

B. Sc. Part-I (Sub.), Paper-I, Group-B (Inorganic Chemistry)

Unit: 2 Chemistry of Elements: Tin (Sn)

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⇒ Position of Tin (Sn) in Periodic table (PT):

Electronic Configuration of Sn<sub>50</sub>: [Kr]<sub>36</sub> 4d<sup>10</sup>5s<sup>2</sup>5p<sup>2</sup>, No. of valence electrons = 4  
No. of Orbitals = 5, Period = 5, Since last electron enters in p-subshell/orbital, so block is p. For p-block, Group = ns + np + 10 = 2 + 2 + 10 = 14. Thus, tin (Sn) is placed in group 14 under p-block in <sup>the</sup> modern PT along with Carbon (C), Silicon (Si), Germanium (Ge), Lead (Pb) & Flerovium (Fl). Position of tin in group-14 is justified on the basis of following similarity and gradation properties:

- (i) They show similar outer electronic configuration ns<sup>2</sup>np<sup>2</sup> (n = 2 to 7).
- (ii) They show common oxidation state: +4
- (iii) They form oxides of type MO<sub>2</sub> with air or oxygen.  $M + O_2 \xrightarrow{\Delta} MO_2$  (M = C, Si, Ge, Pb)
- (iv) They form tetrachloride (MCl<sub>4</sub>) with chlorine (Cl<sub>2</sub>). Their stability decrease from C to Pb.
- (v) Electronegativity decrease from C to Pb and metallic property increase from C to Pb.

⇒ Ores of Tin: Tin does not occur free state, but found in combined states in nature. Its important or chief ores are:

1. Oxide form/ore: Cassiterite or Tin stone (SnO<sub>2</sub>), contains 78% Sn.
2. Sulphide form/ore: Tin pyrites (SnS<sub>2</sub>·Cu<sub>2</sub>S·FeS), contains 35% Sn.

⇒ Extraction of Tin: Tin metal is mainly extracted from tin stone ore. It involves following steps:

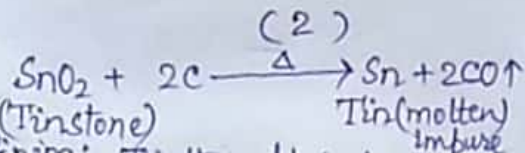
Step-1 Concentration of Ore: The tin stone ore contains 6-10% SnO<sub>2</sub>. The rest is worthless gangue (sand & earthy matter), tungstates of Fe & Mo, FeS<sub>2</sub> etc. The powdered ore is made free from the impurities by following methods:

(a) Gravity separation method: The powdered ore is washed in a stream of water when the lighter sand and earthy matter flows away while the heavier ore particles settle to the bottom.

(b) Electromagnetic separation process: The magnetic impurities of Wolframite (FeWO<sub>4</sub>) are removed by this method. The washed ore is dropped on a brass/leather belt moving over electromagnetic rollers. The wolframite particles being attracted by the magnet fall in separate heap near the magnetic rollers.

Step-2 Roasting: The concentrated ore is roasted in a large rotating furnace which is slowly heated in the beginning in a free supply of air to oxidise S to SO<sub>2</sub> and As to As<sub>2</sub>O<sub>3</sub>, which volatilize off.  $S + O_2 \xrightarrow{\Delta} SO_2 \uparrow$ ;  $4As + 3O_2 \xrightarrow{\Delta} 2As_2O_3 \uparrow$

Step-3 Smelting: The roasted ore is mixed with anthracite coke in the ratio of 1:4, and <sup>(Arsenous Oxide)</sup> the mixture is subjected to heat in a reverberatory furnace when tin oxide is reduced to the metallic tin. A small amount of lime is also added as flux. The molten Sn (tin) metal is tapped out of the furnace.

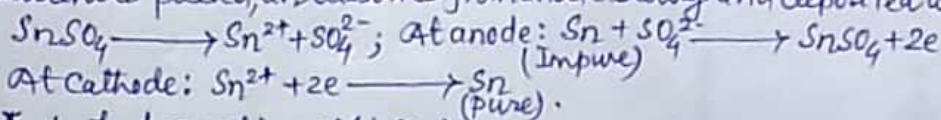


**Step 4 Refining:** Tin thus obtained is crude and contains Fe, Cu, S, As, W as chief impurities. Crude tin is purified in the following successive methods:

(a) **Liquation:** The crude tin is first treated on the sloping hearth of reverberatory furnace when the easily fusible tin melts at  $232^\circ\text{C}$  and flows away, leaving behind the impurities such as Cu, Fe, etc.

(b) **Poling:** The molten tin is stirred by poles of green wood whereby the impurities of Cu, Fe etc. are oxidised and rise to the surface as scum, and removed. Tin thus obtained is 99% pure.

(c) **Electrolytic refining:** Blocks of impure tin are suspended from the anode of an electrolytic bath containing a solution of tin sulphate ( $\text{SnSO}_4$ ) with a little of glue and phospho sulphonic acid in dilute  $\text{H}_2\text{SO}_4$ , the cathode is a sheet of pure tin (tin). When electric current is passed, tin dissolves from anode slowly and deposited at the cathode.

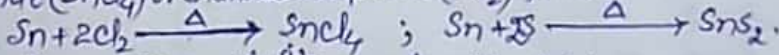


⇒ **Important reactions of tin (Sn):** 1. Tin is a white, shining, soft metal (M.P.  $232^\circ\text{C}$ ), <sup>(pure/impure)</sup>

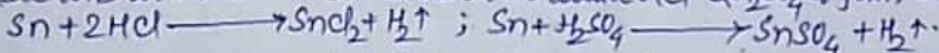
2. **Reaction with air/O<sub>2</sub>:** Tin does not react with dry air (O<sub>2</sub>) at ordinary temp, but <sup>(impure tin)</sup> turns black in moist air. On heating it in air, SnO<sub>2</sub> (tin dioxide) is formed.  $\text{Sn} + \text{O}_2 \xrightarrow{\Delta} \text{SnO}_2$

3. **Reaction with water:** It does not react with water at any temp, but red hot tin decomposes steam with the evolution of H<sub>2</sub>.  $\text{Sn} + 2\text{H}_2\text{O} \longrightarrow \text{SnO}_2 + 2\text{H}_2\uparrow$

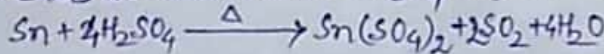
4. **Reaction with non-metals:** On heating tin with Cl<sub>2</sub> gas or sulphur vapours, stannic chloride (SnCl<sub>4</sub>) or stannic sulphide (SnS<sub>2</sub>) formed.



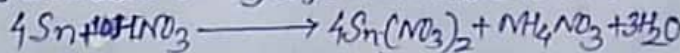
5. **Reactions with acids:** (i) It reacts with dilute HCl & H<sub>2</sub>SO<sub>4</sub> to form stannous salts.



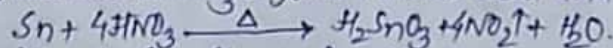
(ii) It reacts with concentrated H<sub>2</sub>SO<sub>4</sub> to form stannic sulphate & SO<sub>2</sub> gas evolved.



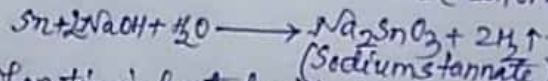
(iii) It reacts with dilute HNO<sub>3</sub> to form stannous nitrate & ammonium nitrate.



It reacts with conc. HNO<sub>3</sub> to form stannic acid and nitrogen dioxide (NO<sub>2</sub>) evolved.



6. **Reaction with alkali:** It reacts with caustic alkali (NaOH or KOH) to form stannate salt and H<sub>2</sub> gas evolved.



7. **Reaction with HgCl<sub>2</sub>:** When tin is heated with mercuric chloride (HgCl<sub>2</sub>), stannous chloride is formed.  $\text{HgCl}_2 + \text{Sn} \xrightarrow{\Delta} \text{SnCl}_2 + \text{Hg}\downarrow$

⇒ **uses/Applications of Tin:** Main applications/uses of tin are-

(i) It is used in preventing corrosion of iron sheets/tin plating.

(ii) Tin foils are used as wrappers (iii) In making alloys; solder (Pb + Sn), bronze (Cu + Sn) etc.