ICSE Living Science

CHEMISTRY

Book 10

TEACHER'S HANDBOOK

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Contents

CHAPTER – 1

THE PERIODIC CLASSIFICATION AND PERIODIC PROPERTIES OF ELEMENTS

P. 12 CHECK YOUR PROGRESS

1. **a.** Sixth

b. 30

c. electrons

d. group

2. **a.** 2

b. 15

c. 18

d. 7

e. Lanthanoids

3. **a.** There are 2 elements in period 1 and 8 elements each in period 2 and period 3 of the periodic table.

b. Group 6

c. Common feature of the electronic configurations of the elements at the end of period 2 and period 3 is that both have their octet complete or have 8e$^-$ in outermost shell.

Period 2 → Ne (10) → 2, 8

Period 3 → Ar (18) → 2, 8, 8

P. 17 CHECK YOUR PROGRESS

1. **a.** group, metallic

b. more

c. number of outer electrons

2. **a.** Li > Be > B > C > N > O > F (increasing order of atomic size)

b. Be > Mg > Ca > Sr > Ba (increasing order of metallic character)

c. I < Br < Cl < F (increasing order of electronegativity)

d. F > S > Si > Al > Mg (increasing order of ionization energy)

P. 19 CHECK YOUR PROGRESS

1. **a.** largest

b. Francium

c. decrease

2. **a.** Group 17 elements need one electron to complete its octet while group 1 elements lose one electron to complete its octet.

b. Halogens have seven electrons in their last shell. These elements therefore have a tendency to accept an electron and form negatively charged ion. So, halogens have high electron affinity.

c. The metallic character depends on atomic size. So, larger the atomic size, more metallic is the element. Larger atomic size, easier for element to lose its electrons so → more metallic is the element.

P. 20–21 EXERCISES

A. **1.** atomic numbers

2. lower, higher

3. remains the same

4. remains the same

5. decreases, number of valence electrons, number of shells

6. greater

7. smaller, zero

8. non-metal

B. **1.** d. depends on the period

2. d. depends on the position of the element in the periodic table

3. b. decreases down a group

4. d. increases and decreases depending on position of the element

5. c. increases

6. d. caesium

7. a. 1

8. b. nitrogen

C. **1.** The longest period of the periodic table is period 6/period 7.

2. The distance from the centre of the nucleus to the outermost shell is atomic radius.

3. The tendency of an element to attract electrons towards itself in a compound is known as electronegativity.

4. kJ/mol

5. An element that displays radioactivity is Francium.

D. **1.** group IIIA, Period 3

2. metal

3. 3

4. Aluminium

E. **1.** Dobereiner gave ‘Law of Triads’. It failed because it could be applied to few elements only.

Newland gave ‘Law of Octaves’. It failed with the discovery of inert gas or zero group.

Mendeleev gave periodic classification based on increasing order of atomic weight. It had many defects like position of H, presence of inversion pairs, no place for isotopes, dissimilar elements placed together and similar placed separately.

2. As we move down a group, the number of shells keeps on increasing and therefore the atomic size increases. Therefore, the electronegativity decreases.

3. **a.** Alkali metals have one valence electron in their outermost shell and hence they all form monovalent cations. Alkali metals are very reactive and are therefore not found in the free state.

b. All halogens are very reactive and do not occur in their free state in nature. They are found in the combined form in the earth’s crust.

4. Alkali metals are good reducing agents because they have very low ionization potential and can lose electrons easily.

P. 21–23 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. **a.** Electronegativity

b. Valence electrons

2. **a.** less than (<)

b. less than (<)

3. **a.** **i.** Five valence electrons

ii. M

iii. T

iv. T

b. **i.** metallic

ii. Smallest

c. **i.** I. Ionic bond II. Covalent bond

ii. I. ZX II. WX

2015

4. **a.** **i.** Barium will form ions most readily because its ionization potential is lowest in the group. So removal of electrons is easy.

ii. All these elements have two electrons in their valence shells.

5. **a.** Li < Na < K < Rb < Cs (increasing order of metallic character)

b. Na > Mg > Si > S > Cl (decreasing order of atomic size)

c. K < Na < Si < S < Cl (increasing order of ionization energy)

d. I < Br < F < Cl (increasing order of electron affinity)

2014

6. **a.** **iv.** atomic radius decreases and nuclear charge increases.

b. **i.** 3 shells and 2 valence electrons.

7. **a.** 3rd period, 16 Group

b. Z is a non-metal.

c. H_2Z

d. Covalent compound

2013

8. **iv.** fluorine.

9. **a.** J

b. R

c. M

d. 5

e. T

f. Y Krypton

g. Covalent bond, molecular formula = A_2H

2012

10. **a.** **iv.** Argon

b. **ii.** Calcium

11. **a.** Ionization potential of elements increases across a period because across a period atomic size decreases and nuclear charge increases, so more energy is required to remove a valence electron.

b. Alkali metals are good reducing agents because they have low ionization potential.

12. Sodium

2011

13. The oxidizing power of elements increases on moving from left to right along a period in the periodic table because the electron affinity of elements increases.

14. **a.** **i.** 1

b. **iii.** They are metallic in nature.

15. a. increases

b. decreases

16. Third group, third period

2010

17. d. 7

18. a. Electronegativity across the period – increases

b. Non-metallic character down the group – decreases

19. a. Ionization potential: It is the energy required to remove an electron from an isolated gaseous atom in its ground state.

b. Electron affinity: It is the amount of energy released when an isolated gaseous atom accepts an electron to form the gaseous negative ion.

20. a. 3rd period

b. six

c. non-metal

CHAPTER – 2

CHEMICAL BONDING

P. 28 Check Your Progress

1. **a.** metallic
   b. Larger
   c. Halogens
   d. lose
   e. electrons

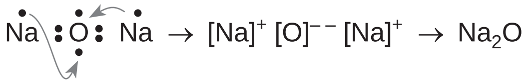
2. Ionic bond formation of potassium chloride

Metal: **Potassium**	Non-metal: **Chlorine**
Atomic number: 19	Atomic number: 17
E.C. 2, 8, 8, 1	E.C. 2, 8, 7
Valence electrons: 2	Valence electrons: 7
Electron dot structure:	Electron dot structure:
	
Potassium has one electron to donate to achieve stable octet configuration	Chlorine atom can accept one electron to achieve stable octet configuration

$K\ Cl \rightarrow [K]^{+}[Cl]^{-} \rightarrow KCl$

Ionic bond formation of sodium oxide

Metal: **Sodium**	Non-metal: **Oxygen**
Atomic number: 11	Atomic number: 8
E.C. 2, 8, 1	E.C. 2, 6
Electron dot structure:	Electron dot structure:
	



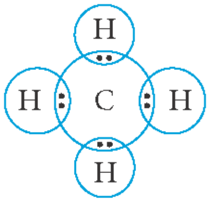
$Na\ O\ Na \rightarrow [Na]^{+}[O]^{--}[Na]^{+} \rightarrow Na_2O$

3. **a.** Two conditions favouring the formation of an ionic bond are
   i. Low ionization potential of the metallic element that forms a cation. If the ionization potential is low, a cation will be formed easily.
   ii. Large electron affinity of the non-metallic element that forms an anion. If the electron affinity is high, an anion will be formed easily.
   b. Ionic compounds conduct electricity in molten or aqueous state because it contains free electrons that can move only in aqueous state.
   c. Chloride ion is stable as it contains an extra electron and thus achieve [2, 8, 8] configuration.

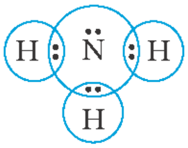
P. 32 Check Your Progress

1. **a.** **i.** non-volatile
   b. **ii.** non-polar covalent compound.
   c. If X is a covalent compound, it is likely to have a
   i. low melting point.

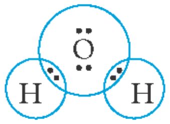
2. **a.** Methane.



   b. Ammonia.



   c. Water.

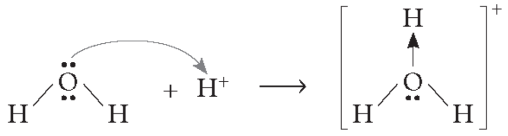


3. **a.** Give two examples in each case.
   i. Solid covalent compounds – Iodine, Sugar
   ii. Gaseous polar compounds – Ammonia, hydrogen sulphide
   iii. Gaseous non-polar compounds – Oxygen and nitrogen
   iv. Liquid non-polar compounds – Methane and ethane
   b. Give reasons for the following.
   i. Methane does not conduct electricity as it does not conduct electricity in its molten or aqueous state because it contains neither the ions nor free electrons required for conduction.
   ii. The electronegativity difference is very low or zero. If there is a difference in electronegativities then the bond is a polar bond. If there is no difference in electronegativities, then the bond is non-polar. So, covalent compounds can be polar as well as non-polar in nature.
   iii. The molecules of carbon tetrachloride (a covalent compound) are held together by relatively weaker forces as compared to that in ionic compounds. Therefore, melting and boiling points of covalent compounds are generally low. So, carbon tetrachloride has a low boiling point.

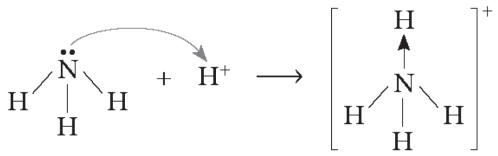
iv. Polar compounds ionize in water. They ionize in solution, like HCl forms H^+ and Cl^- ions in aqueous state. They contain free electrons/ions in aqueous state.

P. 34 CHECK YOUR PROGRESS

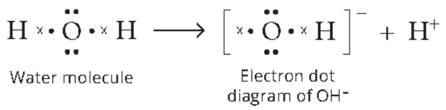
1. **a.** Hydroxyl ion
   b. Lone pair of electrons
   c. Single covalent bond
   d. Hydronium ion
   e. Two
2. **a.** Hydronium ion



   b. Ammonium ion

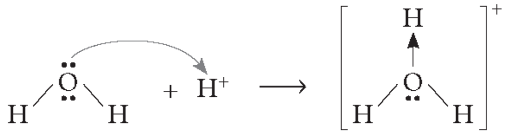


   c. Hydroxyl ion



3. A chemical bond formed by sharing a pair of electrons between two atoms, both of which are provided by only one of the combining atoms is called coordinate bond. The atom which provides the electron pair for the formation of coordinate bond is called donor and the atom or ion sharing donated electron pair is called acceptor.

   Example:



P. 34–35 EXERCISES

A. 1. helium

2. two

3. Covalent

4. covalent

5. electronic shells

B. 1. b **2.** c **3.** d **4.** b **5.** b

C. 1. Ammonia

2. Lone pair

3. Triple covalent bonds

4. Coordinate bond

5. Covalent

D. 1. An atom is neutral but cation is positively charged. Atom is unstable but cation is stable.

2. An atom is neutral but anion is negatively charged. Atom is unstable but anion is stable.

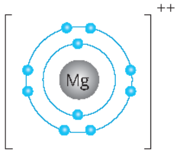
3. Covalent bonds are formed by sharing of electrons while electrovalent bonds are formed by transfer of electrons.

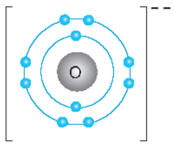
4. Non-polar covalent bonds are formed between same atoms, for example, H_2, Cl_2, N_2, but polar covalent bonds are formed between different atoms, for example, HCl, H_2O.

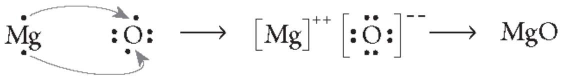
5. Sodium chloride has ionic bonding but hydrogen chloride is formed by covalent bonding.

E. 1. Magnesium oxide:

Metal: **Magnesium**	Non-metal: **Oxygen**
Atomic number: 12	Atomic number: 8
EC: 2, 8, 2	EC: 2, 6
Valence electrons: 2	Valence electrons: 6
Electron dot structure:	Electron dot structure:
$\overset{\bullet}{\underset{\bullet}{\text{Mg}}}$	$:\overset{\bullet}{\underset{\bullet}{\text{O}}}:$
Magnesium has two electrons to donate.	Each oxygen atom can accept two electrons.
Magnesium ion	**Oxide ion**
$Mg - 2e^- \longrightarrow Mg^{++}$	$O + 2e^- \longrightarrow O^{--}$
$[Mg]^{++}$	$\left[:\overset{\bullet\bullet}{\underset{\bullet\bullet}{\text{O}}}:\right]^{--}$



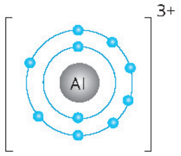


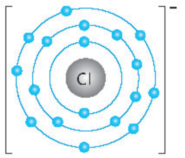


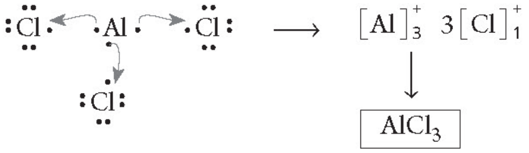
Ionic bond formation in magnesium oxide

2. Aluminium chloride:

Metal: **Aluminium**	Non-metal: **Chlorine**
Atomic number: 13	Atomic number: 17
EC: 2, 8, 3	EC: 2, 8, 7
Valence electrons: 3	Valance electrons: 7
Al	:Cl:
Aluminium has 3 electrons to donate	Each chlorine atom can accept 1 electron.
Aluminium ion	**Chloride ion**
$Al - 3e^- \longrightarrow Al^{3+}$	$Cl + e^- \longrightarrow Cl^-$







F. 1. Characteristics of covalent bond

   i. It is formed by sharing of one or more electron pairs

   ii. It does not form ions

2. Hydrogen chloride ionizes and dissolves in water to form hydrochloric acid.

3. Cations are smaller than their corresponding atoms because they have greater nuclear pull due to greater number of protons.

4. Two electrons in the outer shell of an oxygen atom are involved in the formation of carbon dioxide molecule.

5. Hydrogen always form a single bond as it contains only one electron in its outer shell.

6. Conditions favouring the formation of a covalent bond

   i. A covalent bond is formed between two nonmetals.

   ii. The difference in electronegativity between the combining atoms of the two non-metals must be sufficiently low or zero.

P. 35–36 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. high

2. a. 17

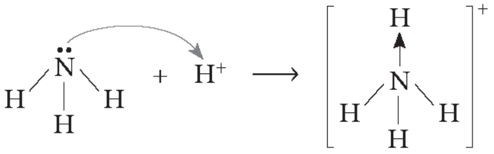
3. a. i. Ionic bond

   ii. Covalent bond

b. i. ZX

   ii. WX

4.



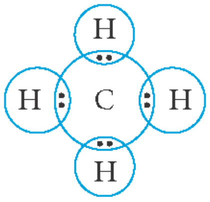
Coordinate bond formation in ammonium ion

2015

5. b. Ammonium chloride

6. Carbon tetrachloride is a covalent compound. It does not have free electrons in it, so it does not conduct electricity.

7. Methane is an organic compound and its formula is CH_4. The hydrogen atom and carbon atom contribute one electron each to the shared pair of electrons for the formation of each C-H bond. In the process, each hydrogen atom attains duplet of electrons and the carbon atom attains the octet of electrons.



8. a. $y + 3e^- \rightarrow Y^{3-}$

   b. $3X + Y_2 \rightarrow X_3Y_2$

9. a. Covalent bonding (as it is L molecule).

   b. Rearrangement of molecules.

2014

10. a. ii. a low melting point and low boiling point.

   b. iv. nitrogen.

11. Ionization

2013

12. Coordinate bond

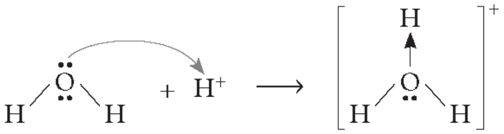
13. a. ii. Ammonium chloride

   b. iii. They are insoluble in water.

14. Sodium chloride is soluble in water whereas carbon tetrachloride is insoluble in water. Electrical conductivity: Sodium chloride conducts electricity in the molten and in the aqueous solution state, whereas carbon tetrachloride being non-polar covalent compound does not conduct electricity.

2012

15.



Coordinate bond formation in hydronium ion

2011

16. Because there is a big difference between E.N. of H and Cl.

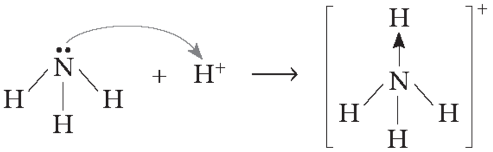
17. **a.** sharing

b. high

c. nitrogen

2010

18.



Coordinate bond formation in ammonium ion

19. **a.** Sodium chloride → ionic bond

b. Ammonium ion → covalent and coordinate bond

c. Carbon tetrachloride → covalent bond

CHAPTER – 3

ACIDS, BASES AND SALTS

P. 43 CHECK YOUR PROGRESS

1. **a.** Oxyacids
b. Phosphorous acid, H_3PO_3
c. Citric acid.
d. Tartaric acid
e. Water

2. **a.** $SO_3 + H_2O \rightarrow H_2SO_4$
b. $P + 5HNO_3 \rightarrow H_3PO_4 + H_2O + 5NO_2$
c. $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$
d. $CuO + HCl \rightarrow CuCl_2 + H_2O$
e. $ZnS + HCl \rightarrow ZnCl_2 + H_2S$

P. 48 CHECK YOUR PROGRESS

1. **a.** purple
b. yellow
c. acidity
d. ammonia.
e. Calcium hydroxide

2. **a.** CaO
b. $NaOH$
c. $Mg(OH)_2$
d. Ammonium hydroxide
e. $Mg(OH)_2$

3. **a.** $2Mg + O_2 \rightarrow 2MgO$
b. $Ca + H_2O \rightarrow Ca(OH)_2 + H_2$
c. $FeSO_4 + 2NaOH \rightarrow Fe(OH)_2\downarrow + Na_2SO_4$
d. $Fe(OH)_2 + 2HCl \rightarrow FeCl_2 + 2H_2O$
e. $2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$

P. 52 CHECK YOUR PROGRESS

1. **a.** acidic, metal
b. acidic
c. $BaSO_4$
d. greater
e. normal

2. **a.** red litmus paper turns blue
b. blue litmus paper turns red
c. blue litmus paper turns red

3.

Salt	*Neutralization*
Zinc sulphate	Neutralization
Barium sulphate	Precipitation
Ferric sulphate	Displacement
Ferrous sulphide	Synthesis

P. 53–54 EXERCISES

A. **1.** Ammonium hydroxide
2. Lead (II) chloride
3. Magnesium hydroxide
4. Carbon dioxide

B. **1.** Hydracid is an acid that contains only hydrogen and a nonmetallic element in its molecule.

2. Acidity of a base represents number of replaceable hydroxyl ions present in the base.

3. Indicator is a chemical compound used to detect the acidic or basic nature of a solution by sharp change in its colour.

4. Hydrolysis of salts are chemical reactions in which salt reacts with water to form parent acid and parent base.

5. Concentrated acid is an acid which contains less amount of water.

C. **1.** $NaHCO_3$
2. $Mg(OH)Cl$
3. $KCl.MgCl_2 \cdot 6H_2O$
4. Na_2ZnO_2
5. $NaKSO_4$

D. **1.** 0 – 6.9 (Acidic)
2. 0 – 6.9 (Acidic)
3. 7.1 – 14 (Basic)
4. 0 – 6.9 (Acidic)
5. 7.1 – 14 (Basic)

E. **1.** **a.** $NaHSO_4$
b. $AgCl$
c. $Pb(NO_3)_2$
d. $CuSO_4$

2. Sodium hydrogen sulphate, $NaHSO_4$

3. **a.** pH < 7 (acidic solution)
b. **i.** R **ii.** R **iii.** Q

4. **a.** $ZnS + 2HCl \rightarrow ZnCl_2 + H_2S$
$ZnCl_2 + Na_2CO_3 \rightarrow ZnCO_3 + 2NaCl$

b. Precipitation

$$Na_2CO_3 + 2HCl \xrightarrow[\text{Neutralisation}]{} 2NaCl + H_2O + CO_2$$

c. Neutralisation

$$BaCO_3 + H_2SO_4 \xrightarrow[\text{Neutralisation}]{} BaSO_4 + H_2O + CO_2$$

OR

$$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$$

Precipitation

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4\downarrow + 2HCl$$

d. $2NH_4OH + H_2SO_4 \rightarrow 2H_2O + (NH_4)2SO_4$

Neutralisation

5. a. Salt prepared by precipitation

Insoluble salt (double decomposition)

Example – Barium sulphate ($BaSO_4$)

b. Sodium nitrate

Reaction

$$\underset{\text{sodium hydroxide}}{NaOH} + \underset{\text{nitric acid}}{HNO_3} \rightarrow NaNO_3 + \underset{\text{water}}{H_2O}$$

c. Precipitation reaction

$$\underset{\text{barium chloride}}{BaCl_2} + \underset{\text{sodium sulphate}}{Na_2SO_4} \rightarrow \underset{\text{(white ppt)}}{BaSO_4} + \underset{\text{sodium chloride}}{2NaCl}$$

6. a. Iron (III) Chloride: Iron chloride is formed by direct combination of elements.

$$2Fe + 3Cl_2 \rightarrow 2FeCl_3$$

b. Potassium sulphate: By neutralization of KOH with dilute sulphuric acid.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

c. Iron (II) sulphate: Iron sulphate is prepared by the action of dilute acid on an active metal.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

d. Potassium zincate: By the action of metals with alkalis.

$$Zn + 2KOH \rightarrow K_2ZnO_2 + H_2$$

e. Potassium chloride: By the neutralization reaction of strong acid with strong base.

$$KOH + HCl \rightarrow KCl + H_2O$$

P. 54–56 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. a. alkaline

b. i. $AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3$

ii. $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

iii. $H_2SO_4 + \underset{\text{sodium sulphite}}{Na_2SO_3} \rightarrow Na_2SO_4 + H_2O + SO_2$

c. i. When dilute hydrochloric acid is added to lead nitrate solution, insoluble white precipitate of lead chloride is formed. When the mixture is heated, the precipitate dissolves because lead chloride is soluble in water.

$$Pb(NO_3)_2 + 2HCl \rightarrow \underset{\substack{\text{white precipitate} \\ \text{(insoluble salt)}}}{PbCl_2\downarrow} + 2HNO_3$$

ii. $\underset{\text{barium chloride}}{BaCl_2} + \underset{\text{sodium sulphate}}{Na_2SO_4} \rightarrow \underset{\substack{\text{barium sulphate} \\ \text{(white ppt.)}}}{BaSO_4\downarrow} + \underset{\text{sodium chloride}}{2NaCl}$

iii. $CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2CO_3 \rightarrow CUCl_2 + H_2O + CO_2\uparrow$

d.

a. $Pb(NO_3)_2$ from PbO	**iii.** Neutralization
b. $MgCl_2$ from Mg	**i.** Simple displacement
c. $FeCl_3$ from Fe	**v.** Combination
d. $NaNO_3$ from NaOH	**ii.** Titration
e. $ZnCO_3$ from $ZnSO_4$	**iv.** Precipitation

2015

2. a. Nitric acid

b. Sulphuric acid is a strong acid compared to acetic acid. A strong acid has more ionisable hydrogen ions in it. Hence the electrical conductivity of sulphuric acid is more than acetic acid at a given concentration.

c. i. $2Fe + \underset{\text{dry chlorine gas}}{3Cl_2} \rightarrow \underset{\text{iron(III) chloride}}{2FeCl_3}$

ii. $2FeCl_3 + 2CO_2 + O_2 \rightarrow 2FeCO_3 + 3Cl_2$

iii. $FeCO_3 + 2HNO_3 \rightarrow Fe(NO_3)_2 + H_2CO_3$

3. a. Na_2O

b. SO_2

c. Al_2O_3

d. SiO_2

4. a. $ZnCO_3$

b. $Ca(NO_3)_2$

2014

5. 1

6. Barium chloride solution after reaction with dilute sulphuric acid forms barium sulphate and hydrochloric acid while no effect is seen on dilute hydrochloric acid.

Reaction

$$BaCl_2 + H_2SO_4 \rightarrow \underset{\text{(white ppt.)}}{BaSO_4} + 2HCl$$

7. a. $PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2\uparrow$

$Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4\downarrow + 2HNO_3$

b. $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2\uparrow$

c. $CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2\uparrow$

2013

8. i. hydronium

ii. hydroxide

iii. Salt

iv. Water

v. Hydrogen

9. Pungent smelling or rotten eggs like smelling hydrogen sulphide gas is liberated when copper sulphide is treated with dilute hydrochloric acid.

10. Acidic salt

11. a. i. Carbon monoxide

b. iii. Zinc oxide

12. a. Sodium + Dilute Sulphuric Acid to obtain Sodium Sulphate

$2Na + H_2SO_4 \rightarrow Na_2SO_4 + H_2\uparrow$

b. Copper(II) carbonate + Zinc nitrate to obtain Zinc Carbonate

$ZnNO_3 + CuCO_3 \rightarrow ZnCO_3 + CuNO_3$

c. Copper(II) carbonate + Dilute Sulphuric acid to obtain Copper(II) Sulphate

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

d. Iron + Dilute Sulphuric acid to obtain Iron(II) Sulphate

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2\uparrow$

2012

13. The blue colour of the copper sulphate solution disappears due to the formation of colourless zinc sulphate.

14.

a.	Acid salt	**iii.**	Sodium hydrogen sulphate
b.	Double salt	**i.**	Ferrous ammonium sulphate
c.	Ammonium hydroxide solution	**v.**	Contains ions and molecules
d.	Dilute hydrochloric acid	**ii.**	Contains only ions
e.	Carbon tetrachloride	**iv.**	Contains only molecules

2011

15. b. hydrogen sulphide

16. a. Simple displacement: Zinc sulphate

b. Neutralization: Sodium nitrate

c. Decomposition by acid: Sodium hydrogen sulphate

d. Double decomposition: Lead chloride

e. Direct Synthesis: Lead (III) chloride

17. $Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 + 2NaNO_3$

2010

18. a. A compound which is insoluble in cold water, but soluble in hot water: Lead (II) chloride.

b. A compound whose aqueous solution is neutral in nature: Sodium chloride

19. a. i. weak acid

b. i. formic acid

c. iii. tetramine copper(II) sulphate

20. a. C

b. B

21. a. $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

b. $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

c. $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

d. $PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2$

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

22. $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$

CHAPTER – 4

ANALYTICAL CHEMISTRY

P. 61 CHECK YOUR PROGRESS

1. **a.** transition

b. orange

c. $FeCl_2$

d. NH_4OH

e. $Zn(OH)_2$

2. **a.** Cu^{2+} ($CuSO_4$)

b. Pb^{2+} $Pb(NO_3)_2$

c. Fe^{3+} ($FeCl_3$)

3. **a.** $Ca(NO_3)_2 + 2NaOH \rightarrow Ca(OH)_2\downarrow + 2NaNO_3$

b. $FeCl_3 + 3NH_4OH \rightarrow Fe(OH)_3\downarrow + 3NH_4Cl$

c. $2Al + 2KOH + H_2O \rightarrow 2KAlO_2 + 3H_2\uparrow$

d. $Pb(OH)_2 + 2NaOH \rightarrow Na_2PbO_2 + 2H_2O$

e. $Cu(OH)_2 + 4NH_4OH \rightarrow [Cu(NH_3)_4](OH)_2 + 4H_2O$

4. **a.** $Pb + \underset{\text{(conc.)}}{2KOH} \rightarrow \underset{\text{potassium plumbite}}{K_2PbO_2} + H_2\uparrow$

b. $Zn(OH)_2 + 2HCl \rightarrow ZnCl_2 + 2H_2O$

c. $2Al + \underset{\text{(conc.)}}{2KOH} + 2H_2O \rightarrow \underset{\text{potassium aluminate.}}{2KAlO_2} + 3H_2\uparrow$

d. $CaCl_2 + 2NH_4OH = Ca(OH)_2 + 2NH_4Cl$

5. If a **light blue** precipitate is formed which is insoluble in excess sodium hydroxide, then the metal cation in the salt solution is copper(II) or cupric.

If a **white gelatinous** precipitate is formed which dissolves in excess sodium hydroxide, then the metal cation in the salt solution can be zinc (Zn^{2+}).

6. If a **white** precipitate is formed which does not dissolve in excess ammonium hydroxide, then the metal cation in the salt solution is lead(II).

$Pb(NO_3)_2 + 2NH_4OH \rightarrow Pb(OH)_2\downarrow + 2NH_4NO_3$

$Pb^{2+} + 2NH^4OH \rightarrow Pb(OH)_2\downarrow + 2NH^{4+}$

P. 63–64 EXERCISES

A. **1.** c **2.** b **3.** b

B. **1.** Zn^{2+}

2. Mn^{2+}

3. Cr^{3+}

4. Ti^{3+}

5. Fe^{3+}

C. **1.** Pale green lustrous crystals

2. Pale green crystals

3. Yellowish brown powder

4. Pale green powder

D. **1.** Sodium zincate $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

2. Lead plumbate $Pb(OH)_2 + 2NaOH \rightarrow Na_2PbO_2 + 2H_2O$

3. Sodium meta-aluminate $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

4. Sodium stannate $Sn + 2NaOH \rightarrow Na_2SnO_2 + H_2$

5. Sodium zincate $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

E.

		Iron II salts	**Iron III salts**
1.	With sodium hydroxide	gives dirty or pale green precipitate	gives brown precipitate
2.	With copper II hydroxide	**Sodium hydroxide** gives bluish white precipitate	**Ammonium hydroxide** gives bluish white precipitate soluble in excess to give deep blue solution
3.	With sodium hydroxide	**Magnesium chloride** gives white precipitate insoluble in excess	**Zinc chloride** gives white precipitate soluble in excess NaOH
4.	With water	**Hydrated Cobalt chloride** no change it remains pink	**Anhydrous Cobalt chloride** it converts from blue to pink
5.	With sodium hydroxide	**Magnesium nitrate** gives white precipitate insoluble in excess	**Lead nitrate** gives white precipitate soluble in excess NaOH

F. **1.** It is silver chloride [AgCl] dissolves in excess of NH_4OH.

Product formed is $[Ag(NH_3)_2]Cl$ [Soluble colourless Diamine Argentous(I) chloride]

2. $PbCO_3 + 3NaOH \rightarrow Na[Pb(OH)_3] + Na_2CO_3$

$ZnCO_3 + 4NaOH \rightarrow Na_2[Zn(OH)_4] + Na_2CO_3$

$$CaCO_3(s) + 2NaOH(aq) \rightarrow Ca(OH)_2(aq) + Na_2CO_3(aq)$$

If chalky white precipitate is formed it would be Pb^{2+}, if white gelatinous precipitate is formed, it would be Zn^{2+} cation and if white precipitate is formed, it would be Ca^{2+} cation.

3. **a.** $CuSO_4$
   - **i.** Dropwise manner

     $$CuSO_4 + 2NH_4OH \rightarrow \underset{\text{Light blue}}{Cu(OH)_2\downarrow} + (NH_4)_2SO_4$$

   - **ii.** Excess

     $$Cu(OH)_2 + 4NH_4OH \rightarrow \underset{\text{Inky blue}}{[Cu(NH_3)_4](OH)_2} + 4H_2O$$

   b. $FeCl_3$
   - **i.** Dropwise manner

     $$FeCl_3 + 3NH_4OH \rightarrow \underset{\text{Reddish brown}}{Fe(OH)_3\downarrow} + 3NH_4Cl$$

   - **ii.** Excess

     $$Fe^{3+} + 3NH_4OH \rightarrow \underset{\text{Insoluble}}{Fe(OH)_3\downarrow} + 2NH_4^+$$

   c. $ZnSO_4$
   - **i.** Dropwise manner

     $$ZnSO_4 + 2NH_4OH \rightarrow \underset{\text{White gelatinous ppt.}}{Zn(OH)_2\downarrow} + (NH_4)_2SO_4$$

   - **ii.** Excess

     $$Zn(OH)_2 + 4NH_4OH \rightarrow \underset{\text{colourless solution}}{[Zn(NH_3)_4](OH)_2} + 4H_2O$$

4. **a.** Not soluble

   b. Sodium hydroxide

   c. Ammonium hydroxide
5. **a.** Zinc.

   b. Hydrogen

   c. sodium zincate
6. **a.** NaOH

   b. NaOH

   c. KOH
7. **a.** Cu

   b. $CuSO_4 + 2NH_4OH \rightarrow Cu(OH)_2\downarrow + (NH_4)_2SO_4$
8. **a.** PbO [Lead monoxide]

   b. Al_2O_3 [Aluminium oxide]

   c. Na_2ZnO_2 [Sodium zincate]
9. **a.** $FeCl_3 + 3NH_4OH \rightarrow Fe(OH)_3\downarrow + 3NH_4Cl$

   b. $Pb + \underset{\text{(conc.)}}{2KOH} \xrightarrow{\Delta} \underset{\text{potassium plumbite}}{K_2PbO_2} + H_2\downarrow$

   c. $Cu(OH)_2 + 4NH_4OH \rightarrow [Cu(NH_3)_4](OH)_2 + 4H_2O$

P. 64–65 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. AgCl
2. **a.** A pale blue precipitate is formed and the precipitate dissolves when excess of ammonium hydroxide is added

   $$CuSO_4 + 2NH_4OH \rightarrow Cu(OH)_2\downarrow + (NH_4)_2SO_4$$

   Pale blue

   $$Cu(OH)_2 + (NH_4)2SO_4 + 2NH_4OH \rightarrow [Cu(NH_3)_4]SO_4 + 4H_2O$$

   (Excess) Deep blue solution

   b. White gelatinous precipitate of $Zn(OH)_2$ is formed and it dissolves in excess of ammonium hydroxide.

   $$ZnSO_4 + 2NH_4OH \rightarrow Zn(OH)_2\downarrow + (NH_4)_2SO_4$$

   $$Zn(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \rightarrow [Zn(NH_3)_4]SO_4 + 4H_2O$$

   (Excess) (Soluble)
3. **a.** Fe^{3+}

   b. $Pb^{2+.}$

   c. Mg^{2+}

2015

4. **i.** Zn^{2+} **ii.** Cu^{2+} **iii.** Ca^{2+} **iv.** NH_4^+

2014

5. Distinguish between the following pairs of compounds using test given within brackets.

   a. Using ammonium hydroxide:

Iron(II) Sulphate	Iron(III) Sulphate
Dirty green precipitate of $Fe(OH)_3$ is formed	Gelatinous brown precipitate of $Fe(OH)_3$ is formed

   b. Using excess ammonium hydroxide:

Lead Salt	Zinc Salt
White precipitate of $pb(OH)_2$, insoluble in excess NH_4OH solution, is formed	Gelatinous white ppt. of $Zn(OH)_2$, soluble in excess of NH_4OH solution, is formed

6. A white precipitate is obtained which is insoluble in excess of sodium hydroxide.

2013

7. When NaOH solution is added in excess to both the solutions, white precipitate is formed in $Zn(CO_3)_2$ which dissolves in NaOH solution and no such precipitate is formed with $Ca(NO_3)_2$.

8. State two relevant observations for each of the following:

- **a.** **i.** When NH_4OH is added in small quantity, a pale blue precipitate of copper hydroxide is formed.
  - **ii.** When NH_4OH is added in excess, an inky blue solution of tetraamine copper sulphate is formed.
- **b.** **i.** When NH_4OH is added in minimum quantities, a white soluble ppt. of $Zn(OH)_2$ is formed.
  - **ii.** When NH_4OH is added in excess, a colourless solution of tetraamine zinc sulphate is formed.

2012

9. Hydrogen gas evolved

10. State one observation for each of the following.

- **a.** A white ppt of lead oxide is formed
- **b.** A reddish-brown ppt of ferric oxide is formed which remains insoluble in excess of sodium hydroxide

11. **a.** Cl^- ion

b. Aqueous ferrous nitrate when treated with NaOH solution gives a dirty green ppt.

Aqueous lead nitrate when treated with NaOH solution gives a white ppt which dissolves in excess NaOH.

2011

12. When ammonium hydroxide is first added in a small quantity and then in excess to copper sulphate solution; first a light blue precipitate appears then solution turns inky blue.

13. **b.** Lead

14. **a.** $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

b. $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

15.

List X	List Y
a. Pb^{2+}	**iv.** White soluble in excess
b. Fe^{2+}	**iii.** Dirty green
c. Zn^{2+}	**v.** White soluble in excess
d. Fe^{3+}	**i.** Reddish brown
e. Cu^{2+}	**vi.** Blue
f. Ca^{2+}	**ii.** White insoluble in excess.

2010

16. **a.** $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

b. $NH_4Cl + NaOH \rightarrow NaCl + NH_3\uparrow + H_2O$

17. Solution A

CHAPTER – 5

MOLE CONCEPT AND STOICHIOMETRY

P. 70 Check Your Progress

1. $2NO + O_2 \rightarrow 2NO_2$

$2NO = 2NO_2$

$2 : 2$ ratio

$100\ cm^3 = 100\ cm^3$

Since NO and NO_2 are in 2 : 2 ratio.

$\therefore$ Volume of NO_2 formed will be $100\ cm^3$.

Alternatively

$O_2 = 2NO_2$

$1 = 2$

$50\ cm^3 = 100\ cm^3$

Same answer because O_2 and NO_2 are in 1 : 2 ratio.

2. $2CO + O_2 \rightarrow 2CO_2$

$2CO = 2CO_2$

$2 : 2$

$\therefore \quad 200\ cm^3 = x$

$$x = \frac{200 \times 2}{2}$$

$x = 200\ cm^3$

Volume of CO_2 formed = $200\ cm^3$

$2CO = O_2$

$2 : 1$

$200\ cm^3 = x$

$$x = \frac{200 \times 1}{2}$$

$x = 100\ cm^3$

Only $100\ cm^3$ of O_2 is used, so volume of oxygen left = $100\ cm^3$

3. a. $2H_2 + O_2 \rightarrow 2H_2O$ (steam)

$2H_2 = 2H_2O$

$2 : 2$

$22.4\ L = x$

$$x = \frac{2 \times 22.4}{2}$$

$x = 22.4\ L$

Volume of steam = 22.4 L

b. $2H_2 = O_2$

$2 : 1$

$22.4\ L = x$

$$x = \frac{22.4}{2}$$

$x = 11.2\ L$

Volume of oxygen used up = 11.2 L

Volume of unused oxygen = 22.4 – 11.2 = 11.2 L

Steam at room temperature changes to liquid.

4. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

C_3H_8 (propane) = $5O_2$

$22400\ cm^3 = 5 \times 22400\ cm^3$

$x = 100\ cm^3$

$$x = \frac{22400 \times 100}{5 \times 22400}$$

$x = 20\ cm^3$

Volume of propane used = $20\ cm^3$

P. 77–78 Check Your Progress

1. Number of moles = $\dfrac{\text{weight in gram (mass)}}{\text{M wt}}$

Mass = moles × M wt

= 0.2 × 18

= 3.6 g ($H_2O = 2 + 16 = 18$)

Mass of water = 3.6 g

2. $7\ L\ O_2 = 10\ g$

$22.4\ L\ O_2 = x$

$$x = \frac{22.4 \times 10}{7} = 32\ g$$

Molecular mass of O_2 = 32 g

3. $N_2 = 2N$

= 2 × 14

= 28

$28\ g\ N_2 = 22.4\ L$

$2.8\ g = x$

$$x = \frac{2.8 \times 22.4}{28 \times 100} = 22.4\ L$$

Volume of N_2 = 2.24 L

4. a. 22.4 L

b. $Cl_2 = 2 \times (Cl)$

= 2 × 35.5

= 71 g

P. 80 Check Your Progress

1. 32

2. It means that carbon dioxide is 22 times heavier than an atom of hydrogen.

3. 35.5

4. Molecular mass of gas A = 4 and the molecular mass of gas B = 10

5. 22 kg

P. 81 CHECK YOUR PROGRESS

1. Percentage of Aluminium in cryolite (Na_3AlF_6) = ?

Relative molecular mass

$$= 3\ (Na) + Al + 6\ (F)$$
$$= 3 \times 23 + 27 + 6 \times 19$$
$$= 69 + 27 + 114 = 210$$

$$\text{Percentage of Aluminum} = \frac{\text{Mass of Al}}{\text{Relative mol. mass}} \times 100$$
$$= \frac{27}{210} \times 100$$
$$= \frac{270}{21}$$
$$= 12.857\%$$

2. Percentage of oxygen in ethanol (C_2H_5OH) = ?

Relative molecular mass of C_2H_5OH

$$= 2\ (C) + 5\ (H) + O + H$$
$$= 2 \times 12 + 5 \times 1 + 16 + 1$$
$$= 24 + 5 + 16 + 1$$
$$= 46$$

$$\text{Percentage of oxygen} = \frac{\text{Mass of oxygen}}{\text{Relative mol. mass}} \times 100$$
$$= \frac{16}{46} \times 100$$
$$= \frac{1600}{46}$$
$$= 34.78\%$$

3. Percentage of nickel in nickel sulphate ($NiSO_4$) = ?

Relative molecular mass

$$= Ni + S + (4)\ O$$
$$= 59 + 32 + 4 \times 16$$
$$= 59 + 32 + 64$$
$$= 155$$

$$\text{Percentage of Nickel} = \frac{\text{Mass of Nickel}}{\text{Relative mol. mass}} \times 100$$
$$= \frac{59}{155} \times 100$$
$$= \frac{5900}{155}$$
$$= 38.06\%$$

4. Percentage of water of crystallization in green vitriol ($FeSO_4{\cdot}7H_2O$) = ?

Relative molecular mass

$$= Fe + S + 4\ (O) + 7\ (H_2O)$$
$$= 56 + 32 + 4 \times 16 + 7 \times 18$$
$$= 56 + 32 + 64 + 126$$
$$= 278$$

$$\text{Percentage of water} = \frac{\text{Mass of water of crystallisation}}{\text{Relative mol. mass}} \times 100$$
$$= \frac{126}{278} \times 100$$
$$= \frac{12600}{278}$$
$$= 45.32\%$$

5. Percentage of water of crystallization in alum ($K_2SO_4{\cdot}Al_2(SO_4)_3{\cdot}24H_2O$) = ?

Relative molecular mass

$$= 2\,K + S + 4 \times O + 2 \times Al + 3\,(S + 4 \times O) + 24\,(H_2O)$$
$$= 2 \times 39 + 32 + 4 \times 16 + 2 \times 27 + 3\,(32 + 4 \times 16) + 24 \times 18$$
$$= 78 + 32 + 64 + 54 + 3\,(32 + 4 \times 16) + 432$$
$$= 228 + 288 + 432$$
$$= 948$$

$$\text{Percentage of water} = \frac{\text{Mass of water of crystallisation}}{\text{Relative mol. mass}} \times 100$$
$$= \frac{432}{948} \times 100$$
$$= \frac{43200}{948}$$
$$= 45.57\%$$

6. 62.94% (use the similar method as done above)

P. 83–84 CHECK YOUR PROGRESS

1.

Element	%	At. wt.	Relative ratio	Simplest ratio
Na	14.13	23	$\frac{14.13}{23} = 0.62$	$\frac{0.614}{0.311} = 2$
S	9.97	32	$\frac{9.97}{32} = 0.311$	$\frac{0.311}{311} = 1$
H	6.22	1	$\frac{6.22}{1} = 6.22$	$\frac{6.22}{0.311} = 20$
O	69.5	16	$\frac{69.5}{16} = 4.34$	$\frac{4.34}{0.311} = 14$

$\therefore$ E.F. = Na : S : H : O

= 2 : 1 : 20 : 14

= $Na_2SH_{20}O_{14}$

Since all hydrogen is present as water of crystallisation.

∴ There are $10H_2O$ molecules.
Atoms of O left 14 – 10 = 4.

Thus molecular formula = $Na_2SO_4 \cdot 10H_2O$

2.

Element	%	At. wt.	Relative ratio	Simplest ratio
N	35	14	$\frac{35}{14} = 2.5$	$\frac{2.5}{2.5} = 1 \times 2 = 2$
H	5	1	$\frac{5}{1} = 5$	$\frac{5}{2.5} = 2 \times 2 = 4$
O	60	16	$\frac{60}{16} = 3.75$	$\frac{3.75}{2.5} = 1.5 \times 2 = 3$

∴ E.F. = N : H : O
= 2 : 4 : 3
(A) = $N_2H_4O_3$

Element	%	At. wt.	Relative ratio	Simplest ratio
N	63.63	14	$\frac{63.63}{14} = 4.54$	$\frac{4.54}{2.27} = 2$
O	36.37	16	$\frac{36.37}{16} = 2.27$	$\frac{2.27}{2.27} = 1$

∴ E.F. = N : O
= 2 : 1
(B) = N_2O

The compound A is ammonium nitrate because it forms nitrous oxide. NH_4NO_3

3. E.F. = C : H : N
= 9 : 1 : 3.5
× 2 × 2 × 2
18 2 7
E.F. = $C_{18}H_2N_7$
E.F. wt = 18C + 2H + 7(N)
= 18 × 12 + 2 × 1 + 7 × 14
= 216 + 2 + 98 = 316

4.

Element	%	At. wt.	Relative ratio	Simplest ratio
C	12.8	12	$\frac{12.8}{12} = 1.06$	$\frac{1.06}{1} = 1$
H	2.1	1	$\frac{2.1}{1} = 2.1$	$\frac{2.1}{1.06} = 1.98$
Br	85.1	80	$\frac{85.1}{80} = 1.06$	$\frac{1.06}{1.06} = 1$

∴ E.F. = C : H : Br
= 1 : 2 : 1
= CH_2Br

119 cc occupies 1g

∴ 22400 cc occupies = $\frac{1}{119} \times 22400 = 188$

∴ M wt = 188
E.F. wt = CH_2Br = 12 + 2 + 80 = 94

∴ $\eta = \frac{\text{E.F. wt}}{\text{M wt}} = \frac{188}{94} = 2$

∴ M.F. = η × E.F.
= 2 × CH_2Br = $C_2H_4Br_2$

5. Wt of the carbohydrate = 310
Wt of carbon left = 124
∴ Wt of H_2O vap. = 186
18 g H_2O = 1 mole of H_2O
186 g = x

$$x = \frac{186}{18} = 10 \text{ moles}$$

$10H_2O$ moles represent H & O in 20 : 10 ratio.

Residue left 124 (carbon)

12 g = 1 C mole
124 g = x

$$x = \frac{124}{12} = 10$$

∴ Relative ratio of C, H & O is 10 : 20 : 10 = 1 : 2 : 1

∴ E.F. = CH_2O

P. 86–87 CHECK YOUR PROGRESS

1. a. $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$
M wt = 164 g
$2Ca(NO_3)_2 = 4NO_2$
2 × 164 g = 4 × 22.4 L
16.4 g = x

$$x = \frac{16.4 \times 4 \times 22.4}{164 \times 2 \times 100} = \frac{448}{100}$$

x = 4.48 L

Volume of liberated NO_2 = 4.48 L

b. $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$
2 × 164 g = 2 × 56 g
16.4 g = x

$$x = \frac{16.4 \times 2 \times 56}{2 \times 64 \times 10} = \frac{56}{10}$$

x = 5.6 g

Weight of cal. oxide (CaO) obtained = 5.6 g

2. a. $Ca(OH)_2 + 2NH_4Cl \rightarrow CaCl_2 + 2NH_3 + 2H_2O$

M wt of NH_4Cl = N + 4H + Cl
= 14 + 4 × 1 + 35.5
= 14 + 4 + 35.5
= 53.5 g

M wt of $CaCl_2$ = Ca + 2Cl
= 40 + 2 × 35.5
= 40 + 71
= 111 g

$2NH_4Cl = CaCl_2$
2 × 53.5 = 111
53.5 = x

$$x = \frac{111 \times 5.35}{2 \times 53.5} = 5.5 \text{ g}$$

x = 5.5 g

Amount of $CaCl_2$ formed = 5.5 g

b. $2NH_4Cl = 2NH_3$
2 × 53.5 g = 2 × 22.4 L
53.5 g = x

$$x = \frac{5.35 \times 2 \times 22.4}{2 \times 53.5 \times 100} = \frac{220}{100}$$

x = 2.24 L

Volume of ammonia liberated = 2.24 L

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

M wt of Al_4C_3 = 4Al + 3C
= 4 × 27 + 3 × 12
= 108 + 36 = 144

$Al_4C_3 = 3CH_4$
144 = 3 × 22.4 L
14.4 = x

$$x = \frac{3 \times 22.4 \times 14.4}{144 \times 100} = \frac{672}{100}$$

x = 6.72 L

Volume of methane liberated = 6.72 L

4. a. $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

M wt of FeS_2 = Fe + 2S
= 56 + 2 × 32
= 56 + 64
= 120 g

$FeS_2 = 2S$
120 g = 64 g
30 g = x

$$x = \frac{30 \times 64}{120}$$

x = 16 g

30 g of FeS_2 has 16 g of S.

b. $4FeS_2 = 8SO_2$
4 × 120 = 8 × 22.4 L
30 g = x

$$x = \frac{30 \times 8 \times 22.4}{2 \times 120} = \frac{22.4}{2}$$

x = 11.2 L

30 g of FeS_2 will form 11.2 L of SO_2 at STP.

5. a. $2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$

$2H_2S = 2SO_2$

[M wt of SO_2 = S + 2(O) = 32 + 2 × 16 = 32 + 32 = 64]

2 × 22.4 L = 2 × 64 g
x = 12.8 g

$$x = \frac{2 \times 22.4 \times 12.8}{2 \times 64 \times 100} = \frac{448}{100}$$

x = 4.48 L

Volume of H_2S needed is 4.48 L.

b. $2H_2S = 3O_2$
2 × 22.4 L = 3 × 22.4 L
4.48 L = x

$$x = \frac{4.48 \times 3 \times 22.4}{2 \times 22.4}$$

x = 6.72 L

Volume of oxygen needed = 6.72 L

6. $(NH_4)_2Cr_2O_7 \rightarrow N2 + Cr_2O_3 + 4H_2O$

M wt of $(NH_4)2Cr_2O_7$ = 2(N) + 8H + 2Cr + 7(O)
= 2×14+8×1+2×52+7×16
= 28 + 8 + 104 + 112
= 252

$(NH_4)_2Cr_2O_7 = N_2$
252 = 22.4 L
63 = x

$$x = \frac{22.4 \times 63}{252} = \frac{22.4}{4}$$

x = 5.6 L

Volume of N_2 liberated = 5.6 L

P. 87–89 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. **c.** 1 : 1

2. **a.** 20 L at STP has mass = 32 g

So, 1 L at STP has mass = $\frac{32}{20}$ g

$\therefore$ 22.4 L has mass = $\frac{32}{20}$ × 22.4 g = 35.84 g

b. We have,

$$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$$

$\Rightarrow$ 328 g of $Ca(NO_3)_2 \rightarrow$ 112 g of CaO

$\Rightarrow$ 1 g of $Ca(NO_3)_2 \rightarrow \frac{112\text{ g}}{338}$ of CaO

Thus, 82 g of $Ca(NO_3)_2 \rightarrow \frac{112}{328}$ × 82 g of CaO = 28 g of CaO

Hence, 28 g of calcium oxide is formed when 82 g of calcium nitrate is heated.

Now, 328 g of $Ca(NO_3)_2 \rightarrow$ 4 × 22.4 g of NO_2

$\Rightarrow$ 1 g of $Ca(NO_3)_2 \rightarrow \frac{4 \times 22.4}{328}$ g of NO_2

Thus, 82 g of $Ca(NO_3)_2 \rightarrow \frac{4 \times 22.4 \times 82}{328}$ L of NO_2 = 22.4 L of NO_2

Hence, 22.4 L of NO_2 is evolved.

3. **a.** **i.** 6 × 10^{23} molecules of oxygen gas = 1 mole of oxygen gas

So, 12 × 10^{24} molecules of oxygen gas

= $\frac{1}{6 \times 10^{23}}$ × 12 × 10^{24} moles of oxygen gas

= 20 moles of oxygen gas

Now, mass of one mole of oxygen gas = 32 g

Hence, mass of 20 moles of oxygen gas = 20 × 32 g = 640 g

Thus, 640 g of oxygen gas is present in the cylinder.

ii. 1 mole of oxygen gas at STP = 22.4 L

So, 20 moles of oxygen gas at STP = 22.4 × 20 = 448 L

Thus, volume of oxygen at STP present in the cylinder is 448 L.

b.

Element	%	Relative number of moles	Simplest ratio
C	82.7	82.7/12 = 6.9	$\frac{6.9}{6.9}$ = 1
H	17.3	17.3/1 = 17.3	$\frac{17.3}{6.9}$ = 2.5

Since the ratio of carbon and hydrogen atoms is 1 : 2.5, therefore the simplest whole number ratio will be 2 : 5.

So empirical formula of compound = C_2H_5

Empirical formula mass = 24 + 5 = 29

Vapour density = 29

Mass = Vapour density × 2 = 29 × 2 = 58

$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{58}{29} = 2$

$\therefore$ 22.4 L has mass = $\frac{32}{20}$ × 22.4 g = 35.84 g

$\therefore$ Molecular formula = 2 × C_2H_5 = C_4H_{10}

c. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

Ammonia used = 100 cm^3

Now, 4 × 22400 cm^3 of NH_3 requires 5 × 22400 cm^3 of O_2 [$\because$ 22.4 L = 22400 cm^3]

or 4 × 22400 cm^3 of $NH_3 \rightarrow$ 5 × 22400 cm^3 of O_2

1 cm^3 of $NH_3 \rightarrow \frac{5 \times 22400}{4 \times 22400}$ cm^3 of O_2

So, 100 cm^3 of $NH_3 \rightarrow \frac{5}{4}$ × 100 cm^3 of O_2 = 125 cm^3 of O_2

Thus, 100 cm^3 of NH_3 would require 125 cm^3 of O_2.

2015

4. **a.** 2 g atoms of nitrogen

5. **a.** Given: Mass of sulphur = 3.2 g

32 g of sulphur contain = 6.023×10^{23} atoms

3.2 g of sulphur contain = $\frac{6.023 \times 10^{23}}{32\text{ g}}$ × 3.2 g = 6.023 × 10^{22} atoms

Now,

6.023 × 10^{23} atoms of calcium = 40 g

$\therefore$ 6.023 × 10^{22} atoms of calcium = $\frac{40\text{ g}}{6.023 \times 10^{23}}$ × 6.023 × 10^{22}

= 4 g

Hence, the mass of calcium = 4 g

b. $H_2 + Cl_2 \rightarrow 2HCl$

1 vol 1 vol 2 vols

In this reaction, 1 volume of H_2 reacts with 1 volume of chlorine. So, 4 volumes of chlorine will react with 4 volumes of hydrogen only. (6 – 4 = 2) 2 volumes of hydrogen will be left.

Total 8 litres of HCl gas is produced. Therefore, the volume of residual gas will be 2 litres (hydrogen).

c. Given:

Empirical formula = CH

Vapour density = 13

Empirical formula mass = $12 \times 1 + 1 \times 1 = 13$

Molecular mass = 2 × vapour density

= 2 × 13 = 26

$$n = \frac{\text{Molecular formula mass}}{\text{Empirical formula mass}}$$

$$= \frac{26}{13} = 2$$

Molecular formula = n × Empirical formula

= 2 × CH

= $C_2 H_2$

Hence, the molecular formula of the compound is C_2H_2.

6. $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2(g) + 4H_2O(g) + Cr_2O_3$

Mass of $(NH_4)_2Cr_2O_7$ = 63 g (given)

Molar mass of $(NH_4)2Cr_2O_7$ = 2(14 + 4) + 52 × 2 + 16 × 7 = 252 g

Molar mass of Cr_2O_3 = 2 × 52 + 16 × 3

= 104 + 48 = 152 g

a. 252 g of $(NH_4)_2Cr_2O_7$ = 1 mole

63 g of $(NH_4)_2Cr_2O_7$ = $\frac{63}{252} = \frac{1}{4}$ = 0.25 mole

Hence, 0.25 mole of $(NH_4)_2Cr_2O_7$ is heated.

b. 252 g $(NH_4)_2Cr_2O_7$ gives = 28 g N_2

$\therefore$ 63 g $(NH_4)_2Cr_2O_7$ gives = $\frac{28 \times 63}{252}$ = 7 g N_2

28 g N_2 = 1 mole of N_2

$\therefore$ 7 g N_2 = $\frac{1}{28} \times 7 = \frac{1}{4} = 0.25$ mole

Hence, 0.25 mole N_2 is formed.

c. One mole of an ideal gas at STP occupies 22.4 litres or 22.4 dm^3

So, 0.25 mole of N_2 will occupy = 22.4 × 0.25

= 5.6 litres or 5.6 dm^3

d. 252 g of $(NH_4)_2Cr_2O_7$ gives = 152 g of Cr_2O_3

$\therefore$ 63 g of $(NH_4)_2Cr_2O_7$ gives = $\frac{152}{252} \times 63$

= 38 g of Cr_2O_3

Hence, the mass of Cr_2O_3 formed is 38 g.

2014

7. a. Di. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

2 vol 4 vol

$\therefore$ 1 vol 2 vol

According to Gay Lussac's law

2 volume of CO_2 is produced from 1 volume of C_2H_2

$\therefore$ 8.4 dm^3 of CO_2 at STP is produced from

$$= \frac{1 \times 8.4}{2} = 4.2\ dm^3 \text{ of } C_2H_2$$

Therefore, at STP 4.2 dm^3 of ethyne is required.

b. Molecular formula = (empirical formula)$_n$

$$n = \frac{\text{Molecular formula weight}}{\text{Empirical formula weight}}$$

$$= \frac{2 \times \text{V.D.}}{(2 \times 10 + 5)}$$

(V.D. = vapour density)

$$= \frac{2 \times 25}{25} = 2$$

$\therefore$ Molecular formula = $(X_2Y)_2 = X_4Y_2$

8. a. Avogadro's Law: Equal volumes of all gases at the same temperature and pressure contain the same number of molecules.

b. Molecular weight of NH_3 = (14 + 3 × 1) = 17

Number of moles of NH_3 in 68 g = $\frac{\text{wt.}}{\text{mol. wt.}}$

= $\frac{68}{17}$ = 4 moles

i. Volume occupied by the gas = 4 × 22.4 L

= 89.6 L at STP

ii. 4 moles of ammonia are present in the cylinder.

iii. Number of molecules = No. of moles × N_A

= $4 \times 6.023 \times 10^{23}$

= 24.092×10^{23} molecules

2013

9. **a.** $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

2 v 13 v

$\therefore$ 2 volumes of C_4H_{10} require 13 volumes of O_2

$\therefore$ 1 volume of C_4H_{10} require $\frac{13}{2}$ volumes of O_2

$\because$ 90 dm^3 of C_4H_{10} will require $= \frac{13}{2} \times 90$

$= 585$ dm^3 of O_2

b. The molecular weight of

the gas $= 2 \times$ V.D.

$= 2 \times 8 = 16$ g

As we know that molar mass/weight of a gas occupies 22.4 liters.

$\therefore$ 16 g of gas occupies 22.4 litres at STP

$\therefore$ 24 g of gas will occupy $\frac{22.4}{16} \times 24$

$= 11.2 \times 3 = 33.6$ litres.

c. As Avogadro's law states – Equal volume of all gases at the same temperature and pressure contain the same number of molecules – So, nitrogen gas molecules present in the same container = X.

10. **a.** $2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$

2 volumes 2 volumes 3 volumes

Now,

$\therefore$ 3 volumes of oxygen require 2 volumes of $KClO_3$

$\therefore$ 6.72 litres of O_2 require $= \frac{2}{3} \times 6.72 = 4.48$ L

$KClO_3 = 39 + 35.5 + 16 \times 3$

$= 122.5$ g

$\because$ 22.4 litres of $KClO_3$ has mass = 122.5 g

$\therefore$ 4.48 L of $KClO_3$ has mass $= \frac{122.5}{22.4} \times 4.48 =$ 24.5 g

b. $\therefore$ 22.4 litres of oxygen = 1 mole

$\therefore$ 6.72 litres of oxygen $= \frac{1}{22.4} \times 6.72 = 0.3$ mole

No. of molecules in 0.3 mole of oxygen

$= 0.3 \times 6.023 \times 10^{23}$

$= 1.8069 \times 10^{23}$ molecules

c. $\therefore$ 1 mole of CO_2 occupy 22.4 litres at STP

$\because$ 0.01 mole of CO_2 will occupy $= 22.4 \times 0.01$

$= 0.224$ litres.

2012

11. **a.** **iv.** 22

b. **i.** Number of moles

$$= \frac{\text{Given weight}}{\text{Molecular wt. of substance}}$$

$$= \frac{9.3}{31} = 0.3$$

0.3 moles of phosphorus are taken.

ii. Molecular weight of H_3PO_4

$= (1 \times 3) + (31) + (4 \times 16)$

$= 3 + 31 + 64 = 98$

$\because$ 31 g of phosphorus gives 98 g of phosphoric acid

$\therefore$ 9.3 g " $= \frac{98 \times 9.3}{31}$

$= 29.4$ g of phosphoric acid

iii. From the equation:

1 mole of phosphorus liberates 5 moles of nitrogen dioxide

0.3 moles $= 5 \times 0.3 = 1.5$ moles of NO_2

Now, at STP 1 mole of NO_2 occupies 22.4 L.

$\therefore$ 1.5 moles $= 22.4 \times 1.5 = 33.6$ L

2011

12. Gram molar mass of $SO_2 = 32 + (16 \times 2) = 64$ g

$\therefore$ No. of moles in 320 g of $SO_2 = \frac{320}{64} = 5$ moles

1 mole of SO_2 occupies 22.4 dm^3 at STP.

$\therefore$ 5 moles of SO_2 will occupy $= 5 \times 22.4 = 112$ dm^3

13. *Gay-Lussac's law of combining volumes:* when gases react they do so in volumes which bear a simple whole number ratio to one another and to the volume of the product if gaseous, provided all the volumes are measured at the same temperature and pressure.

14. The equation is as following:

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

1 5

mole moles

1 mole 5 × 22.4 L

at STP

$12 \times 3 + 1 \times 8 = 44$ g $= 5 \times 22.4$ L at STP.

$\therefore$ For 8.8 g of propane $= \frac{5 \times 22.4 \times 8.8}{44}$

$= 22.4$ L of O_2 at STP.

15. a. 1 mole of sulphur = 6×10^{23} atoms = 32 g of sulphur

$$\therefore 10^{22} \text{ atoms of sulphur} = \frac{32 \times 10^{22}}{6 \times 10^{23}} = \frac{32}{60}$$

$$= 0.53 \text{ g}$$

b. 1 mole of CO_2 = 12 + (2 × 16) = 44g

$\therefore$ 0.1 mole of CO_2 = 0.1 × 44 = 4.4 g.

16.

Element	Percent ratio	Atomic mass	Relative no. of atom	Simplest ratio
C	12.67	12	$\frac{12.67}{12} = 1.055$	$\frac{1.055}{1.055} = 1$
H	2.13	1	$\frac{2.13}{1} = 2.13$	$\frac{2.13}{1.055} \cong 2$
Br	85.11	80	$\frac{85.11}{80} = 1.063$	$\frac{1.063}{1.055} \cong 1$

$\therefore$ Empirical formula of the compound = CH_2Br

Molecular formula = (Empirical formula)$_n$

$$n = \frac{\text{Molecular weight}}{\text{E.F. weight}}$$

$$= \frac{2 \times \text{VD}}{\text{E.F. weight}} = \frac{2 \times 94}{(12 + 2 + 80)} = \frac{2 \times 94}{94} = 2$$

$\therefore$ Molecular formula = $(CH_2Br)_2 = C_2H_4Br_2$

2010

17. a. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

b. $\because$ 1 mole $CaCO_3$ releases 1 mole of CO_2

$\therefore$ 4.5 moles of $CaCO_3$ will release 4.5 moles of CO_2

$\therefore$ Volume of CO_2 released at STP = 22.4 × 4.5 = 100.8 L.

18. 10 liters of LPG has

$$\text{Propane} = \frac{60}{100} \times 10 = 6 \text{ litres}$$

$$\text{Butane} = \frac{40}{100} \times 10 = 4 \text{ litres}$$

$$\begin{array}{ccccccc} C_3H_8 & + & 5O_2 & \rightarrow & 3CO_2 & + & 4H_2O \\ 1 \text{ vol} & & & & 3 \text{ vol} & & \\ 6 \text{ L} & & & & 18 \text{ L} & & \end{array}$$

$$\begin{array}{ccccccc} 2C_4H_{10} & + & 13O_2 & \rightarrow & 8CO_2 & + & 10H_2O \\ 2 \text{ vol} & & & & 8 \text{ vol} & & \\ 4 \text{ L} & & & & 16 \text{ L} & & \end{array}$$

Total volume of CO_2 added to atmopshere

= 18 + 16 = 34 L

19. Molecular Formula of ammonium nitrate = NH_4NO_3

$$\% \text{ of N in } NH_4NO_3 = \frac{28}{80} \times 100 = 35\%$$

$$\% \text{ of O in } NH_4NO_3 = \frac{48}{80} \times 100 = 60\%$$

CHAPTER – 6

ELECTROLYSIS

P. 94–95 CHECK YOUR PROGRESS

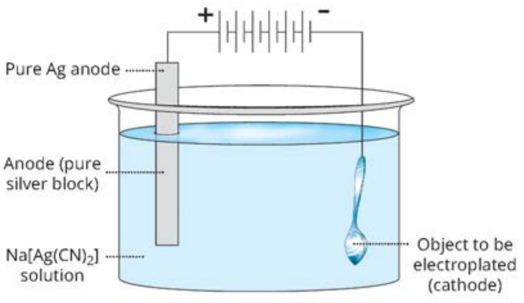
1. **a.** electricity, anode. Deficiency
   b. Current, cathode. excess
   c. lose, anion
   d. electrolyte. ions, ions. Positively, negatively
2. **a. i.** Ions and molecules together
   ii. Because during electrolysis cathode receives electrons, so reduction takes place at cathode and anode releases electrons, and oxidation takes place at anode. Oxidation and reduction processes occur simultaneously.
   b. i. If the compound formed between X and Y and an electric current passed through the molten compound, the element X will be obtained at the cathode and y at the anode of the electrolytic cell.
   ii. For conducting electricity we have two terms: 1. having ion 2. Ions can move easily (so they have to be in solution or molten) Solid bromide is solid so it does not conduct electricity,
   c. 1. Cu^{2+} ion
   2. Chlorine gas is produced at the anode.

P. 100 CHECK YOUR PROGRESS

1. **a.** cathode, anode
   b. oxidized
   c. More
2. **a.** The electrolysis of molten lead bromide liberates lead at cathode and bromine at anode.
   b. Electrolysis of water gives 2 volumes of hydrogen and 1 volume of oxygen.
   c. The blue colour of electrolytic solution of copper sulphate remains same during electrolysis.

P. 103 CHECK YOUR PROGRESS

1. (a) electrolyte (b) silver (c) cathode (d) anode (e) anions.
2. **a.** Cathode: article like spoon or tong to be plated and anode: pure silver metal block
   b. Sodium argento cyanide
   c. The metal that should be electroplated must be pure.
   d.



Electroplating of an object with silver

P. 104–105 EXERCISES

A. 1. Ions
2. Conduction
3. Degree of dissociation
4. The number of ions
5. Neutral

B. 1. Electrode
2. Cathode
3. Cation
4. Electrolytic dissociation
5. Ionization

C. 1. Red vapours of bromine are evolved at anode.
- Greyish lustrous lead deposits over cathode.
- Amount of molten lead bromide decreases.

2. Gases are liberated at anode and cathode in 1 : 2 ratio (oxygen and hydrogen)

3. Hydroxyl ions react with copper anode to form bluish precipitate

4.
- Anode decreases in weight
- Cathode gains in weight

5.
- Anode loses weight or decreases in size
- Article on cathode gets silver plated

D. 1. As per electrolytic reactions. $4H^{+1}$ are needed at cathode and $4OH^-$ at the anode and two molecules of water are produced at the anode. Hence for every two molecules of water, two molecules of hydrogen and one molecule of oxygen are liberated at the cathode and anode respectively.

$$2H_2 \xrightarrow[\text{Cathode}]{H_2SO_4} 2H_2\text{ [cathode]} + O_2\text{ [anode]}$$

2. This is because dilute nitric acid is volatile..

3. Alcohol is a non-electrolyte.

4. Pure lead contains free electrons and conduction of electricity is carried out by the movement of free electrons, but it does not dissociate into ions and hence, is a non-electrolyte.

5. The article to be electroplated should be made of cathode and the anode must be made of the pure metal which is to be electroplated on the article. This is done because during electrolysis, the metal to be electroplated on the article is always deposited at the cathode and forms a thin coating on the cathode

6. because it dissociates into ions.

7. For effective electroplating, a low direct current is passed at a constant rate through the electrolyte for avoiding uneven deposition of the metal which takes place when high or alternating current is used. Thus, the passage of a low current for a longer time gives a smooth, firm, uniform and long lasting deposition of metal on the article.

E. 1. Silver

2. Copper wire

3. At cathode: $\underset{\text{(from electrolyte)}}{Ag^+} + e^- \rightarrow \underset{\text{(deposited on the article)}}{Ag}$

F. 1. Mass of cathode increases where as that of anode decreases due to deposition of pure copper on cathode.

2. The blue colour of copper sulphate is due to the presence of cupric ions (Cu^{++}). Cu^{++} ions are discharged at the cathode and deposited as Pinkish copper metal, but OH– ions are discharged at anode. The electrolyte consists of hydrogen and sulphate ions which associate to form colourless sulphuric acid.

3. The electrolysis of copper sulphate solution is used in the purification of copper using pure copper plate as cathode and impure copper plate as anode.

G. 1. $NaCl \rightarrow Na^+ + Cl^-$

at anode $Cl^- - e^- \rightarrow Cl$

$Cl + Cl \rightarrow Cl_2$

at cathode $Na^+ + e^- \rightarrow Na$

2. $Na[Ag(CN)_2] \rightarrow Na^+ + [Ag(CN)_2]^-$

$[Ag(CN)_2] \rightarrow Ag^+ + 2CN^-$

at anode $Ag - e^- \rightarrow Ag^+$

at cathode $Ag^+ + e^- \rightarrow Ag\downarrow$

3. $X_2Y_3 \rightarrow 2X^{+++} + 3Y^{--}$

at anode $3Y^{--} - 6e^- \rightarrow 3Y$

$3Y + 3Y \rightarrow 3Y_2\uparrow$

at cathode $2X^{3+} + 6e^- \rightarrow 2X$

4. $M_2X_3 \rightarrow 2M^{+++} + 3X^{--}$

at anode $3X^{--} - 6e^- \rightarrow 3X$

$3X + 3X \rightarrow 3X_2\uparrow$

at cathode $2M^{+++} + 6e^- \rightarrow 2M$

5. $ZnSO_4 \rightarrow Zn^{++} + SO_4^{--}$

at anode $\underset{\text{impure}}{Zn} - 2e^- \rightarrow Zn$

at cathode $Zn^{++} + 2e^- \rightarrow Zn\downarrow$

H. 1. Check the electrochemical series

2. Hydrogen ions, hydroxyl ions and sulphate ions

3. Silver ions because it has low ionic mobility

4.
- To make them look more attractive
- To prevent corrosion

I. 1. $X - 2e^- \rightarrow X^{2+}$

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

2. $3X^{+2} + 2Y^{-3} \rightarrow X_3Y_2$

3. **i.** Electroplating of Metals.

ii. Electro-refining of Metals.

4. If the compound formed between X and Y and an electric current passed through the molten compound, the element X will be obtained at the cathode and Y at the anode of the electrolytic cell.

P. 105–106 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. b. mainly ions

2. a. i. Cathode:

$Cu^{2+} + 2e^- \rightarrow Cu$ Anode: $Cu - 2e^- \rightarrow Cu^{2+}$.

ii. Cathode:

$Pb^{2+} + 2e^- \rightarrow Pb$ Anode: $2Br^- - 2e^- \rightarrow 2Br$

$Br + Br \rightarrow Br_2$ (Reddish-brown).

b. i. O_2 (oxygen)

ii. Ag^+

3. a. In solid state, sodium and chloride ions are held together by electrostatic forces of attraction. Thus, they are not free to move about and do not conduct electricity in the solid state. But in fused or aqueous state, the crystal lattice breaks down and the ions become free to move, which allows electricity to be conducted.

b. In electroplating of an article with silver, if silver nitrate solution is used as an electrolyte, the deposition of silver will be very fast and uneven. However, if silver argento-cyanide solution is used as an electrolyte, then silver will be deposited slowly in a uniform manner.

c. Electrolytes on being dissolved in water or in molten state dissociate into positively and negatively charged ions. The movement of these ions results in conduction of electricity. Copper is a solid metal in which there are no free ions, but free electrons which conduct electricity. Therefore, copper is a non-electrolyte even though it is a good conductor of electricity.

2015

4. a. The copper of the anode ionises and deposits at the cathode. The colour of the solution does not fade.

b. i. During electrolysis of molten lead bromide, graphite anode is preferred to other electrodes because graphite rod is unaffected by the reactive bromine vapours.

ii. $PbBr_2 \rightleftharpoons Pb^{2+} + 2Br^-$

During electrolysis of molten lead bromide, both reduction (at cathode) and oxidation (at anode) take place. So, it is a redox reaction.

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

At the anode: $2Br^- - 2e^- \rightarrow 2Br$

$2Br \rightarrow Br_2\uparrow$

c. Using ammonium hydroxide:

Strong electrolyte	Weak electrolyte
These are chemical compounds, which dissociate completely into their aqueous or fused state.	These are chemical compounds, which do not dissociate completely into their aqueous or fused state.
They allow a large amount of electricity to flow through them and hence, are considered good conductors of electricity.	They allow a small amount of electricity to flow through them and hence, are poor conductors of electricity.
Example: Hydrochloric acid, sodium chloride	Example: Acetic acid, phosphoric acid

5. a.

	Anode	Electrolyte
Purification of copper	Impure metal acidified aqueous	$CuSO_4$ solution

b. At anode:

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

2014

6. a. i. (c)

ii. (c)

b. i. Ionization

ii. Electroplating

7. Cathode becomes thick due to deposition of red copper metal.

2013

8. Dark reddish-brown vapour of bromine are liberated at anode and greyish lead is produced on the cathode.

9. a. Liquid carbon tetrachloride

10. a. Right electrode is the oxidising electrode because here copper anode itself ionizes to give Cu^{2+} ions.

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

c.
- In the above electrolytic reaction, copper ions get discharged at the cathode and are deposited at the cathode as reddish-brown copper metal.
- The colour of the electrolytic solution remains blue because the effective concentration of copper ions in solution remains the same.

2012

11. Cations migrate to cathode during electrolysis.

12. d. Aqueous acetic acid

13. Because in an aqueous solution of sodium chloride, Na^+ and Cl^- ions become free and mobile.

14. a. Cu^{2+}

b. Pt

c. Cu^{2+} at cathode

d. H^+

e. Ag

2011

15.

Copper Sulphate Solution	Copper metal
Electric current is produced by flow of ions	Electric current is produced by flow of electrons.
It is the aqueous solution of ionic compound.	It is a metal in solid state.
Copper sulphate undergoes a chemical change.	Copper metal remains unchanged chemically

16. a. Red shiny metal deposits at cathode. Bubbles of a colourless-odourless gas is seen at anode.

b. At cathode

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

At anode

$OH^- - e^- \rightarrow OH$

$4OH \rightarrow 2H_2O + O_2\uparrow$

c. The colour of electrolyte gradually fade from blue to colourless.

2010

17. d. lead(II) bromide

18. a. oxidation

19. a. Nickel sulphate

b. Key chain

c. Pure nickel plate

d. $Ni^{2+} + 2e \rightarrow Ni$

e. $Ni^{2+} - 2e^- \rightarrow Ni^{2+}$

20. In cell A: Sodium chloride (A strong electrolyte) completely dissociates and thus current flows better.

In cell B: Acetic acid (A weak electrolyte) partially ionizes and thus, a weak current flows.

In cell C: Sugar (A covalent compound) does not ionize and thus no current flows.

CHAPTER – 7

METALLURGY

P. 112 CHECK YOUR PROGRESS

1. **a.** ZnS (zinc blende)

b. Roasting

c. The Baeyer's process

d. Aluminium

e. Copper and silver.

2. **a.** Aluminium oxide cannot be reduced by carbon because carbon is less reactive than aluminium so it cannot displace aluminium present in aluminium oxide.

b. Minerals are those substance that occur naturally in the earth's crust whereas those minerals which have high percentage of a particular metal and from which metal can be extracted profitably are called ores. Hence, All ores are called minerals. But, metals cannot be extracted from all minerals profitably. Only some minerals have a high concentration of the metal. Therefore all minerals are not ores.

c. It is so because pine oil selectively wets the sulphide ore and hence brings it to the froath.

d. This method is based upon the difference in the densities of the ore and the gangue particles. The powdered ore is spread on tables having grooves on the top. The powdered ore is then washed with upward stream of water. The lighter gangue particles are washed away and the heavier ore particles are left behind.

P. 116 CHECK YOUR PROGRESS

1. **a.** Bauxite

b. Solder

c. Molten cryolite.

d. Baeyer's process

e. Duralumin

2. **a.** Bauxite is used as main ore from which aluminium is extracted.

b. Sodium hydroxide is mixed to get $NaAlO_2$ after reaction.

c. Cryolite is used to lower the melting point of Aluminium oxide

d. Graphite is used as anode.

P. 116–117 EXERCISES

A. **1.** Fe_2O_3

2. fusion point

3. gun metal

4. copper, zinc and nickel

5. tin

6. tensile strength

B. **1.** **d.** can be produced from it profitably.

2. **c.** gangue.

3. **a.** $CaCO_3 \rightarrow CaO + CO_2$

4. **a.** highly electropositive elements.

5. **d.** copper and tin.

6. **c.** Amalgam

C. **1.** $\underset{\text{Calamine}}{ZnCO_3} \rightarrow ZnO + CO_2$

2. $CuO + H_2 \rightarrow Cu + H_2O$

3. $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s)$

$Fe_2O_3(s) + 3CO(g) \xrightarrow{\text{heat}} 2Fe(s) + 3CO_2(g)$

4. $PbO + C \rightarrow Pb + CO$

D. **1.** Most of the ores are in forms of oxides and sulfide, they are generally extracted by reduction with carbon. But the metals which are more reactive than carbon cannot be obtained by this process. Aluminium is placed higher than carbon in reactivity series so its oxide cannot be decomposed by using C. That is why electrolysis is used to decompose the Al_2O_3 and obtain pure Al.

2. The oxides of very reactive metals cannot be reduced by using hydrogen, carbon or CO. Because these metals have more affinity to oxygen than hydrogen, carbon or CO.

3. Brass is harder than copper as zinc is mixed with it. Zinc makes brass harder.

4. Lead–tin alloy has low melting point. So it is used as solder.

5. Roasting is the process of converting an ore into its oxide by heating strongly in the presence of an excess of air (oxygen), so that oxygen reacts to form the corresponding oxide. It is done for sulphide ores in order to remove sulphur as sulphur gets volatilised in the form of gas.

In case of carbonate ores, we need to eliminate the carbonate and moisture. So, the ore is heated to high temperatures in the absence of air. Carbon, which is in its highest oxidation state, cannot be oxidised further. This process is called calcination.

E. 1. a. Na_3AlF_6

b. Graphite is used in high amounts during the electrolytic process of aluminium oxide because Graphite anode has to be replaced periodically as the oxygen released oxidizes it.

c. $2Al^{3+} + 6e^- \rightarrow 2Al$.

2. a. Noble metals (like gold): it is found in the native state.

b. Moderately reactive metals (like iron): by reduction of oxide ore with carbon.

c. Highly reactive metals (like sodium): by electrolysis

3. The concentration of the ores of aluminium is done by the Baeyer's process and for iron gravity separation method is used.

4. Aluminium

5. Froth floatation process is used in the concentration of a sulphide ore. Roasting is the process in which the concentrated ore is heated strongly below its melting point in the presence of excess of air. This removes the volatile impurities and the ore changes to its oxide. For example,

$$2ZnS + 3O_2 \xrightarrow{\text{heat}} 2ZnO + 2SO_2$$

$$4FeS_2 + 11O_2 \xrightarrow{\text{heat}} 2Fe_2O_3 + 8SO_2$$

Roasting is generally used for sulphide ores. Reduction of oxides of moderately reactive metals: The oxides of moderately reactive metals cannot be reduced by heating alone. The oxides are reduced to corresponding metals by using suitable reducing agent such as carbon (coke), carbon monoxide or aluminium.

$$Fe_2O_3(s) + 3C(s) \xrightarrow{\text{heat}} 2Fe(s) + 3CO(g)$$

$$ZnO(s) + C(s) \xrightarrow{\text{heat}} Zn(s) + CO(g)$$

Carbon monoxide formed also acts as a reducing agent.

$$Fe_2O_3(s) + 3CO(g) \xrightarrow{\text{heat}} 2Fe(s) + 3CO_2(g)$$

$$ZnO(s) + CO(g) \xrightarrow{\text{heat}} Zn(s) + CO_2(g)$$

6. Concentrated ores are first converted into metal oxides by any of the following processes:

Calcination: Carbonate ores are heated in absence of air. The absence of air and heat converts the CO_3 into CO_2 and O. The O remains with the metal as metal-oxide. Heating also expels any water content in the ore. in case these are any volatile impurities or gases trapped in the ore, they are also removed by heating. Example of how calamine ore or zinc carbonate is converted to ZnO by calcination is shown below.

$$ZnCO_3 \xrightarrow{\text{heat}} ZnO + CO_2$$

Calcination is generally used for carbonate and hydrated ores.

Reduction of oxides of moderately reactive metals: The oxides of moderately reactive metals cannot be reduced by heating alone. The oxides are reduced to corresponding metals by using suitable reducing agent such as carbon (coke), carbon monoxide or aluminium.

$$ZnO(s) + C(s) \xrightarrow{\text{heat}} Zn(s) + CO(g)$$

Carbon monoxide formed also acts as a reducing agent.

$$ZnO(s) + CO(g) \xrightarrow{\text{heat}} Zn(s) + CO_2(g)$$

Distillation: This method is used for refining volatile metals such as zinc and mercury. When these metals are heated, they vapourise. The vapours are collected and condensed to give pure metal. The non-volatile impurities are left behind.

P. 118–119 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. reducing agents, donors

2. d. copper and tin

3. Froth flotation

4. a. NaOH (Sodium hydroxide)

b. $2Al(OH)_3 \xrightarrow[\Delta]{1000\ °C} Al_2O_3 + 3H_2O$

c. Cryolite

d. At cathode: $2Al^{3+} + 6e^- \rightarrow 2Al$

e. During electrolysis, aluminium is deposited at the cathode and oxygen is liberated at the anode. Some of the oxygen reacts with the carbon in graphite to form carbon dioxide, thereby slowly burning away the anodes. Thus, the anodes have to be replaced periodically or a number of graphite electrodes have to be used as anodes.

2015

5. c. Solder

6. Aluminium oxide has great affinity towards oxygen; so it cannot be reduced by reducing agents like carbon monoxide. Zinc is moderately reactive, so it gets reduced by carbon.

7. a. i. Cryolite: Cryolite acts as a solvent for the alumina and also lowers the fusion temperature; the mixture melts at 950 °C instead of 2050 °C thereby saving electrical energy.

ii. Sodium hydroxide: Sodium hydroxide is used to remove impurities from the ore.

iii. Graphite: Graphite has high melting point and it is a good conductor of electricity; so it is used as an electrode in the extraction of aluminium.

b. To reduce heat loss by radiation and to prevent the burning of the anode.

2014

8. c. calcination

9. a. Brass: Copper and zinc.

b. Duralumin: Aluminium and copper.

c. Bronze: Copper and Tin.

10. Name the following:

a. Cryolite

b. Zinc blende

2013

11. a. Solder

12. a. Cryolite (Na_3AlF_6) is added to alumina, it lowers the fusion temperature, the mixture melts at 950 °C instead of 2050 °C thereby saving electrical energy.

b. $2Al^{3+} + 6e^- \rightarrow 2Al$

c. The carbon anode has to be renewed periodically as the oxygen released oxidises it.

2012

13. a. Magnesium oxide

14. 1. The alloy contains Cu and Zn, is hard and is used in decorative articles. – **b.** Brass

2. It is stronger than aluminium, light and is used in making light tools. – **a.** Duralumin

3. It is lustrous, hard, corrosion-resistant and used in surgical instruments. – **d.** Stainless Steel

4. Tin lowers the melting point of the alloy and is used for soldering purpose. – **e.** Solder

5. The alloy is hard, brittle, takes up polish and is used for making statues. – **c.** Bronze

15. aluminium

16. a. Caustic alkali dissolves aluminium oxide forming soluble sodium aluminate while impurities remain insoluble and precipitate as red mud.

b. $Al_2O_3{\cdot}2H_2O + 2NaOH \rightarrow 2NaAlO_2 + 3H_2O$

c. Substance is fluorspar (CaF_2) and it increases the conductivity of the electrolyte.

2011

17. a. Coke

b. Bronze

18. When carbon monoxide is passed over heated copper oxide, black powdery copper oxide changes to red shiny copper metal.

19. a. Aluminium

b. Calcination is the process of heating the ore in the absence of air at a temperature not sufficient to melt it. Calcination is generally used for carbonate and hydrated ores. Roasting is the process in which concentrated ore is heated to a high temperature in excess of air. This removes the volume impurities and the ore changes to its oxide. It is generally used for sulphide ores.

c. Froth floatation process

d. Main ore of Iron: Haematite (Fe_2O_3)

Main ore of Aluminium: Bauxite ($Al_2O_3.2H_2O$)

e. Molten Alumina of Cryolite + Fiuorspar.

2010

20. a. Duralumin: Aluminium

b. Brass: Copper

c. Stainless steel: Iron

CHAPTER – 8

STUDY OF COMPOUNDS – HYDROGEN CHLORIDE

P. 124 CHECK YOUR PROGRESS

1. **a.** Concentrated H_2SO_4
   b. $NaHSO_4$
   c. NH_4Cl
   d. Hydrogen gas
   e. Fountain experiment
2. **a.** $P_4O_{10} + 3HCl \rightarrow \underset{\text{phosphorus oxychloride}}{POCl_3} + \underset{\text{metaphosphoric acid}}{3HPO_3}$
   b. $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

P. 127 CHECK YOUR PROGRESS

1. **a.** iron(II) sulphide
   b. lead(IV) oxide, oxidizing agent.
   c. oxidizes
   d. Lead nitrate, hot
2. **a.** SO_2
   b. CO_2
   c. H_2S
   d. $NO_2 + NO$

P. 128–129 EXERCISES

A. 1. Marine acid air
2. light
3. non-volatile
4. highly soluble
5. phenolphthalein

B. 1. Covalent
2. Sodium sulphate
3. Calcium oxide and phosphorus pentoxide
4. Iron (II) chloride
5. Hydrogen sulphide

C. 1. No effect on blue litmus paper.
2. Solution becomes pale green.
3. White fumes are formed.
4. It liberates greenish yellow gas.
5. White precipitation occurs which disappears on warming.

D. 1. $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2\uparrow$
2. $FeS + 2HCl \rightarrow FeCl_2 + H_2S\uparrow$
3. $CaOCl_2 + 2HCl \rightarrow CaCl_2 + H_2O + Cl_2\uparrow$
4. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$
5. $Pb(NO_3)_2 + 2HCl \rightarrow PbCl_2\downarrow + 2HNO_3$

E. 1. A salt soluble in hot water but insoluble in cold water, obtained on heating an oxidizing agent with conc. HCl. – **R:** $PbCl_2$
2. A salt obtained on reaction of an active metal with hydrogen chloride gas. – **S:** $FeCl_2$
3. A soluble salt obtained on reaction of a metallic chloride with liquor ammonia. – **T:** $Ag(NH_3)_2Cl$
4. A salt which is insoluble in dilute nitric acid but soluble in ammonium hydroxide. – **Q:** AgCl
5. A salt obtained when basic gas reacts with hydrogen chloride gas. – **P:** NH_4Cl

F. 1. To avoid the formation of sodium sulphate which fuses with the glass.
2. By upward displacement of air as it is heavier than air.
3. This is due to the presence of dissolved ferric chloride in it.
4. Hydrochloric acid forms a curdy white precipitate with silver nitrate solution. The precipitate is insoluble in nitric acid but soluble in ammonium hydroxide.
5. Due to the formation of hydronium ions, by HCl. It is responsible for the acidic character.
6. The apparatus used for the preparation of hydrochloric acid by funnel arrangement is shown in Figure.
   i. The funnel is attached to the open end of the delivery tube and placed over the water surface such that the funnel rim just touches the water surface.
   ii. When the gas comes in contact with water, it dissolves rapidly causing a pressure variation. This causes the water to be drawn into the funnel.
   iii. The water however remains in the funnel due to its large surface area.
   iv. As the water gets drawn into the funnel, the contact of the funnel with water breaks and back suction stops.
   v. When the water collected in the funnel gets saturated, it is pushed back into the trough. This process continues till all the gas dissolves in water and a saturated solution is formed. This saturated solution is called

concentrated hydrochloric acid and contains about 36 per cent by weight of hydrogen chloride.

7. Hydrogen chloride is a gas while hydrochloric acid is aqueous solution of hydrogen chloride.

8. **i.** The lower end of the thistle funnel must be dipped below the concentrated sulphuric acid and if not the gas obtained will escape out from the thistle funnel.

ii. Temperature should be maintained below 200 °C

iii. Initially, the reaction mixture is heated very slowly to control the evolution of HCl gas.

P. 129–130 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. **a.** **iii.** HCl is highly soluble in water

2. **a.** $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$.

b. Identify the gas evolved and give the chemical test in each of the following cases.

i. When dilute hydrochloric acid is added to lead nitrate, insoluble white precipitate of lead chloride is formed.

$$Pb(NO_3)_2 + 2HCl \rightarrow 2HNO_3 + \underset{\text{(white ppt)}}{PbCl_2\downarrow}$$

When the mixture is heated, the precipitate dissolves because lead chloride is soluble in hot water.

ii. When dilute hydrochloric acid is added to copper carbonate, copper chloride and carbonic acid are formed, which further decomposes to water and carbon dioxide.

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2CO_3 \rightarrow CuCl_2 + H_2O + CO_2\uparrow$$

iii. Dilute hydrochloric acid reacts with sodium thiosulphate to form sodium chloride, liberate sulphur dioxide gas and sulphur.

$$Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2\uparrow + S\downarrow$$

3. **a.** **Gas evolved:** SO_2 (Sulphur dioxide)

Chemical test: It changes orange acidified potassium dichromate green.

b. **Gas evolved:** H_2S (Hydrogen sulphide)

Chemical test: Turns lead nitrate solution black

2015

4. hydrogen chloride

5. Hydrochloric acid.

6. **a.** $NaCl + H_2SO_4 \xrightarrow{<200\ °C} NaHSO_4 + HCl(g)$

Sodium Conc. Sodium hydrogen Hydrogen

chloride sulphuric acid sulphate chloride

If the temperature increases beyond 200 °C, sodium sulphate is formed.

$$NaCl + NaHSO_4 \xrightarrow{<200\ °C} Na_2SO_4(aq) + HCl(g)$$

b. It is dried by passing through concentrated sulphuric acid because it does not react with HCl gas.

c. Wear goggles, gloves and maintain the temperature below 200 °C to avoid the formation of Na_2SO_4. Sodium sulphate sticks to the glass and is difficult to remove.

2014

7. CaO is alkaline

8. $Na_2S + 2HCl \rightarrow 2NaCl + H_2S\uparrow$

9. A colourless odourless gas is liberated with brisk effervesence

10. **a.** Y is hydrogen chloride (HCl) gas.

b. Gas Y is highly soluble in water.

c. Ammonia gas

2013

11. **a.** Sulphur dioxide (SO_2) gas is evolved.

b. Chlorine (Cl_2) gas is released.

12. When dilute HCl acid is added to $AgNO_3$, first AgCl is formed, it reacts with NH_4OH and soluble diamine sliver chloride $[Ag(NH_3)_2Cl]$ is formed.

13. **a.** Add silver nitrate solution to both the solutions. Sodium chloride will form a curdy white precipitate while sodium nitrate does not react with silver nitrate.

b. Ammonia gives dense white fumes with a rod dipped in concentrated hydrochloric acid while hydrogen sulphide gas does not give any fumes with ammonia.

14. Hydrogen chloride gas

2012

15. Aqua regia contains a mixture of one part by volume of concentrated nitric acid and three parts by volume of concentrated hydrochloric acid.

16. Because quick lime is basic in nature and combines with moist hydrogen chloride gas forming calcium chloride.

17. a. $2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$

b. $AgNO_3 + NaCl \rightarrow AgCl\downarrow + NaNO_3$

18. SO_4^{-2} ion

19. A $NaCl + \underset{\text{conc.}}{H_2SO_4} \xrightarrow{\Delta < 200^\circ C} \underset{\text{Hydrogen chloride}}{NaHSO_4 + HCl\uparrow}$

B $2HCl + Fe \rightarrow \underset{\text{Iron (II) chloride}}{FeCl_2} + H_2$

C $\underset{(g)}{HCl} + \underset{(g)}{NH_3} \rightarrow \underset{\text{Ammonium chloride}}{NH_4Cl}$

D $\underset{\text{(dil)}}{2HCl} + \underset{\text{(aq)}}{Pb(NO_3)_2} \rightarrow \underset{\text{Lead chloride}}{PbCl_2\downarrow} + 2HNO_3$

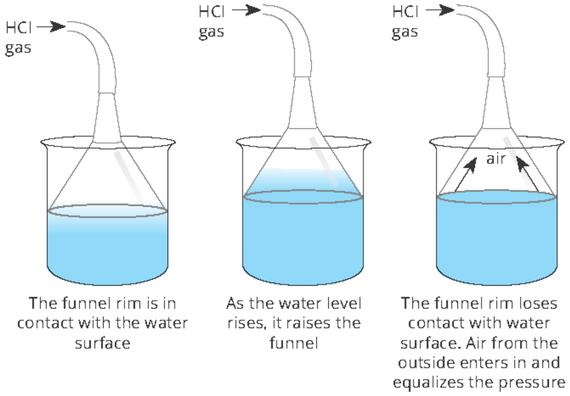
2011

20. d. conc. sulphuric acid.

21. a. $Na_2S_2O_3 + \underset{\text{dil}}{2HCl} \rightarrow 2NaCl + SO_2 + H_2O + S\uparrow$

b. $Ca(HCO_3)_2 + \underset{\text{dil}}{2HCl} \rightarrow CaCl_2 + 2H_2O + 2CO_2\uparrow$

22. a.



The funnel rim is in contact with the water surface

As the water level rises, it raises the funnel

The funnel rim loses contact with water surface. Air from the outside enters in and equalizes the pressure

Funnel arrangement for the preparation of hydrochloric acid.

b. To check back suction
To check escape in air.

c. i. $NaCl + \underset{\text{conc.}}{H_2SO_4} \xrightarrow[\Delta]{< 200^\circ C} NaHSO_4 + HCl\uparrow$

ii. $2NaCl + \underset{\text{conc.}}{H_2SO_4} \xrightarrow[\Delta]{> 200^\circ C} Na_2SO_4 + \underset{\text{aq}}{2HCl\uparrow}$

2010

23. d. Concentrated HCl (3 parts) and concentrated HNO_3 (1 part)

24. When a glass rod dipped in ammonium hydroxide is brought near the mouth of the concentrated acid bottle, dense white fumes are observed.

25. a. A is concentrated H_2SO_4 and B is NaCl.

b. $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

c. If a moist blue litmus is brought near the gas jar, if it turns red, the gas jar is filled with HCl.

d. Hydrogen chloride is denser than air.

26. When silver nitrate is added to dil HCl acid, it will give a white precipitate and when it is added to dil. HNO_3 acid, no change is observed.

27. a. $Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + 4H_2O + Cl_2$

b. $Mg + 2HCl \rightarrow MgCl_2 + H_2\uparrow$

CHAPTER – 9

STUDY OF COMPOUNDS – AMMONIA

P. 136 CHECK YOUR PROGRESS

1. **a.** Ammonium chloride

b. Quicklime (Calcium oxide)

c. Haber's Process

d. Finely divided iron in the presence of molybdenum.

2. **a.** $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3\uparrow$

b. $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$

c. $AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3\uparrow$

d. $(NH_4)_2SO_4 + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O + 2NH_3$

3. **a.** Ammonia cannot be collected over water because ammonia is highly soluble in water.

b. Ammonia is manufactured by Haber's process.

i. Dry nitrogen and hydrogen gas taken in the ratio of 1 : 3 in the presence of finely divided iron and molybdenum at a temperature of 500 °C and under a pressure of 200 atmospheres react to give ammonia.

$$\underset{\text{1 vol}}{N_2(g)} + \underset{\text{3 vol}}{3H_2(g)} \rightleftharpoons \underset{\text{2 vol}}{2NH_3(g)} + \text{heat}$$

ii. In Haber's process, ammonia is prepared from nitrogen and hydrogen taken in the ratio of 1:3 by volume.

iii.
- Nitrogen is obtained by the fractional distillation of air.
- Hydrogen is obtained either from water gas through Bosch process or from natural gas.

c. As ammonium nitrate (NH_4NO_3) is explosive in nature and decomposes on heating, it is not used for the preparation of ammonia.

$NH_4NO_3 \rightarrow N_2O + 2H_2O$

P. 141–142 CHECK YOUR PROGRESS

1. **a.** hydroxide **b.** ammonium chloride

c. neutral **d.** white

e. Ammonium chloride

2. **a.** AgCl **b.** Ammonia

c. NCl_3 **d.** NO_2

e. $Cu(OH)_2$

3. **a.** The yellow-green colour of gaseous chlorine disappears and dense white fumes of ammonium chloride are formed.

b. $3PbO + 2NH_3 \rightarrow 3Pb + 3H_2O + N_2\uparrow$

Observation: A yellow coloured lead(II) oxide is reduced to grey coloured lead metal.

c. When ammonia is passed through phenolphthalein solution, it turns pink.

d. $\underset{\substack{\text{lead}\\ \text{nitrate}}}{Pb(NO_3)_2} + 2NH_4OH \rightarrow \underset{\substack{\text{precipitate is white}\\ \text{insoluble in excess}}}{Pb(OH)_2\downarrow} + 2NH_4NO_3$

P. 143 EXERCISES

A. **1.** ammonia

2. ammonium chloride

3. ammonia

4. liquor ammonia

5. fractional distillation of air,water gas

B. **1.** Conc. H_2SO_4, anhyd. P_2O_5 and anhyd. $CaCl_2$

2. Chlorine and hydrogen chloride

3. Ammonium chloride

4. Tetraammine copper(II) hydroxide

5. Ammonium nitrate

C. **1.** Burns with greenish yellow flame

2. Pale yellow colour changes to grey lustrous metal

3. Brown precipitation occurs

4. White precipitation occurs, soluble in excess to give clear solution

5. Dense brown vapours are formed

D. **1.** $AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3$

2. $2NH_3 + CO_2 \xrightarrow[\text{200 atm}]{\text{150 °C}} NH_2CONH_2 + H_2O$

3. $2NH_3 + 3CuO \xrightarrow{\Delta} N_2 + 3Cu + 3H_2O$

4. $6NH_3 + 3H_2O + P_2O_5 \rightarrow 2(NH_4)_3PO_4$

5. $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

P. 144–145 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. $AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3$

2. **a.** **i.** Ammonia gas

$2NH_4Cl + \underset{\text{slaked lime}}{Ca(OH)_2} \rightarrow CaCl_2 + 2H_2O + 2NH_3$

ii. Nitrogen gas

$NaNO_2 + NH_4Cl \xrightarrow{\text{heat}} NaCl + NH_4NO_2$

$NH_4NO_2 \xrightarrow{\text{heat}} N_2 + 2H_2O$

b. **i.** $8NH_3 + 3Cl_2 \rightarrow 6NH_4Cl + N_2$

ii. $2NH_3 + 3CuO \rightarrow 3Cu + 3H_2O + N_2$

2015

3. Ammonia

4. Ammonia burns in excess oxygen with a greenish-yellow flame forming nitrogen and water vapour.

$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

5. Nitric acid

6. **a.** $2NH_4Cl(s) + Ca(OH)_2(s) \xrightarrow{\text{heat}} CaCl_2(s) + 2H_2O(l) + 2NH_3\uparrow(g)$

Ammonium salt Slaked lime Calcium chloride Ammonia gas

b. $NH_3 + 3Cl_2 \rightarrow 3HCl + NCl_3$

Nitrogen chloride

c. $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

Ammonium sulphate

2014

7. a downward displacement of air

8. $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3\uparrow$

9. A colourless gas with characteristic smell of ammonia is evolved.

10. **a.** Hydroxide ion.

b. It will give dirty green precipitate with iron(II) sulphate solution.

2013

11. Ammonia reacts with excess chlorine to form nitrogen trichloride and hydrogen chloride gas.

12. **a.** ammonium nitrate.

13. $3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$

14.

Name of the process	Temperature	Catalyst	Equation for the catalyzed reaction
Haber's process	450 °C to 500 °C	heated iron and molybdenum	$N_2 + 3H_2 \xrightarrow[\text{450–500 °C, 200–300 atm}]{\text{heated Fe/Mo}} 2NH_3 + \text{Heat}$

2012

15. Nitrogen gas

16. Magnesium nitride reacts with warm water to liberate ammonia.

17. $4NH_3 + 5O_2 \xrightarrow{\text{Pt at 800 °C}} 4NO + 6H_2O + \text{heat}$

18. **a.** Because ammonium nitrate is explosive in nature and dissociate into nitrous oxide and water on heating.

b. Quick lime

c. By downward displacement of air

d. Because it is highly soluble in water.

2011

19. A colourless gas with characteristic pungent smell of ammonia forms.

20. **a.** Ammonia

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

c. By downward displcement of air

d. Quicklime (CaO)

e. When a wet red litmus paper is brought near the mouth of the jar, it turns blue.

21. $3Cl_2 + 8NH_3 \rightarrow 6NH_4Cl + N_2$

22. ammonia, alkaline, ammonium, hydroxyl, dirty green

2010

23. Ammonia burns with a green flame.

24. **a.** Haber's Process

b. Nitrogen (one part) and hydrogen (3 parts)

c. Iron powder

d. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

e. $PbO + 2NH_3 \rightarrow 3Pb + 3H_2O + N_2$

25. **a.** Hydrogen chloride and ammonia gas

b. High solubility of the gas in water.

26. Ammonia

CHAPTER – 10

STUDY OF COMPOUNDS – NITRIC ACID

P. 149 CHECK YOUR PROGRESS

1. **a.** HNO_3 vapours
   b. NO
   c. NO_2

2. **a.** The reaction mixture is not heated beyond 200 °C because of the following reasons:
   - **i.** At high temperature, nitric acid decomposes to form nitrogen dioxide gas.
   - **ii.** The residue of Na_2SO_4 and K_2SO_4 form a hard crust and sticks to glass walls which is difficult to remove and also leads to wastage of fuel.
   - **iii.** Glass apparatus may break.

   b. When excess of water is added, it dissolves nitrogen dioxide in water and thus, the yellow colour of the acid is removed.

   c. The nitric acid collected from the bottom of the absorption tower is in dilute form. It is concentrated by distilling (or boiling) the acid till a constant mixture is obtained and we get 68% concentrated nitric acid. On further distillation with concentrated sulphuric acid, 98% concentrated nitric acid (fuming nitric acid) is obtained. On cooling fuming nitric acid in a freezing mixture, crystals of 100% pure nitric acid is obtained.

P. 153 CHECK YOUR PROGRESS

1. **a.** conc. nitric acid
   b. nitrogen dioxide
   c. sulphur
   d. iron
   e. nascent chlorine

2. **a.** Carbon dioxide
   b. Ferric sulphate
   c. Copper nitrate
   d. Orthophosphoric acid

P. 154–155 EXERCISES

A. **1.** normal
2. nitrogen dioxide
3. concentrated nitric acid
4. calcium oxide
5. concentrated nitric acid

B. **1.** Nitrate ions, Hydrogen ions
2. Magnesium and Manganese
3. Gold and Platinum
4. Iron
5. Zinc nitrate

C. **1.** Solution turns to blue and dense brown vapours are liberated.
2. Proteins turn to yellow.
3. Vigorous reaction occurs and then reaction stops.
4. Colour changes from pale green to orange yellow.
5. White powder is left and dense brown vapours are liberated.

D. **1.** $\underset{\text{(conc.)}}{3HCl} + HNO_3 \rightarrow \underset{\text{(conc.)}}{NOCl} + 2H_2O + 2[Cl]$
2. $NH_4NO_3 \rightarrow N_2O + 2H_2O$
3. $C + 4HNO_3 \rightarrow CO_2 + 2H_2O + 4NO_2$
4. $CaOCl_2 + \underset{\text{(dil.)}}{2HNO_3} \rightarrow Ca(NO_3)_2 + H_2O + Cl_2$

E. **1.** Action of heat on nitric acid. – **Q:** Nitrogen dioxide and oxygen
2. Reaction of carbon with conc. nitric acid. – **S:** Nitrogen dioxide and carbon dioxide
3. Reaction of manganese with cold, very dilute nitric acid. – **P:** Hydrogen
4. Reaction of sulphur with conc. nitric acid. – **R:** Nitrogen dioxide only
5. Reaction of zinc with dilute nitric acid. – **T:** Nitrogen monoxide

F. **1.** Constant boiling of nitric acid yields 68% nitric acid by weight.
2. Concentrated nitric acid is a better oxidizing agent than dilute nitric acid.
3. Methyl orange turns pink when it is added to dilute nitric acid.
4. Hydrogen is released when nitric acid is added to manganese.

G. **1.** Zinc do not give hydrogen gas while reacting with HNO_3 because, nitric acid is a strong oxidizing agent. It oxidizes the hydrogen evolved into water and it itself is reduced to an oxide of Nitrogen such as NO, etc. It can react with some very reactive metals like Cu, Silver etc. Zinc, is less reactive.

2. Iron becomes passive on reaction with concentrated nitric acid as a thin protective layer of Fe_3O_4 is formed.

3. The concentrated sulphuric acid being heavier settles down and iron(III) sulphate layer remains above it, resulting in the formation of brown ring at the junction..

4. Nitric acid is stored in coloured bottles in order to prevent it from the sun light. This is because on explosion to the sun light it gets decomposed into NO_2 and O_2.

H. 1. Freshly prepared ferrous sulphate is used in brown ring test, because if $FeSO_4$ is stored or it is the old one then it reacts with atmospheric oxygen and gets oxidized to form a corrosive brown-yellow coating of basic ferric sulphate, which is an adduct of ferric oxide and ferric sulphate.

2. **i.** The manufacturing of nitrates like silver nitrate and calcium nitrate. Silver nitrate is used in making photographic films.

ii. The purification of gold, silver and platinum because it dissolves impurities of other metals.

iii. As an oxidizer in rocket fuels as it gives large amount of oxygen on oxidation.

iv. Making plastics like cellulose nitrate fibres

3. Add a few drops of $AgNO_3$ solution to each. One sample will form a white precipitate. The other will not have a precipitate. The sample that produced a precipitate is HCl, the other HNO_3

The reactions:

$HCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + HNO_3(aq)$
$HNO_3 + AgNO_3 \rightarrow$ NO reaction – no precipitate

4. The decomposition of nitric acid proves that nitric acid contains oxygen.

5. With concentrated nitric acid:

$$\underset{\text{(conc.)}}{2HNO_3} + 2FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2H_2O + 2NO_2\uparrow$$

With dilute nitric acid:

$$\underset{\text{(dilute)}}{2HNO_3} + 6FeSO_4 + 3H_2SO_4 \rightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO\uparrow$$

6. Nitric acid is a very strong oxidizing agent as it readily gives nascent oxygen both in concentrated as well as in the dilute form. The concentrated acid is usually reduced to nitrogen dioxide (NO_2) while the dilute acid gives nitric oxide (NO).

P. 155–156 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. **a.** $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

b. **i.** Nitric oxide **ii.** Sulphuric acid.

2015

2. When crystals of copper nitrate are heated in a test tube, nitrogen dioxide gas is formed and a black residue of copper oxide is left behind.

$2Cu(NO_3)_2 \rightarrow 2CuO + O_2 + 4NO_2$

3. **a.** Nitric acid is a powerful oxidising agent. The nascent oxygen formed oxidises the hydrogen to water.

$2HNO_3 \rightarrow H_2O + 2NO_2 + [O]$

b. Pure HNO_3 is colourless but it appears yellow when left standing in a glass container due to the dissolution of reddish-brown nitrogen dioxide in the acid. NO_2 is produced due to the decomposition of HNO_3.

c. As nitric acid vapours are corrosive and may corrode rubber, cork or metal, so an all glass apparatus is used in the laboratory preparation of nitric acid.

2014

4. nitric oxide

5. $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

6. Platinum gauze catalyst at 800 °C in presence of oxygen.

7. **a.** $NaNO_3 + H_2SO_4 \xrightarrow{T < 200\ °C} NaHSO_4 + HNO_3$

b. $C_2H_5Cl + NaOH \rightarrow C_2H_5OH + NaCl$

8. $CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2\uparrow$

2013

9. Nitrogen dioxide (NO_2) gas is liberated.

10. $C + 4HNO_3 \rightarrow CO_2 + 4NO_2 + 2H_2O$

2012

11. Nitrogen dioxide gas

12. A reddish-brown gas is liberated.

13. Magnesium reacts with very dilute nitric acid to liberate hydrogen gas.

2011

14. platinum

15. A reddish brown pungent smelling gas evolves.

16. **a.** A glass retort

b. Because above 200 °C nitric acid will decompose.

17. $Fe(OH)_3 + 3HNO_3 \rightarrow Fe(NO_3)_3 + 3H_2O$

2010

18. **d.** concentrated hydrochloric acid (3 parts) and concentrated nitric acid (1 part).

CHAPTER – 11

STUDY OF COMPOUNDS – SULPHURIC ACID

P. 160 CHECK YOUR PROGRESS

1. a. Sulphur trioxide is not directly dissolved in water to get H_2SO_4 because with water a large amount of heat is released. This results in the formation of a dense fog of H_2SO_4 which does not condense easily.

b. At high temperature sulphur trioxide may decompose back to SO_2 and O_2 so an optimum temperature of 400-500 °C is generally used.

c. Of all acids, sulphuric acid is the most important. It is used directly or indirectly in all industries. Hence it is called “king of chemicals”.

d. Sulphuric acid is called oil of vitriol because it was first prepared by the dry distillation of green vitriol ($FeSO_4 \cdot 7H_2O$) and obtained as an oily viscous liquid.

2. a. When sulphur trioxide reacts with water, it forms sulphuric acid. This reaction is highly exothermic and very dangerous because the heat of reaction vaporises the sulphuric acid forming a dense fog.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

b. After passing through converters, sulphur trioxide is cooled and passed into an absorption tower where it is absorbed in concentrated sulphuric acid to form oleum ($H_2S_2O_7$).

$$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$$

c. Oleum is diluted by adding a calculated amount of water to obtain H_2SO_4 of the desired strength.

$$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$$

3. a. The main purpose of the Contact process is manufacturing of sulphuric acid.

b. S and O_2

c. Platinum or vanadium pentoxide

d. $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

P. 164 CHECK YOUR PROGRESS

1. a. Copper sulphate crystals are dehydrated by concentrated sulphuric acid.

b. Oxalic acid reacts with concentrated sulphuric acid to produce a mixture of carbon dioxide and carbon monoxide.

c. Concentrated sulphuric acid on reaction with sodium chloride gives hydrogen chloride gas.

d. Concentrated sulphuric acid releases sulphur dioxide gas, carbon dioxide gas and water on reaction with non-metals.

2. a. Dilute sulphuric acid is a dibasic acid,so it forms normal salts and acid salts.

b. When oil of vitriol is added to sodium carbonate, a brisk effervescence is observed due to the production of CO_2 gas.

c. Concentrated sulphuric acid is used to prepare nitric acid because it is a strong as well as nonvolatile acid, therefore, it is capable of displacing more volatile nitric acid from sodium or potassium nitrate on heating the reaction mixture.

d. Sulphuric acid cannot be used to dry hydrogen sulphide gas as they react with the acid.

3. a. sugar charcoal

b. SO_2 and CO_2 gases

c. $ZnSO_4$ and SO_2

d. Iodine and Sulphur dioxide gas

P. 165–166 EXERCISES

A. 1. Lead nitrate

2. sulphur

3. sulphur dioxide

4. sulphur dioxide

5. sulphur dioxide

B. 1. Contact Process, Lead Chamber Process

2. Carbon dioxide

3. Hydrogen chloride

4. Sulphur dioxide

5. Hydrogen sulphide

C. 1. i. $Zn + \underset{\text{(dil)}}{H_2SO_4} \rightarrow ZnSO_4 + H_2\uparrow$

ii. $Zn + \underset{\text{(Conc)}}{2H_2SO_4} \rightarrow ZnSO_4 + 2H_2O + SO_2$

2. Charring occurs.

3. Splashing followed by liberation of heat occurs.

4. Concentrated sulphuric acid dehydrates blue crystalline hydrated copper sulphate (blue vitriol) and turns it into white amorphous copper sulphate powder.

5. White precipitation takes place.

D. **1.** $C + \underset{\text{(conc.)}}{2H_2SO_4} \rightarrow CO_2 + 2H_2O + 2SO_2\uparrow$

2. $S + \underset{\text{(conc.)}}{2H_2SO_4} \rightarrow 2H_2O + 3SO_2\uparrow$

3. $H_2S + \underset{\text{(conc.)}}{2H_2SO_4} \rightarrow SO_2 + 2H_2O + S$

4. $2HI + \underset{\text{(conc.)}}{H_2SO_4} \rightarrow 2H_2O + SO_2 + I_2$

5. $CaOCl_2 + \underset{\text{(dil.)}}{H_2SO_4} \rightarrow CaSO_4 + H_2O + Cl_2\uparrow$

E. **1.** **a.** $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

b. An exothermic reaction. Lowering the temperature retards the rate of reaction.

c. X – catalytic oxidation

Y – Absorption

Z – Dilution

d. The temperature should be maintained between 450 to 500 °C for catalytic conversion of sulphur dioxide to sulphur trioxide. If the temperature is above 500 °C (or high), sulphur trioxide may decompose to give sulphur dioxide and oxygen. However, the low temperature slows down the rate of reaction.

e. Sulphur trioxide is not directly dissolved in water to get H_2SO_4 because with water a large amount of heat is released. This results in the formation of a dense fog of H_2SO_4 which does not condense easily.

2. Copper does not react with dilute sulphuric acid but reacts with concentrated sulphuric acid. Because concentrated sulphuric acid is a strong oxidizing agent.

3. SO_2

4. $Zn + 2H_2SO_4 \rightarrow ZnSO_4 + 2H_2O + SO_2$

5. The impurity of arsenic oxide should be removed before passing the mixture of SO_2 and air through the catalytic chamber as this reduces the efficiency of the catalyst or poisons the catalyst, and can even destroy it.

6. Sulphuric acid is hygroscopic in nature. It readily absorbs water vapour from the atmosphere. Therefore, it is used as a good dehydrating agent and kept in airtight bottles to prevent it from getting diluted.

7. **a.** $Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2$

b. $Pb(NO_3)_2 + H_2SO_4 \rightarrow \underset{\text{(white ppt.)}}{PbSO_4\downarrow} + 2HNO_3$

P. 166–167 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. $H_2SO_4 + Na_2SO_3 \rightarrow Na_2SO_4 + H_2O + SO_2$

2. **a.** When barium chloride solution is mixed with sodium sulphate solution, then an insoluble precipitate of barium sulphate and solution of sodium chloride is formed.

$BaCl_2 + Na_2SO_4 \rightarrow \underset{\text{(white ppt)}}{BaSO_4\downarrow} + 2NaCl$

b. When concentrated sulphuric acid is added to sugar crystals it dehydrates sugar and turns it into black spongy carbon.

$C_{12}H_{22}O_{11} \xrightarrow[\text{concentrated}]{H_2SO_4} 12C + 11H_2O$

3. **a.** **ii** = Non-volatile acid

b. **i** = Typical acid property

c. **iii** = Oxidizing agent

2015

4. **a.** Nitric acid

b. Conc. sulphuric acid

c. Sulphuric acid

5. **a.** $\underset{\substack{\text{Potassium}\\\text{hydrogen}\\\text{carbonate}}}{2KHCO_3} + \underset{\substack{\text{Dil.}\\\text{sulphuric}\\\text{acid}}}{H_2SO_4} \rightarrow \underset{\substack{\text{Potassium}\\\text{sulphate}}}{K_2SO_4} + \underset{\text{Water}}{2H_2O} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{2CO_2}\uparrow$

b. $\underset{\text{Sulphur}}{S} + \underset{\substack{\text{Conc.}\\\text{sulphuric acid}}}{2H_2SO_4} \rightarrow \underset{\substack{\text{Sulphur}\\\text{dioxide}}}{3SO_2} + \underset{\text{Water}}{2H_2O}$

6. Conversion of sulphur trioxide into sulphuric acid

$$\underset{\text{Sulphur trioxide}}{SO_3} + H_2SO_4 \rightarrow \underset{\text{oleum}}{H_2S_2O_7}$$

Dilution of oleum

$$H_2S_2O_7 + H_2O \rightarrow \underset{\text{Sulphuric acid}}{2H_2SO_4}$$

2014

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

8. Using barium chloride solution:

Dil H_2SO_4	Dil HCl
$BaSO_4$ and HCl is formed	No effect

9. Platinum vanadium pentoxide (V_2O_5) as catalyst and temperature of 450 °C – 500 °C.

10. **a.** $CuSO_4 \cdot 5H_2O \xrightarrow[\text{concentrated}]{H_2SO_4} CuSO_4 + 5H_2O$

b. $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2\uparrow + H_2O$

c. $NaCl + H_2SO_4 \xrightarrow{< 200\ ^\circ C} NaHSO_4 + HCl\uparrow$

2013

11. It dehydrates blue crystalline hydrated copper sulphate and turns it into white amorphous copper sulphate powder.

12. **b.** Oxidizing agent

13. $C_{12}H_{22}O_{11} \xrightarrow[\text{concentrated}]{H_2SO_4} 12C + 11H_2O$

14. Dilute sulphuric acid

2012

15. Hydrogen sulphide gas

16. **i.** **b**

ii. **d**

iii. **c**

iv. **a**

v. **d**

17. $ZnS + H_2SO_4 \rightarrow ZnSO_4 + H_2S\uparrow$

2011

18. Sugar crystals first turn brown, then to black spongy mass. Steam also evolves.

19. **a.** Hydrogen sulphide

20. $Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

21. **a.** $2SO_2 + O_2 \underset{V_2O_5}{\rightleftharpoons} 2SO_3 + \text{heat}$

$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

b. **i.** Non-volatile nature

ii. Oxidizing property

2010

22. **a.** $S + H_2SO_4 \rightarrow 2H_2O + 3SO_2$

b. $C_{12}H_{22}O_{11} + H_2SO_4 \rightarrow 12C + 11H_2O + H_2SO_4$

23. **a.** $ZnSO_4 + Na_2CO_3 \rightarrow ZnCO_3 + Na_2SO_4$

b. $ZnCO_3 + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O + CO_2$

c. $Zn(NO_3)_2 + 2NaOH \rightarrow Zn(OH)_2 + 2NaNO_3$

d. $Zn(OH)_2 \rightarrow ZnO + H_2O$

e. $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$

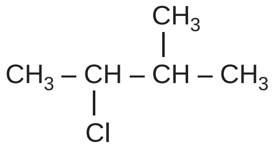
CHAPTER – 12

ORGANIC CHEMISTRY–I

P. 178 CHECK YOUR PROGRESS

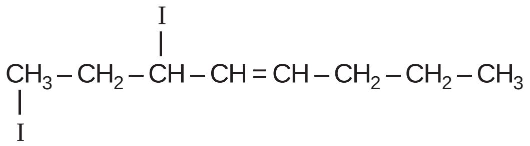
1. **a.** Hept-3-yne
- **b.** Butan-2-ol
- **c.** Pent-2-ene
- **d.** 3-chloro-4-methyl hexane
- **e.** 2, 4 dimethyl hexane
- **f.** 3 chloro butanal
- **g.** 4, 4-dimethylpentanal
- **h.** 4-methyl butanoic acid
- **i.** 5-iodo 5-methyl hex-2-one
- **j.** 4, 4-dimethyl-2 chloro Butanoic acid

2. **a.**



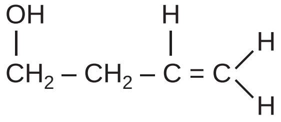
$CH_3 - \underset{\displaystyle Cl}{\underset{|}{CH}} - \overset{\displaystyle CH_3}{\overset{|}{CH}} - CH_3$

b.



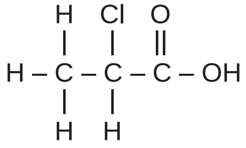
$\underset{\displaystyle I}{\underset{|}{CH_3}} - CH_2 - \overset{\displaystyle I}{\overset{|}{CH}} - CH = CH - CH_2 - CH_2 - CH_3$

c.



$\overset{\displaystyle OH}{\overset{|}{CH_2}} - CH_2 - \overset{\displaystyle H}{\overset{|}{C}} = C\genfrac{}{}{0pt}{}{\diagup H}{\diagdown H}$

d.



$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle Cl}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle O}{\overset{||}{C}} - OH$

P. 182–183 EXERCISES

A. **1.** aliphatic

2. parent alkane

3. isomers

4. functional group, number of carbon atoms

B. **1.** A functional group is a chemically reactive atom or group of atoms present within the molecule of an organic compound which is responsible for its characteristic chemical properties.

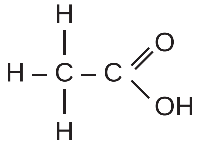
2. Carbon has the unique ability to form bonds with other atoms of carbon, thereby, forming a large number of molecules. This property is called catenation.

3. Chain Isomerism: This isomerism arises due to different branching of 'C' atom.

4. Positional Isomerism: This isomerism arises due to change in the position of either functional group or any substituent within the same compound.

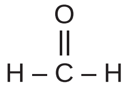
5. Functional Isomerism: This isomerism arises due to the presence of different functional groups within the same molecular formula.

C. **1.**



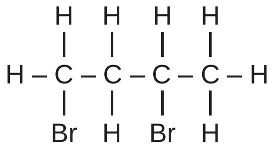
$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - C\genfrac{}{}{0pt}{}{\diagup\!\!\diagup O}{\diagdown OH}$

2.



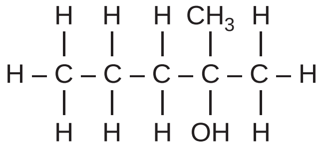
$H - \overset{\displaystyle O}{\overset{||}{C}} - H$

3.



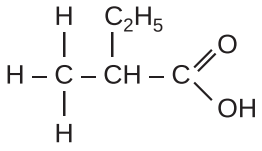
$H - \overset{\displaystyle H}{\underset{\displaystyle Br}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle Br}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - H$

4.



$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle CH_3}{\underset{\displaystyle OH}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - H$

5.



$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle C_2H_5}{\overset{|}{CH}} - C\genfrac{}{}{0pt}{}{\diagup\!\!\diagup O}{\diagdown OH}$

D. **1.** Alcohol

2. Carboxylic acid

3. Aldehydes

4. Alcohol

5. Ethers/Aldehydes

E. **1.** Chloroethane

2. Ethene

3. Ethanal

4. 1, 1- dichloroethane

5. 2, 3-dichloropentane

6. 5-ethyl-oct-2-yne

7. 2 methyl 5-butanol

F. **1.** Since the origin of these compounds was organic, they were called organic compounds and the compounds obtained from minerals were called minerals or inorganic compounds. Almost 90% of all known compounds are of organic nature and they are mainly made of carbon and hydrogen.

2. Tetravalency of carbon atom, catenation, iosomerism

3. Hydrocarbons are organic compounds containing only carbon and hydrogen. They are divided into aliphatic (open chain) and cyclic (closed chain) compounds. Hydrocarbons can either be saturated or unsaturated. Saturated hydrocarbons contain only single covalent bonds between carbon atoms. Saturated hydrocarbons are called alkanes or paraffins.

   Unsaturated hydrocarbons contain atleast one carbon – carbon double bond or carbon-carbon triple bond.

   Unsaturated hydrocarbons are of two types, alkenes or olefins and alkynes or acetylenes.

4. Carbon has some really unique properties which help to form such a large number of compounds. Catenation is the ability of carbon compounds to form long chains, branched chains or rings. Smaller nucleus helps it to attract more number of electrons. Carbon has four valence electrons and it forms four covalent bonds by sharing its four electrons with atoms of carbon or atoms of some other element. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine, etc. This characteristic property of the carbon atom, by the virtue of which it forms four covalent bonds, is called tetravalency. Organic compounds having the same molecular formula but different structural formulae are called isomers and the phenomenon is called isomerism. The isomers have different properties as the arrangement of atoms are different.

5. A homologous series is a series of organic compounds each containing a characteristic functional group. The successive members of the series are called homologues.

   a. 14 u

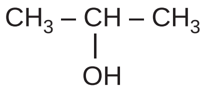
   b. Every member of a homologous series differs from its successive member by a CH_2 unit.

6.

HCOOH	CH_3CHO
CH_3COOH	C_2H_5CHO
C_2H_5COOH	C_3H_7CHO

7. $CH_3CH_2 – CH_2 – OH$

   1-propanol



$$\underset{\displaystyle OH}{CH_3 – \underset{|}{CH} – CH_3}$$

2-propanol

Both have same alcoholic group.

$CH_3 – O – C_2H_5$

Ethyl-methyl ether

It has ether group.

CHAPTER – 13

ORGANIC CHEMISTRY–II

P. 191 CHECK YOUR PROGRESS

1. a. C_2H_5COONa

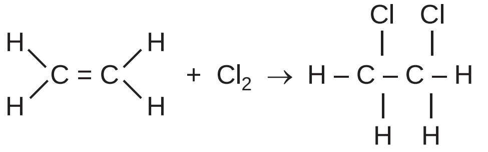
b. CaC_2 (calcium carbide)

c. HCHO (formaldehyde)

d. CH_4

e. The Wurtz reaction

2. a.



$$H_2C=CH_2 + Cl_2 \rightarrow H-\underset{H}{\overset{Cl}{C}}-\underset{H}{\overset{Cl}{C}}-H$$

ethene 1, 2-dichloroethane

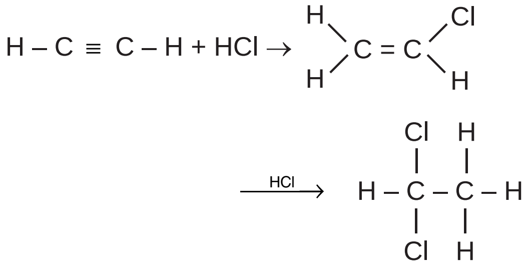
b. $2CH_4 + O_2 \xrightarrow[120\ \text{atm}]{\text{Cu tube at } 200\ °C} 2CH_3OH$

Methane Methanol

$2C_2H_6 + O_2 \xrightarrow[120\ \text{atm}]{\text{Cu tube at } 200\ °C} 2C_2H_5OH$

Ethane Ethanol

c.



$$H-C\equiv C-H + HCl \rightarrow H_2C=CHCl \xrightarrow{HCl} H-\underset{Cl}{\overset{Cl}{C}}-\underset{H}{\overset{H}{C}}-H$$

1, 1 – dichloroethane

3. a. Bromine is reddish brown in colour. When ethene is added to bromine solution, ethene decolourises bromine water forming dibromoethane.

b. Cabon monoxide. A poisonous gas, is formed.

c. Ethene decolourises cold alkaline potassium permanganate solution (Baeyer's reagent). The purple colour of alkaline potassium permanganate is discharged.

P. 194 CHECK YOUR PROGRESS

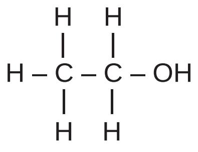
1. a. dehydration

b. concentrated sulphuric acid

c. hydrogenation

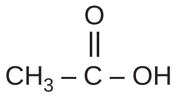
d. nickel

2. a.



$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-OH$$

b.



$$CH_3-\overset{O}{\overset{\|}{C}}-OH$$

3. a. $C_2H_4 + H_2SO_4 \xrightarrow[30\ \text{atm}]{80\ °C} C_2H_5HSO_4$

ethyl hydrogensulphate

$C_2H_5HSO_4 + H_2O \xrightarrow{\text{boiling}} C_2H_5OH + H_2SO_4$

b. $H_2C = CH_2 + H_2O \xrightarrow{H^+} H_3C - CH_2 - OH$

$H_3C - CH_2 - OH \xrightarrow{KMnO_4} H_3C - COOH$

c.

$C_2H_5OH \xrightarrow{[O]} CH_3CHO \xrightarrow{[O]} CH_3COOH + H_2O$

ethanol acetaldehyde acetic acid

d.

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

ethyl acetate

P. 195–196 EXERCISES

A. 1. homologous, saturated

2. addition

3. 1,2-diiodoethane

4. colourless

5. hydrogenation

6. addition

B. 1. Ethyne reacts with bromine in carbon tetrachloride to first form dibromoethene and then tetrabromoethane. During the addition of bromine to ethyne, the red-brown colour of bromine gets decolourised.

2. ethane is formed

3. Ethene burns in air with a smoky luminous flame forming carbon dioxide and water vapour.

4. Acetic acid combines with alcohols to form sweet smelling esters in the presence of dehydrating agents like anhydrous zinc chloride or concentrated sulphuric acid. This phenomenon is called esterification.

$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$

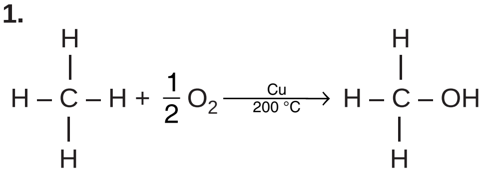
ethyl ethanoate (ester)

C. 1. Diffused sunlight

2. Concentrated H_2SO_4 at 170 °C

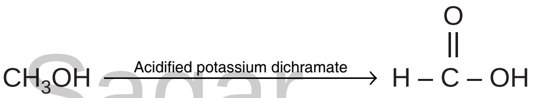
3. Soda lime

D. 1.



$$H-\underset{H}{\overset{H}{C}}-H + \frac{1}{2}O_2 \xrightarrow[200\ °C]{Cu} H-\underset{H}{\overset{H}{C}}-OH$$

methyl alcohol



$$CH_3OH \xrightarrow{\text{Acidified potassium dichramate}} H-\overset{O}{\overset{\|}{C}}-OH$$

2. $CH_4 + Cl_2 \xrightarrow{\text{UV light}} CH_3Cl + HCl$

methane   methyl chloride

$CH_3Cl + Cl_2 \xrightarrow{\text{UV light}} CH_2Cl_2 + HCl$

methylene dichloride

$CH_2Cl_2 + Cl_2 \xrightarrow{\text{UV light}} CHCl_3 + HCl$

chloroform

$CHCl_3 + Cl_2 \xrightarrow{\text{UV light}} CCl_4 + HCl$

carbon tetrachloride

3. $CH \equiv CH \xrightarrow{+Br_2} CHBr = CHBr$

ethyne   1,2-dibromoethene

$\xrightarrow{+Br_2} CHBr_2 - CHBr_2$

1,1,2,2-tetrabromoethane

4. $CH_3 - CH_3 + \frac{1}{2}O_2 \xrightarrow[200\ °C]{Cu} CH_3CH_2OH$

ethanol

5. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

E. 1. F Cl Br I

$\longrightarrow$

decreasing order of reactivity.

2. Red precipitate is obtained.

3. **a.** ethane

b. ethyne

c. methane

4. Denatured alcohol is also called methylated alcohol. Consumption of denatured alcohol is extremely harmful; it causes blindness or death if consumed even in small doses. This denatured alcohol or spirit is called spurious or illicit alcohol.

5. Carbon dioxide

F. 1. Ethene

2. Ethyne

3. Methanol

4. Ethane

P. 196–198 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. hydrogenation

2. $C_2H_5Cl + KOH(aq) \rightarrow C_2H_5OH + KCl$

3. **a.** Nickel

b. Addition reaction

4. **a.** Prop - 2 - ene

b. 2-Butyne

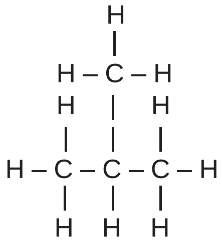
c. Ethanal

5. **a.** $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

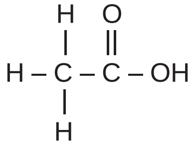
b. $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

c. $C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4 \text{ at } 170\ °C} C_2H_4 + H_2O$

6. **a.**

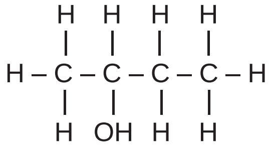


b.



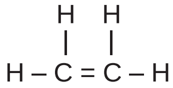
$\mathrm{H - \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}} - \overset{\overset{O}{||}}{C} - OH}$

c.



$\mathrm{H - \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}} - \overset{\overset{H}{|}}{\underset{\underset{OH}{|}}{C}} - \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}} - \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}} - H}$

7. **a.**



$\mathrm{H - \overset{\overset{H}{|}}{C} = \overset{\overset{H}{|}}{C} - H}$

b. Bromine in CCl4 has orange colour. When added dropwise to ethene, the orange colour of bromine disappears as ethene undergoes addition reaction to form colourless ethylene bromide.

2015

8. **a.** Ethyne

b. Ethane

9. **c.** They can undergo addition as well as substitution reactions.

10. The red-brown colour of bromine gets decolourised.

11. **a.** $CH_3COOH(l) + C_2H_5OH(l) \xrightarrow{\text{Conc. } H_2SO_4}$

Ethanoic acid   Ethanol

$CH_3COOC_2H_5(l) + H_2O(l)$

Ethyl ethanoate   Water

b. $CaC_2(s) + 2H_2O \rightarrow Ca(OH)_2(s) + C_2H_2(g)\uparrow$

Calcium carbide   Water   Calcium hydroxide   Ethyne

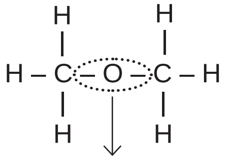
c. $CH_3COONa(s) + NaOH(s) \xrightarrow[300\ °C]{CaO}$

Sodium ethanoate   Sodium hydroxide

$Na_2CO_3(s) + CH_4(g)\uparrow$

Sodium carbonate   Methane

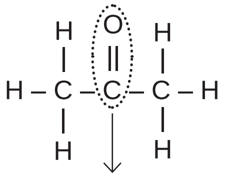
12. **a.** Dimethyl ether



$H-C-O-C-H$

Functional group

b. Propanone



$H-C-C(=O)-C-H$

Functional group

13. **a.** Hydrogenation

b. Methane

c. Esterification

d. Catenation

e. Dehydrohalogenation

2014

14. **d.** ethyne

15. sodium ethoxide

16. Ketone

17. **a.** $C_2H_5COONa + NaOH \xrightarrow{CaO\ 300\ °C} C_2H_6 + Na_2CO_3$

b. $C_2H_5Cl + NaOH \rightarrow C_2H_5OH + NaCl$

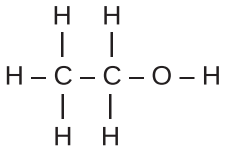
18. Using alkaline potassium permanganate solution:

Ethane	Ethene
No effect.	Solution of potassium permanganate gets decolourised.

19. **a.** In presence of nickel as a catalyst and heating to about 200 °C

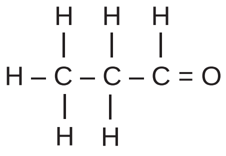
b. Dropping ethylene dibromide into a boiling ethanoic solution of potassium hydroxide.

20. **a.** Ethanol



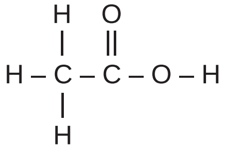
$H-C-C-O-H$

b. 1-propanal



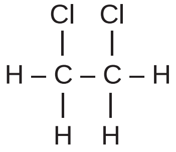
$H-C-C-C=O$

c. Ethanoic acid



$H-C-C(=O)-O-H$

d. 1, 2-dichloroethane



$H-C-C-H$

21. **a.** Alkynes **ii.** C_nH_{2n-2}

b. Alkanes **i.** C_nH_{2n+2}

2013

22. Ethane gas evolves when sodium propionate is heated with soda lime.

23. Halogenation

24. Ethene decolourises alkaline potassium permaganate solution ($KMnO_4$) (oxidation) while ethane does not decolourise $KMnO_4$ solution

25. **c.** They can undergo both substitution as well as addition reactions.

26. **a.** $CH_3I + 2H \xrightarrow[C_2H_5OH]{Zn/Hg} CH_4 + HI$

Iodomethane Methane

b. $C_2H_5OH \xrightarrow[at\ 170\ °C]{Conc.\ H_2SO_4} H_2C = CH_2 + H_2O$

Ethyl alcohol Ethene

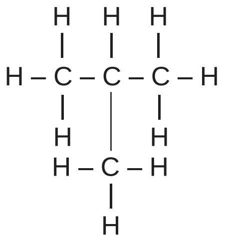
c. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

Carbon carbide Ethyne

d. $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

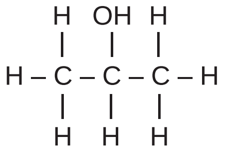
Ethyl bromide Ethyl alcohol

27. **a.** an isomer of *n*-butane.



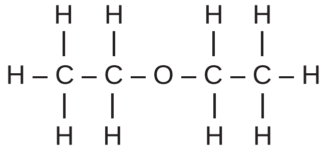
$H-C-C-C-H$

b. 2-Propanol.



$H-C-C(OH)-C-H$

c. diethyl ether.



$H-C-C-O-C-C-H$

28. a. Methane is a saturated hydrocarbon, no electron is available for addition reaction. Ethene is a unsaturated hydrocarbon, due to availability of electrons, it takes part in addition reaction.

b. Ethyne is highly reactive compound due to the presence of a triple bond between C–C atom. Ethane has a double bond between C–C atom.

c. Hydrocarbons produce a lot of energy, when burnt in air, so they are excellent fuels.

2012

29. A colourless solution is obtained and brown colour of bromine vapours disappear.

30. a. Ethyne

b. acetic acid

c. Ethene

d. Ethanol

31. a. Because on cooling below its melting point (17 °C) it solidifies and forms little ice-like crystals.

b. $\underset{\text{acetic acid}}{CH_3COOH} + \underset{\text{ethyl alcohol}}{C_2H_5OH} \rightarrow CH_3COOC_2H_5 + H_2O$

2011

32. Acetylene

33. a. iii. Carboxy – COOH

b. i. Addition reaction

c. ii. 6

34. a. i. nickel

ii. esterification

iii. acetic acid

iv. ethanol

b. $CH_2Br.\ CH_2Br + 2KOH \rightarrow CH \equiv CH + 2KBr + 2H_2O$

35. a. Because 90% compounds contain C and H and these are obtained from either plants or animals.

b. During this, carbon monoxide is formed which is poisonous in nature.

36. a. $C_2H_5Cl + \underset{(aq)}{KOH} \rightarrow C_2H_5OH + KCl$

b. $CH_3COONa + NaOH \xrightarrow[\text{(sodalime)}]{CaO} CH_4 + Na_2CO_3$

c. $CH_3CH_2OH + O \xrightarrow[K_2Cr_2O_7]{} CH_3COOH + H_2\uparrow$

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

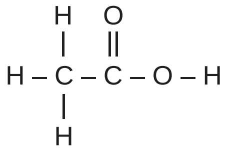
e. $2C_2H_5OH + 2Na \rightarrow 2C_2H_5Na + H_2\uparrow$

2010

37. a. iii. ethyne

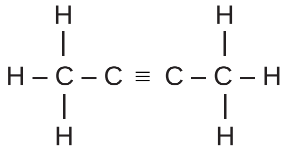
b. i. methanol

38. a. Ethanoic acid



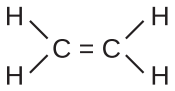
$H-C-C-O-H$

b. But-2-yne



$H-C-C \equiv C-C-H$

39. a.



b. Addition reaction

c. Bromine solution gets decolourised.

d. Ethanol

e. Heat ehanol and conc. H_2SO_4 at 170 °C

CHAPTER – 14

PRACTICAL CHEMISTRY

P. 205 CHECK YOUR PROGRESS

1. a. White

b. Yellow

c. Black

2. a. NH_4OH

b. dil. H_2SO_4

c. $MgCl_2$

3. a. The salt solution reacts with $Ba(NO_3)$ solution to give a white precipitate soluble in dilute HNO_3 but insoluble in dilute H_2SO_4. **iii.** SO_4^{2-}

b. The salt reacts with conc. H_2SO_4 on heating evolving a coloured gas which turns potassium iodide paper brown. **ii.** NO_3^-

c. The salt solution reacts with $AgNO_3$ solution to give a white precipitate insoluble in dilute HNO_3. **iv.** Cl^-

d. The salt solution reacts with $Ba(NO_3)_2$ solution to give a white precipitate insoluble in dilute HNO_3. **i.** CO_3^{2-}

4. a. CO_2

b. HCl

c. Nitrogen dioxide

d. SO_2

P. 207 EXERCISES

A. 1. Nesseler's Reagent

2. Silver nitrate solution

3. Ferrous sulphate solution

4. Lead acetate paper

5. Ammonium hydroxide

B. 1. Chlorine

2. Hydrogen sulphide, sulphur dioxide

3. Hydrogen sulphide

4. Chlorine

5. Sulphur dioxide

C. 1. Sulphuric acid gives white precipitate with barium chloride solution while nitric acid does not give such precipitate.

2. Hydrochloric acid gives white precipitate with silver nitrate solution while nitric acid does not give such precipitate.

3. Same as in (1) or (2) above.

4. Magnesium nitrate and zinc nitrate give white precipitate with sodium hydroxide. The precipitate of Zn dissolves in excess NaOH while that of Mg does not dissolve.

5. Barium carbonate liberates carbon dioxide while barium sulphite liberates sulphur dioxide with dil. HCl. Carbon dioxide extinguishes burning splinter while sulphur dioxide does not.

D. 1. $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

2. $CuCO_3 \xrightarrow{\Delta} CuO + CO_2$

3. $NH_4Cl \xrightarrow{\Delta} NH_3(g) + HCl(g)$

4. $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

5. $2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2 + O_2$

E. 1. Lead nitrate will react with ferrous sulphate to form thick white precipitate.

2. Due to the formation of lead sulphide.

3. Due to the formation of soluble complex $[Ag(NH_3)_2Cl]$.

4. Because both are reducing gases.

5. Because ferrous sulphate undergoes hydrolysis.

P. 207–208 QUESTIONS BASED ON PREVIOUS ICSE EXAMINATIONS

2016

1. a. Fe^{3+}

b. Pb^{2+}

c. Mg^{2+}

2015

2. hydrogen Sulphide

3. Lead acetale turns black because of the formation of black lead sulphide.

$(CH_3COO)_2Pb + H_2S \rightarrow 2CH_3COOH + Pbs\downarrow$

4. a. Cl^-

b. CO_3^{2-}

c. SO_3^{2-}

5. a. Zn^{2+}

b. Cu^{2+}

c. Ca^{2+}

d. $NH^{+}{}_4$

2014

6. Using dilute sulphuric acid:

Sodium Nitrate	Sodium Sulphite
Sodium bisulphate ($NaHSO_4$) and HNO_3 is formed	Na_2SO_4 and SO_2 is formed

7. Starch iodide paper turns blue-black.

8. Cation P is Ca^{2+}

9. **a.** Gas Q is hydrogen sulphide gas.

   b. Substance R is a base.

2013

10. **a.** Add silver nitrate solution to both the solutions. Sodium chloride will form a curdy white precipitate while sodium nitrate does not react with silver nitrate.

    b. Ammonia gives dense white fumes with a rod dipped in concentrated hydrochloric acid while hydrogen sulphide gas does not give any fumes with ammonia.

    c. When NaOH solution is added in excess to both the solutions, white precipitate is formed in $ZN(CO_3)_2$ which dissolves in NaOH solution and no such precipitate is formed with $Ca(NO_3)_2$.

    d. Carbon dioxide turns lime water milky in the formation of $CaCO_3$ while no such reaction takes place with SO_2 gas.

11. CO

2012

12. SO_2 gas

13. **a.** NO_3^- ion

    b. Cl^- ion

    c. CO_3^{2-} ion

    d. SO_4^{2-} ion

14. **a.** Sodium carbonate when treated with dil H_2SO_4 will liberate colourless odourless gas with brisk effervescence. The gas will turn lime water milky and will have no effect on acidified potassium permanganate solution.

    b. Aqueous ferrous nitrate when treated with NaOH solution gives a dirty green ppt.

    Aqueous lead nitrate when treated with NaOH solution gives a white ppt. which dissolves in excess of NaOH.

    c. When Manganese dioxide is heated with conc. HCl a pungent smelling greenish yellow chlorine gas is evolved.

    When copper oxide is heated with conc. HCl no such gas is evolved.

15. The blue colour of the copper sulphate solution disappears due to the formation of colourless zinc sulphate.

16. $AgNO_3 + NaCl \rightarrow AgCl\downarrow + NaNO_3$

2011

17. barium chloride

18. **b.** NO_3^-

2010

19. **a.** **i.** Nitroso iron(II) sulphate

    b. **iii.** Chromium sulphate

20. **a.** Litmus turns blue to red then gets bleached.

    b. Red rose peals turn white.

    c. Paper turns pink to white.

21. Silver nitrate solution when added to dil HCl will give a white precipitae. When $AgNO_3$ is added to dl HNO_3, no change is seen.

22. **a.** L → Copper nitrate

    M → Nitrogen dioxide gas

    N → Hydrogen sulphide gas

    b. $2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$

    c. $H_2S + Cu(NO_3)_2 \rightarrow CuS + 2HNO_3$