Chemical Industry - Complete Exercise

MCQs (Multiple Choice Questions)

Q. I. The metal present in combined state is called _____

Ans: (a) Mineral

Q. II. The blister copper is refined by _____

Ans: (c) Electrolysis

Q. III. Sodium carbonate is commercially manufactured by _____ process

Ans: (a) Solvay's

Q. IV. Chemical formula of urea is _____

Ans: (b) NH_2CONH_2

Q. V. Urea is probably most important _____ fertilizer

Ans: (b) Nitrogenous

Q. VI. Raw materials used for manufacturing urea are _____

Ans: (a) CO_2 and NH_3

Q. VII. Petroleum is mixture of many _____

Ans: (a) Hydrocarbons

Q. VIII. Different fractions of petroleum are separated by _____

Ans: (a) Fractional distillation

Q. IX. Which one is a step of metallurgical process _____

Ans: (a) Roasting

Q. X. The blister form of copper is _____ copper

Ans: (b) Impure

Short Answer Questions

Q. i. What is Metallurgy?

Ans: Metallurgy is the science and technology of extracting metals from their ores and refining them for practical use. It includes three main steps:

1. Concentration — removal of gangue (impurities) from ore
2. Reduction — converting metal compound into free metal
3. Refining — purifying the extracted metal

Q. ii. How is Blister Copper Purified?

Ans: Blister copper is purified by Electrolytic Refining.

- Anode = Impure blister copper (thick slab)
- Cathode = Thin sheet of pure copper
- Electrolyte = Copper sulphate ($CuSO_4$) solution

When electric current is passed:

- Copper dissolves from the anode
- Pure copper deposits on the cathode
- Impurities settle at the bottom as Anode Mud

Result: 99.9% pure copper is obtained.

Q. iii. How is Sodium Carbonate Commercially Prepared?

Ans: Sodium carbonate (Na_2CO_3) is prepared by Solvay's Process. Raw Materials: NaCl (brine), NH_3, CO_2, $CaCO_3$

Step 1: Brine is saturated with ammonia gas. Step 2: CO_2 is passed → $NaHCO_3$ precipitates out. $NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3\downarrow + NH_4Cl$

Step 3: $NaHCO_3$ is filtered and heated: $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2\uparrow$

Step 4: NH_3 is recovered and recycled.

Q. iv. Describe the Concentration of Copper Ore.

Ans: Copper ore ($CuFeS_2$) is concentrated by the Froth Flotation Method.

1. Ore is crushed into fine powder.
2. Crushed ore is mixed with water and pine oil in a tank.
3. Air is blown through the mixture — froth is formed.
4. Ore particles attach to froth and rise to the surface.
5. Gangue (waste) sinks to the bottom.
6. Froth is collected and dried → concentrated ore is obtained.

Q. v. What is Drilling of Petroleum?

Ans: Drilling is the process of making deep holes (wells) in earth's crust to reach underground petroleum deposits.

- Steel pipes are inserted into drilled holes to prevent collapse.
- Petroleum flows up due to gas pressure or is pumped out.
- The place where petroleum is found underground is called an Oil Reservoir.

Q. vi. Draw Flow Sheet Diagram of Solvay's Process.

Ans:

$NaCl$ (Brine) + NH_3
↓
Ammoniated Brine
↓ (CO_2 passed)
$NaHCO_3$ precipitates
↓ (Filtered)
$NaHCO_3$ (solid)
↓ (Heated)
$Na_2CO_3 + H_2O + CO_2\uparrow$
(Final Product — Sodium Carbonate)

Q. vii. What is the Origin of Petroleum?

Ans: Petroleum was formed millions of years ago from remains of dead marine plants and animals.

- These organisms were buried under layers of mud and rock at the bottom of seas.
- Over millions of years, due to high temperature and pressure, these remains were converted into petroleum.
- This is called Organic (Biogenic) Theory of Petroleum Origin.
- Petroleum is called Fossil Fuel.

Comprehensive Questions

Q. i. Describe the Composition of Petroleum in Detail.

Ans: Petroleum (crude oil) is a dark brown oily liquid with an unpleasant smell. It is a complex mixture of hydrocarbons.

Chemical Composition:

- Carbon (C) = 83 – 87%
- Hydrogen (H) = 11 – 14%
- Sulphur (S) = 0 – 4%
- Nitrogen (N) = 0 – 1%
- Oxygen (O) = 0 – 2%

Types of hydrocarbons present:

1. Alkanes
2. Cycloalkanes
3. Aromatic hydrocarbons

Impurities: Small amounts of sulphur, nitrogen and oxygen compounds are also present.

Q. ii. How is Urea Manufactured Commercially?

Ans: Urea (NH_2CONH_2) is manufactured by reacting Ammonia (NH_3) and Carbon dioxide (CO_2).

Raw Materials: NH_3 and CO_2 Conditions: Temperature = 180–200°C | Pressure = 200 atm

Reaction: Step 1: $2NH_3 + CO_2 \rightarrow NH_2COONH_4$ (Ammonium carbamate) Step 2: $NH_2COONH_4 \rightarrow NH_2CONH_2 + H_2O$ (Urea)

- Urea solution is concentrated and converted into granules.
- Urea contains 46% nitrogen.
- It is the richest and most widely used nitrogenous fertilizer.

Q. iii. Describe the Extraction of Copper from its Ore.

Ans: Copper is extracted from Copper Pyrite ($CuFeS_2$).

Step 1 — Crushing & Concentration: Ore is crushed and concentrated by the Froth Flotation method.

Step 2 — Roasting: Concentrated ore is heated in air: $2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2\uparrow$

Step 3 — Smelting: Roasted ore is melted in blast furnace with silica (SiO_2): $FeO + SiO_2 \rightarrow FeSiO_3$ (slag — removed)

Step 4 — Bessemerization: Molten mass is treated in Bessemer converter with air: $Cu_2S + O_2 \rightarrow 2Cu + SO_2\uparrow$ This gives Blister Copper (~98% pure).

Step 5 — Electrolytic Refining: Blister copper is purified by electrolysis. Result: 99.9% pure copper is obtained.

Q. iv. Describe in Detail the Solvay's Process.

Ans: Solvay's process is used to manufacture Sodium Carbonate (Na_2CO_3).

Raw Materials: NaCl, NH_3, CO_2, $CaCO_3$

Step 1 — Preparation of Brine: NaCl is dissolved in water to prepare saturated brine.

Step 2 — Ammoniation: Brine is saturated with NH_3 gas → ammoniated brine is formed.

Step 3 — Carbonation: CO_2 is passed → $NaHCO_3$ precipitates: $NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3\downarrow + NH_4Cl$

Step 4 — Filtration: $NaHCO_3$ is separated by filtration.

Step 5 — Calcination: $NaHCO_3$ is heated: $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2\uparrow$

Step 6 — Recovery of NH_3: $2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3\uparrow + 2H_2O$ NH_3 is recycled back into the process.

Final Product: Na_2CO_3 (Washing Soda / Soda Ash)

Q. v. Define Fractional Distillation. How is it Carried Out in Petroleum?

Definition: Fractional distillation is the process of separating a mixture of liquids into its components (fractions) on the basis of their different boiling points.

Process:

1. Crude oil is heated in a furnace at very high temperature.
2. The vapours enter a tall Fractionating Column (hot at bottom, cool at top).
3. Different fractions condense at different levels based on boiling points.
4. Fractions with high boiling point condense near the bottom.
5. Fractions with low boiling point rise higher and condense near the top.

Fractions of Petroleum:

Fraction	Boiling Point	Use
Petroleum Gas	Below 30°C	LPG / Fuel
Gasoline / Petrol	30 – 200°C	Car fuel
Kerosene	175 – 275°C	Jet fuel, stoves
Diesel	250 – 350°C	Diesel engines
Lubricating Oil	300 – 370°C	Lubrication
Fuel Oil	370 – 400°C	Ships, industry
Bitumen / Asphalt	Above 400°C	Road making
