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CLASS XII CHEMISTRY NOTES

GENERAL PRINCIPLES AND
PROCESSES OF ISOLATION
OF ELEMENTS

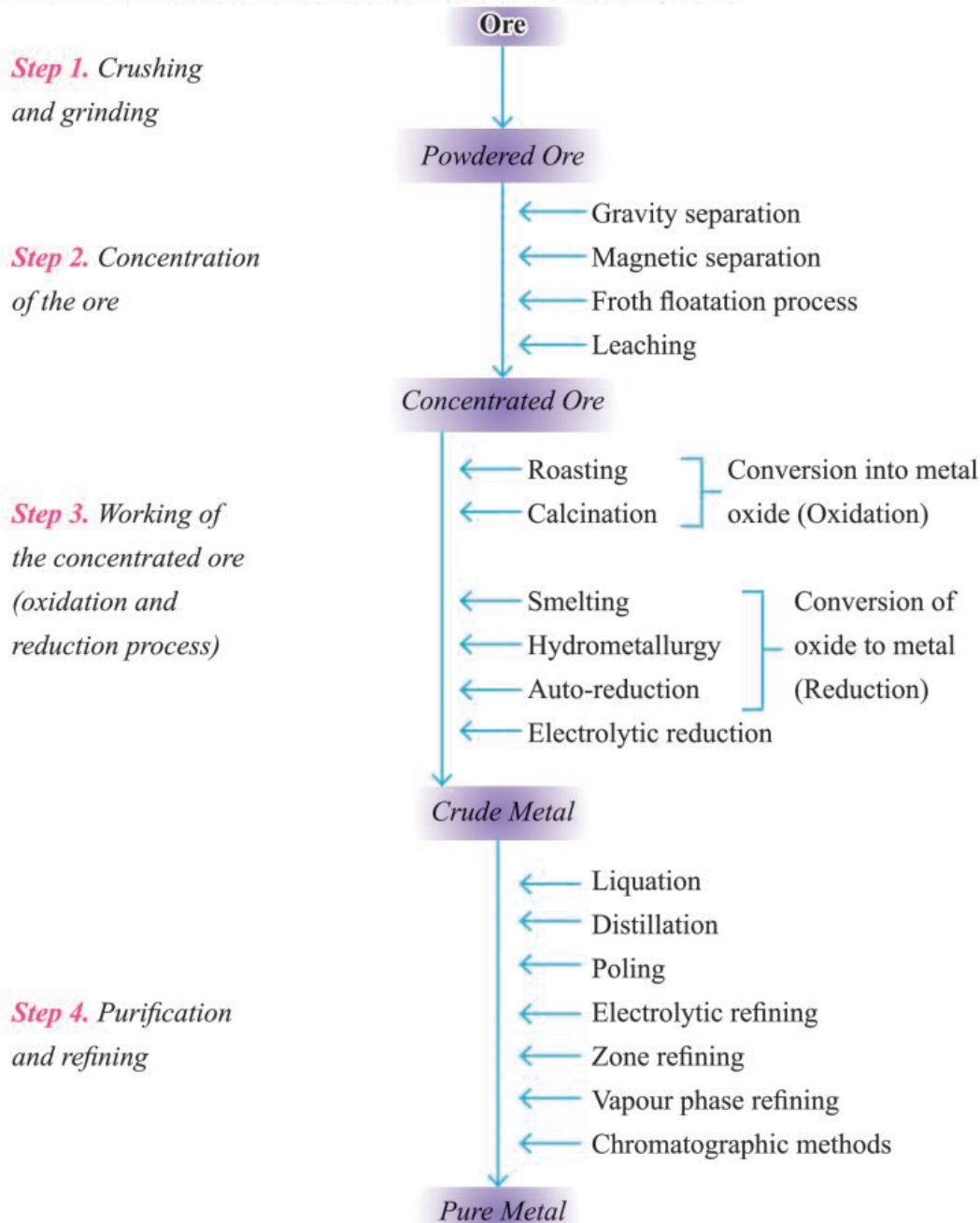
KEY NOTES AND IMPORTANT
QUESTIONS WITH ANSWERS



UNIT-6

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

Flow-sheet diagram of metallurgical process is given below :



General Types of Ores of Metals

Type of Ore	Metal	Name of ore
1. Oxides	Iron	Haematite, Fe_2O_3
	Aluminium	Bauxite, $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
	Copper	Cuprite, Cu_2O
	Zinc	Zincite, ZnO
	Manganese	Pyrolusite, MnO_2
2. Sulphides	Copper	Copper pyrites, CuFeS_2
	Lead	Galena, PbS
	Zinc	Zinc blende, ZnS
	Mercury	Cinnabar, HgS
3. Carbonates	Iron	Siderite, FeCO_3
	Copper	Malachite, $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$
	Calcium	Limestone, CaCO_3
	Magnesium	Dolomite, $\text{MgCO}_3 \cdot \text{CaCO}_3$
4. Chloride	Sodium	Rock salt, NaCl
	Magnesium	Carnallite, $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
	Silver	Horn silver, AgCl
5. Sulphates	Calcium	Gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
	Lead	Anglesite, PbSO_4
6. Silicates	Magnesium	Calcium magnesium silicate, $\text{CaSiO}_3 \cdot 3\text{MgSiO}_3$ (Asbestos)

Various Types of Steel

Type of Steel	Carbon content	Properties	Uses
Mild Steel (Medium carbon)	0.2-0.5%	(i) It can be hardened by heat treatment. (ii) It has a good machining property. (iii) It is very good for welding.	(i) Lightly stressed machine fittings, turbine, motors, steel) railway axels, crank shafts, fish plates, cross heads, etc.
Hard Steel	0.5-0.7%	(i) It can be imparted desired hardness by heat treatment. (ii) It can be welded with a great care. Extremely hard	Wheels for railways service, cushion springs, clutch springs, dies, set screws, etc.
Chrome Steel	1.5-2% Cr		For making armour – piercing projectiles, crushing machinery and cutlery.
Stainless Steel	11.5% Cr 2% Ni	Resists corrosion	For making cutlery, utensils, surgical instruments, auto-mobile parts and cycle parts.

Note : NaCN is used as depressant when an ore contains both ZnS and PbS. It selectively prevents ZnS from coming to the froth but allows PbS to come with the froth in froth floatation process.

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

Q. 1. Name three metals which occur in native state in nature.

Ans. Au, Ag and Pt.

Q. 2. What are collectors in froth floatation process ? Give one example.

Ans. Pine oil.

Q. 3. Give the names and formulae of three ores which are concentrated by froth floatation process.

Ans. Galena (PbS), Zinc blende (ZnS), Cinnabar (HgS).

Q. 4. Among Fe, Cu, Al and Pb, which metal(s) cannot be obtained by smelting ?

Ans. Al.

Q. 5. What is the thermodynamic criteria for the feasibility of a reaction ?

Ans. ΔG should be -ve or $\log K = +ve$.

Q. 6. Why can't aluminium be reduced by carbon ?

[Hint : Al is stronger reducing agent than carbon.]

Q. 7. Name the most important form of iron. Mention its one use.

Ans. Cast iron is used for making gutter pipes, castings, railway sleepers, toys etc.

Q. 8. Name the impurities present in bauxite ore.

Ans. SiO_2 , Fe_2O_3 and TiO_2 .

Q. 9. What is the composition of copper matte ?

[Hint : Cu_2S and FeS]

Q. 10. Which form of copper is called blister copper ?

[Hint : The solidified copper obtained has blistered appearance due to the evolution of SO_2 , so it is called blistered copper.]

Q. 11. What are froth stabilizers ? Give two examples.

[Hint : Examples are cresol and aniline.]

Q. 12. A sample of galena is contaminated with zinc blende. Name one chemical which can be used to concentrate galena selectively by froth floatation method.

Ans. NaCN

Q. 13. What are the constituents of German silver ?

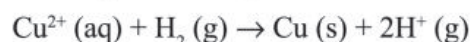
Ans. Cu = 25-30%, Zn = 25-30%, Ni = 40-50%]

Q. 14. Why is froth floatation process selected for concentration of the sulphide ore ?

Ans. Sulphide ore particles are wetted by oil (Pine oil) and gangue particles by water.

Q. 15. Write the reaction involved in the extraction of copper from low grade ores.

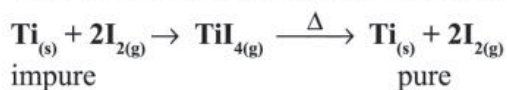
Ans. First step is leaching of ore with acid or bacteria then,



Q. 16. Although aluminium is above hydrogen in the electrochemical series, it is stable in air and water. Why ?

[Hint : Due to formation of inert oxide Al_2O_3 .]

Q. 17. Which method of purification is represented by the following reaction :



[Hint : Van Arkel method]

Q. 18. Zinc is used but not copper for the recovery for metallic silver from the complex $[\text{Ag}(\text{CN})_2]^-$, although electrode potentials of both zinc and copper are less than that of Ag. Explain why ?

[Hint : Zinc reacts at faster rate as compared with copper, further zinc is cheaper than copper.]

Q. 19. Write the composition of molten mixture which is electrolysed to extract aluminium.

[Hint : Molten $\text{Al}_2\text{O}_3 + \text{Na}_3\text{AlF}_6$ or CaF_2]

SHORT ANSWER-I TYPE QUESTIONS (2 Marks)

Q. 1. What is hydrometallurgy ? Give one example where it is used for metal extraction.

Ans. Leaching followed by reduction is called hydrometallurgy. It is used in extraction of copper.

Q. 2. Name the process for the benefaction/concentration of (i) an ore having lighter impurities, (ii) sulphide ore.

[Hint : (i) Gravity separation
(ii) Froth floatation]

Q. 3. Mention the role of cryolite in the extraction of aluminium.

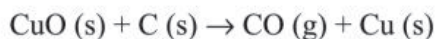
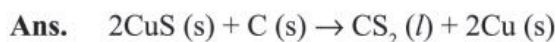
[Hint : It lowers the melting point of the mixture and brings conductivity.]

Q. 4. Mention the role of following :

- (a) SiO_2 in the metallurgy of Cu.
- (b) CaCO_3 in the metallurgy of Fe.
- (c) CO in the metallurgy of iron.
- (d) I_2 in the purification of zirconium.

[Hint : (a) Flux
(b) CaCO_3 decomposed to CaO, which acts as flux.
(c) Reducing agent
(d) To form a volatile complex with Zr.]

Q. 5. Extraction of copper directly from sulphide ore is less favourable than from its oxide through reduction. Explain.



G value is more -ve in second case as compared with first case.

Q. 6. The graphite electrodes in the extraction of 'aluminium' by Hall-Heroult process need to be changed frequently. Why ?

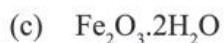
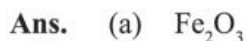
Q. 7. Write the chemical formulae of the following ores :

(a) Haematite

(b) Magnetite

(c) Limonite

(d) Siderite



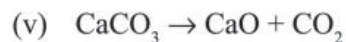
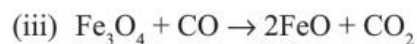
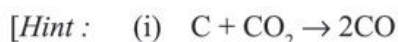
Q. 8. Give equations for the industrial extraction of zinc from calamine.



Q. 9. Name the elements present in anode mud during refining of copper. Why does it contain such elements ?

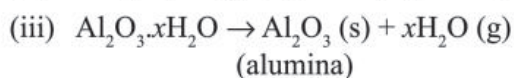
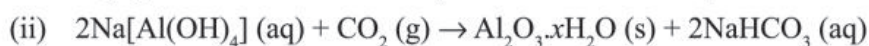
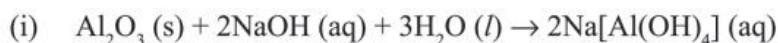
Ans. Au and Ag. They are not oxidized at anode. They are less electropositive than copper.

Q. 10. Write the chemical reactions taking place in different zones in the blast furnace for the extraction of iron from its ore.



Q. 11. How are impurities separated from bauxite ore to get pure alumina ?

[Hint : By leaching.



Q. 12. Why is the reduction of a metal oxide easier if metal formed is in liquid state at the temperature of reduction ?

[Hint : Entropy is more positive when the metal is in liquid state as compared with solid state, so ΔG becomes more -ve.]

Q. 13. What is pyrometallurgy ? Explain with one example.

Ans. A process of reducing a metal oxide by heating with either coke or some other reducing agent. *E.g.*, Al, Mg etc.



Q. 14. Write the method to produce copper matte from copper pyrites.

[Hint : Froth floatation.]

Q. 15. Copper can be extracted by hydrometallurgy but not zinc. Explain why ?

[Hint : $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -\text{ve}$, $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +\text{ve}$]

Q. 16. Gibbs energy of formation G_f° of MgO (s) and CO (g) at 1273 K and 2273 K are given below :

$$G_f^\circ [\text{MgO (s)}] = -941 \text{ kJ mol}^{-1} \text{ at } 1273 \text{ K}$$

$$G_f^\circ [\text{CO (g)}] = -439 \text{ kJ mol}^{-1} \text{ at } 1273 \text{ K}$$

$$G_f^\circ [\text{MgO (s)}] = -314 \text{ kJ mol}^{-1} \text{ at } 2273 \text{ K}$$

$$G_f^\circ [\text{CO (g)}] = -628 \text{ kJ mol}^{-1} \text{ at } 2273 \text{ K}$$

On the basis of above data, predict the temperature at which carbon can be used as a reducing agent for MgO (s).

Ans. For the reaction, $\text{MgO (s)} + \text{C (s)} \rightarrow \text{Mg (s)} + \text{CO (g)}$

At 1273 K, $G_r = G_f^\circ [\text{CO (g)}] - G_f^\circ [\text{MgO (s)}] = -439 - (-941) \text{ kJ mol}^{-1} = 502 \text{ kJ mol}^{-1}$

At 2273 K, $G_r = -628 - (-314) \text{ kJ mol}^{-1} = -314 \text{ kJ mol}^{-1}$

The temperature is 2273 K.

SHORT ANSWER-II TYPE QUESTIONS (3 Marks)

Q. 1. State the principle of refining of metal by the following methods :

- Zone refining
- Electrolytic refining
- Vapour phase refining

[Hint : (a) The impurities are more soluble in the melt than in the solid state of the metal.

(b) Impure metal is made to act as anode, while the strip of same metal in pure form as cathode.]

Q. 2. How is pure copper obtained from its principle ore ? Write the chemical reactions occurring during the extraction.

[Hint : (i) $2\text{CuFeS}_2 + \text{O}_2 \rightarrow \text{Cu}_2\text{S} + 2\text{FeS} + \text{O}_2$

(ii) $\text{Cu}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$

(iii) $\text{Cu}_2\text{O} + \text{C} \rightarrow 2\text{Cu} + \text{CO}$

(iv) $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$]

Q. 3. Name the method of refining of the following metals :

(a) Hg (b) Sn (c) Cu (d) Ge (e) Ni (f) Zr

Ans. (a) Distillation, (b) Liquation, (c) Electrolytic refining, (d) Zone refining, (e) Mond process, (f) Van Arkel process]

Q. 4. The native silver forms a water soluble compound (B) with dilute aqueous solution of NaCN in the presence of a gas (A). The silver metal is obtained by the addition of a metal (C) to (B) and complex (D) is formed as a byproduct. Write the structures of (C) and (D) and identify (A) and (B) in the following sequence :

$\text{Ag} + \text{NaCN} + [\text{A}] + \text{H}_2\text{O} \rightarrow [\text{B}] + \text{OH}^- + \text{Na}^+ [\text{C}] + [\text{B}][\text{D}] + \text{Ag}$

Ans. $[\text{A}] = \text{O}_2$

$[\text{B}] = \text{Na}[\text{Ag}(\text{CN})_2]$

$[\text{C}] = \text{Zn}$

$[\text{D}] = \text{Na}_2[\text{Zn}(\text{CN})_4]$

Q. 5. In the cyanide extraction process of silver ore argentite from, name the oxidizing and reducing agents. Write the chemical equations of the reactions involved.

[Hint : $4\text{Ag} + 8\text{NaCN} + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{Na}[\text{Ag}(\text{CN})_2] + 4\text{NaOH}$

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

(i) Oxidising agent – O_2 (ii) Reducing agent = Zn

