]

(i) Why is direct absorption of hydrogen chloride gas in water not feasible ?

(ii) What arrangement is done to dissolve hydrogen chloride gas in water ?

(d) *For the electro-refining of copper :* [2]

(i) What is the cathode made up of ?

(ii) Write the reaction that takes place at the anode.

Answers :

(a) **(i)** Preparation of NH_3 gas using alkali can be done by reacting ammonium sulphate with sodium hydroxide.

$$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + 2H_2O + Na_2SO_4$$

(ii) Concentrated sulphuric acid is not used for drying ammonia gas because concentrated sulphuric acid (H_2SO_4) being acidic in nature reacts with basic ammonia gas to give ammonium sulphate [$(NH_4)_2SO_4$].

(iii) Ammonia gas is not collected over water because it has a high solubility in water and it dissolves in water to give a basic solution.

$$NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$$

(b) **(i)** Sulphuric acid is used for preparation of hydrogen chloride gas in laboratory. This is preferred over other acids because of the following reasons :

(a) It has low volatility than HCl gas (so that the produced HCl gas is collected easily).

(b) It has dehydrating properties, so the HCl gas produced can be effectively dehydrated to remove traces of water.

(c) It has comparatively less oxidant power so formation of other by products can be avoided.

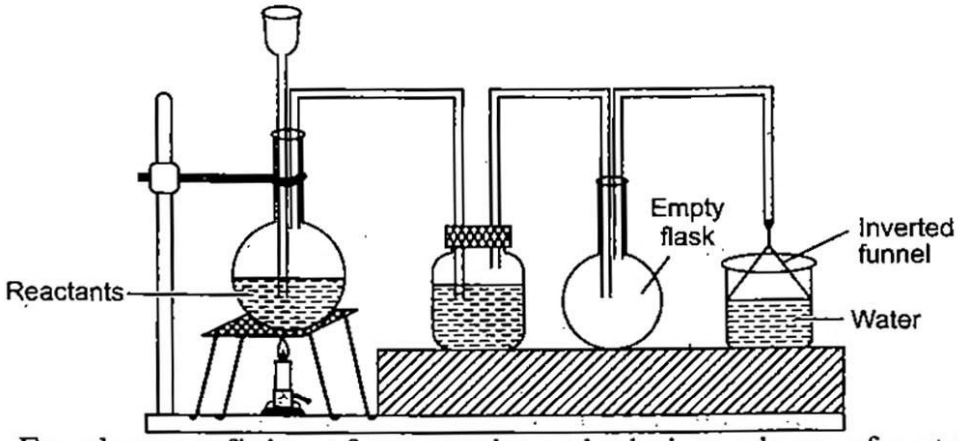
(ii) Laboratory preparation of hydrogen chloride gas can be done by heating NaCl with concentrated sulphuric acid :

$$NaCl + H_2SO_4 \xrightarrow{420\ K} NaHSO_4 + HCl\ (\uparrow)$$

(c) **(i)** Hydrogen chloride gas is not directly absorbed in water because direct absorption leads to the back suction of water.

(ii) Hydrogen chloride gas is produced by reacting sodium chloride and sulphuric acid in a reaction vessel, the outlet from the vessel containing hydrogen chloride gas is put into another vessel containing sulphuric acid which helps to obtain dry hydrogen chloride gas. The dry gas then reaches to the vessel containing water through an empty vessel (this empty vessel is kept for accommodation of any back suction of water during absorption of hydrogen chloride gas in water). After travelling the empty vessel, hydrogen chloride gas is introduced to the vessel containing water through a pipe fitted with a funnel at the end and over the water vessel, this ensures maximum surface area for hydrochloric acid gas absorption in water.

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(d) (i) For electro-refining of copper the cathode is made up of a strip of pure copper metal.

(ii) The reaction taking place at anode (made up of impure copper) is :

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

Question 4.

(a) *The percentage composition of a gas is :* **[2]**
Nitrogen 82.35%, Hydrogen 17.64%.
Find the empirical formula of the gas. [N = 14, H = 1]

(b) *Aluminium carbide reacts with water according to the following equation :* **[4]**

$$Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$$

(i) What mass of aluminium hydroxide is formed from 12g of aluminium carbide ?

(ii) What volume of methane at s.t.p. is obtained from 12g of aluminium carbide ?

[Relative molecular weight of $Al_4C_3 = 144$; $Al(OH)_3 = 78$]

(c) *(i) If 150 cc of gas A contains X molecules, how many molecules of gas B will be present in 75 cc of B ?* **[2]**

The gases A and B are under the same conditions of temperature and pressure.

(ii) Name the law on which the above problem is based.

(d) *Name the main component of the following alloys :* **[2]**

(i) Brass

(ii) Duralumin

Answers :

(a) Nitrogen : 82.35 % and hydrogen : 17.64%
So N : H is 4.67 : 1, or rounding off
N:H is 5 : 1
So, the empirical formula of the gas would be, NH_5.

(b) (i) $Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$
One mole of Al_4C_3 gives 4 moles of $Al(OH)_3$
i.e., 144 g of Al_4C_3 gives 4×78 g of $Al(OH)_3$
So, 12 g of Al_4C_3 gives $\frac{312 \times 12}{144}$ g of $Al(OH)_3$
$= 26$ g of $Al(OH)_3$.

(ii) One mole of Al_4C_3 gives 3 moles of methane

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12 g of Al_4C_3 gives $\frac{48 \times 12}{144}$ g of $CH_4 = 4$ g

Now, 16 g of methane has volume 22.4 L (at STP, the volume of one mole of any gas is 22.4 L)

4 g of methane would occupy 5.6 L.

So, 5.6 L of methane would be obtained from 12 g of Al_4C_3.

(c) **(i)** There will be X/2 molecules of gas B in 75 cc volume.

(ii) The above problem is based on Avogadro's law, which states that : 'Equal volumes of all gases under similar conditions of temperature and pressure contain the same number of molecules.'

(d) **(i)** Main components of brass are Copper and Zinc.

(ii) Main components of Duralumin are Aluminium (95%), Copper (4%), Manganese (0.5%) and Magnesium (0.5%).

Question 5.

(a) *Complete the following table which relates to the homologous series of hydrocarbons.* **[6]**

General formula	IUPAC name of the homologous series	Characteristic bond type	IUPAC name of the first member of the series
C_nH_{2n-2}	(A)_____	(B)_____	(C)_____
C_nH_{2n+2}	(D)_____	(E)_____	(F)_____

(b) *(i) Name the most common ore of the metal aluminium from which the metal is extracted. Write the chemical formula of the ore.* **[4]**

(ii) Name the process by which impure ore of aluminium gets purified by using concentrated solution of an alkali.

(iii) Write the equation for the formation of aluminium at the cathode during the electrolysis of alumina.

Answers :

(a)

General formula	IUPAC names of the homologous series	Characteristic bond type	IUPAC name of the first member of the series
C_nH_{2n-2}	(A) Alkyne	(B) —C—C triple bond (one sigma and two pi bonds between C—C) —C—H sigma bond	(C) Ethyne (C_2H_2)
C_nH_{2n+2}	(D) Alkane	(E) —C—C single bond (C—C sigma bond) —C—H sigma bond	(F) Methane (CH_4)

(b) **(i)** Most common ore of aluminium metal is bauxite, $AlO_x(OH)_{3-2x}$ (where $0 < x < 1$).

(ii) The process by which impure ore of aluminium gets purified by using concentrated solution of an alkali is known as 'Leaching'. Aluminium is leached out of its ore using sodium hydroxide as sodium aluminate, leaving the impurities behind .

$$Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2Na[Al(OH)_4](aq)$$

(iii) During electrolysis of alumina, the cathode reaction is :

$$Al^{3+}(melt) + 3e^- \rightarrow Al(l)$$

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Question 6.

(a) *A compound **X** (having vinegar like smell) when treated with ethanol in the presence of the acid **Z**, gives a compound **Y** which has a fruity smell. The reaction is :* **[4]**

$$C_2H_5OH + X \xrightarrow{Z} Y + H_2O$$

*(i) Identify **Y** and **Z**.*

*(ii) Write the structural formula of **X**.*

(iii) Name the above reaction.

(b) *Ethane burns in oxygen to form CO_2 and H_2O according to the equation :* **[4]**

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

If 1250 cc of oxygen is burnt with 300 cc of ethane.

Calculate :

(i) the volume of CO_2 formed.

(ii) the volume of unused O_2.

(c) *Three solutions P, Q and R have pH value of 3.5, 5.2 and 12.2 respectively. Which one of these is a :* **[2]**

(i) Weak acid ?

(ii) Strong alkali ?

Answers :

(a) **(i)** Compound Y is acetic acid (CH_3COOH) as it has vinegar like smell.
Z is a protic acid for example HCl (aq).

(ii) The structural formula of X is $CH_3COOC_2H_5$ (Ethyl ethanoate or ethyl acetate).

(iii) The above reaction is known as 'Esterification' reaction.

$$\underset{\text{Ethanol}}{C_2H_5OH} + \underset{\text{Acetic acid}}{CH_3COOH} \xrightarrow[\text{Esterification}]{H_3O^+} \underset{\text{Ethyl acetate}}{CH_3COOC_2H_5}$$

(b) The given equation is :

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

(i) So, according to above equation, 2 V(volumes) of ethane reacts to give 4 V of carbon dioxide.
So, 300 cc of ethane would give 600 cc of carbon dioxide.

(ii) Also, 2 V(volumes) of ethane reacts with 7 V of oxygen .
300 cc of ethane is 2 V, so oxygen required for 300 cc of ethane is

$$\frac{300 \times 7}{2} = 1050 \text{ cc}$$

The remaining oxygen would be :

$$1250 \text{ cc} - 1050 \text{ cc} = 200 \text{ cc}$$

(c) **(i)** R is a weak acid as its pH is 12.2, strong acids have pH less than 7.0.

(ii) R is a strong alkali as its pH is 12.2.

Question 7.

(a) *Give a chemical test to distinguish between the following pairs of chemicals :* **[4]**

(i) Lead nitrate solution and zinc nitrate solution.

(ii) Sodium chloride solution and sodium nitrate solution.

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(b) *Write a balanced equation for the preparation of each of the following salts :* **[2]**

(i) Copper sulphate from copper carbonate.

(ii) Zinc carbonate from zinc sulphate.

(c) *(i) What is the type of salt formed when the reactants are heated at a suitable temperature for the preparation of nitric acid ?* **[2]**

(ii) State why for the preparation of nitric acid, the complete apparatus is made up of glass.

(d) *Which property of sulphuric acid is shown by the reaction of concentrated sulphuric acid with :* **[2]**

(i) Ethanol ?

(ii) Carbon ?

Answers :

(a) (i) Add aqueous hydrochloric acid solution to the solution of lead nitrate and solution of zinc nitrate prepared separately. The solution of lead nitrate would give a white precipitate of $PbCl_2$ whereas there would be no reaction with zinc nitrate solution.

$$Pb^{2+} + 2\,Cl^- \rightarrow PbCl_2(\downarrow)$$

(ii) Add aqueous solution of silver nitrate ($AgNO_3$) to the solution of sodium chloride and solution of sodium nitrate prepared separately. The solution of sodium chloride would give a white precipitate of AgCl whereas there would be no reaction with sodium nitrate solution.

(b) (i) Preparation of copper sulphate from copper carbonate can be done by reacting copper carbonate with sulphuric acid.

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + CO_2 + H_2O$$

(ii) Zinc carbonate from zinc sulphate can be prepared by reacting zinc sulphate with sodium carbonate.

$$ZnSO_4 + Na_2CO_3 \rightarrow ZnCO_3 + Na_2SO_4$$

(c) (i) Sodium sulphate is formed if the reactants (sulphuric acid and sodium nitrate) for the preparation of nitric acid are heated above 200°C. The sodium sulphate formed deposits as a hard crust and is difficult to remove.

$$NaNO_3 + NaHSO_4 \xrightarrow{> 200°C} Na_2SO_4 + HNO_3$$

(ii) All glass apparatus should be used while preparing nitric acid as the nitric acid vapours are highly corrosive and they corrode the cork or rubber fittings used in the apparatus.

(d) (i) Reaction of concentrated sulphuric acid with ethanol leads to formation of ethene, which shows that it is dehydrating in nature.

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[\text{Dehydration}]{H_2SO_4} \underset{\text{Ethene}}{C_2H_4} + H_2O$$

(ii) Reaction of concentrated sulphuric acid with carbon shows its oxidizing nature, where it oxidizes carbon to carbon dioxide.

$$C + H_2SO_4 \rightarrow CO_2 + H_2O + 2SO_2$$

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