

1. Which of the following metals can be extracted through alkali leaching technique?

[2023 (08 Apr Shift 1)]

- (1) Sn
- (2) Pb
- (3) Au
- (4) Cu

2. In Hall-Heroult process, the following is used for reducing  $Al_2O_3$  :-

[2023 (08 Apr Shift 2)]

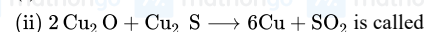
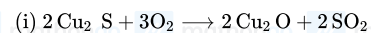
- (1) Magnesium
- (2)  $Na_3AlF_6$
- (3) Graphite
- (4)  $CaF_2$

3. Which of the following is used as a stabilizer during the concentration of sulphide ores?

[2023 (10 Apr Shift 1)]

- (1) Pine oils
- (2) Fatty acids
- (3) Xanthates
- (4) Cresols

4. In the extraction process of copper, the product obtained after carrying out the reactions



[2023 (11 Apr Shift 1)]

- (1) Blister copper
- (2) Reduced copper
- (3) Copper scrap
- (4) Copper matte

5. Given below are two statements:

**Statement I:** In the metallurgy process, sulphide ore is converted to oxide before reduction.

**Statement II:** Oxide ores in general are easier to reduce.

In the light of the above statements, choose the most appropriate answer from the options given below:

[2023 (11 Apr Shift 2)]

- (1) **Statement I** is correct but **Statement II** is incorrect
- (2) Both **Statement I** and **Statement II** are incorrect
- (3) **Statement I** is incorrect but **Statement II** is correct
- (4) Both **Statement I** and **Statement II** are correct

6. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R

Assertion A: In the Ellingham diagram, a sharp change in slope of the line is observed from  $Mg \rightarrow MgO$  at  $-1120^\circ C$

Reason R: There is a large change of entropy associated with the change of state

In the light of the above statements, choose the correct answer from the options given below

[2023 (12 Apr Shift 1)]

- (1) Both A and R are true but R is NOT the correct explanation of A
- (2) A is false but R is true
- (3) Both A and R are true and R is the correct explanation of A
- (4) A is true but R is false

7. Which one of the following is most likely a mismatch?

[2023 (13 Apr Shift 1)]

- (1) Zinc-Liquation
- (2) Copper-Electrolysis
- (3) Nickel-Mond process
- (4) Titanium-van Arkel Method

8. Given below are two statements related to Ellingham diagram :
- Statement I : Ellingham diagrams can be constructed for formation of oxides, sulphides and halides of metals.
- Statement II : It consists of plots of  $\Delta H^\circ$  vs T for formation of oxides of elements.

In the light of the above statements, choose the most appropriate answer from the options given below :

[2023 (13 Apr Shift 2)]

- (1) Both Statement I and Statement II are correct
  - (2) Both Statement I and Statement II are incorrect
  - (3) Statement I is correct but Statement II is incorrect
  - (4) Statement I is incorrect but Statement II is correct
9. Which one of the following is not an example of calcination?

[2023 (15 Apr Shift 1)]

- (1)  $\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$
- (2)  $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O} \xrightarrow{\Delta} \text{Fe}_2\text{O}_3 + x\text{H}_2\text{O}$
- (3)  $2\text{PbS} + 3\text{O}_2 \xrightarrow{\Delta} 2\text{PbO} + 2\text{SO}_2$
- (4)  $\text{CaCO}_3 \cdot \text{MgCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{MgO} + 2\text{CO}_2$

**ANSWER KEYS**

1. (1)      2. (3)      3. (4)      4. (1)      5. (4)      6. (3)      7. (1)      8. (3)  
 9. (3)

1. (1)  
 Leaching is often used if the ore is soluble in some suitable solvent. The ore of tin metal is cassiterite ( $\text{SnO}_2$ ). Cassiterite is readily soluble in alkali. The reaction is shown below.  

$$\text{SnO}_2 + 2\text{NaOH} + 2\text{H}_2\text{O} \rightarrow \text{Na}_2[\text{Sn}(\text{OH})_6]$$

2. (3)  
 The process of extracting Al metal by electrolysis of a mixture of purified  $\text{Al}_2\text{O}_3$  and  $\text{Na}_3\text{AlF}_6$  is known as Hall and Heroult process. Graphite is used as anode which is useful in the reduction of alumina oxide to the Al metal. The graphite electrode reacts with the oxygen released at cathode to form carbon dioxide and carbon monoxide. Therefore, the role of graphite as an anode in the extraction of Al is to check the formation of oxygen. In other words, we can say its role is to prevent the oxidation of Al back to  $\text{Al}_2\text{O}_3$  by oxygen.

3. (4)  
 Froth flotation is a process for selectively separating hydrophobic materials from hydrophilic. The principle of froth flotation process is that sulphide ores are preferentially wetted by the pine oil, whereas the gangue particles are wetted by the water. Cresols and aniline are used as froth stabilisers.

4. (1) The copper(I) sulphide produced is converted to copper with a final blast of air. The end product of this is called blister copper - a porous brittle form of copper, about 98 – 99.5% pure. The reactions given are carried out in the production of blister copper using self reduction.

5. (4)  
 Both **Statement I** and **Statement II** are correct.  
 In many metallurgical processes, sulphide ores are first converted to oxide ores through a process known as roasting or calcination. The conversion of sulphide ore to oxide ore is done to remove the sulphur and simplify the subsequent reduction process. Oxide ores are generally easier to reduce compared to sulphide ores. This is because oxygen is already bonded to the metal in oxide ores, making it easier to remove the oxygen and extract the metal through reduction reactions.



For line II  $\Delta S$  is more negative than line I. In the Ellingham diagram, a sharp change in slope of the line is observed for Mg – MgO at  $-1120^\circ\text{C}$  because that is the boiling point of magnesium.

From diagram,

$$\Delta S_{\text{I}} = (S_{\text{solid}}) - (S_{\text{solid}} + S_{\text{gas}})$$

$$\Delta S_{\text{II}} = (S_{\text{liquid}}) - (S_{\text{solid}} + S_{\text{gas}})$$

There is a large increase in entropy associated with the change of state of magnesium. So, both Assertion (A) and Reason (R) are true and (R) is the correct explanation of (A).

7. (1) Mond's process involves the combination of carbon monoxide with nickel readily and reversibly and gives nickel tetracarbonyl. This process is used to extract and purify nickel.

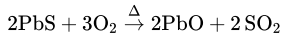
The Van Arkel technique is used to refine Zirconium or Titanium. Impurities found in Zirconium or Titanium in the form of nitrogen and oxygen are eliminated using this technique.

Copper is purified by electrolysis. Electricity is passed through solutions containing copper compounds, such as copper sulphate. The anode (positive electrode) is made from impure copper and the cathode (negative electrode) is made from pure copper.

Mercury and zinc are purified by distillation method. Liquation is a metallurgical method to remove lead containing silver from copper and remove antimony minerals from ore.

8. (3) An Ellingham diagram is a graph showing the temperature dependence of the stability of compounds. Ellingham diagrams can be drawn for Sulphides, Oxides and Halides. The Ellingham diagram is a graph that shows how the  $\Delta G_f^0$  varies with temperature as a result of the formation of elemental oxides.

9. (3) Calcination is a process in which ore is heated in the absence of air or air might be supplied in a limited quantity. Roasting involves the heating of ore lower than its melting point in the presence of air or oxygen.



The above reaction is an example of roasting. Rest all the reactions are heated in the absence of oxygen.