

**METALLURGY**

- Which of the following ore is concentrated using group 1 cyanide salt ?  
 (1) Sphalerite (2) Calamine  
 (3) Siderite (4) Malachite
- $Al_2O_3$  was leached with alkali to get X. The solution of X on passing of gas Y, forms Z. X, Y and Z respectively are :  
 (1)  $X = Na[Al(OH)_4]$ ,  $Y = SO_2$ ,  $Z = Al_2O_3$   
 (2)  $X = Na[Al(OH)_4]$ ,  $Y = CO_2$ ,  $Z = Al_2O_3 \cdot xH_2O$   
 (3)  $X = Al(OH)_3$ ,  $Y = CO_2$ ,  $Z = Al_2O_3$   
 (4)  $X = Al(OH)_3$ ,  $Y = SO_2$ ,  $Z = Al_2O_3 \cdot xH_2O$
- The major components in "Gun Metal" are :  
 (1) Cu, Zn and Ni (2) Cu, Sn and Zn  
 (3) Al, Cu, Mg and Mn (4) Cu, Ni and Fe
- Match List-I with List-II.  

List-I (Metal)	List-II (Ores)
(a) Aluminium	(i) Siderite
(b) Iron	(ii) Calamine
(c) Copper	(iii) Kaolinite
(d) Zinc	(iv) Malachite

Choose the correct answer from the options given below:  
 (1) (a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)  
 (2) (a)–(ii), (b)–(iv), (c)–(i), (d)–(iii)  
 (3) (a)–(i), (b)–(ii), (c)–(iii), (d)–(iv)  
 (4) (a)–(iii), (b)–(i), (c)–(iv), (d)–(ii)
- Ellingham diagram is a graphical representation of:  
 (1)  $\Delta H$  vs T (2)  $\Delta G$  vs T  
 (3)  $\Delta G$  vs P (4)  $(\Delta G - T\Delta S)$  vs T
- The major components of German Silver are :  
 (1) Ge, Cu and Ag (2) Zn, Ni and Ag  
 (3) Cu, Zn and Ni (4) Cu, Zn and Ag
- The method used for the purification of Indium is :  
 (1) van Arkel method  
 (2) liquation  
 (3) zone refining  
 (4) vapour phase refining

- Match List -I with List - II  

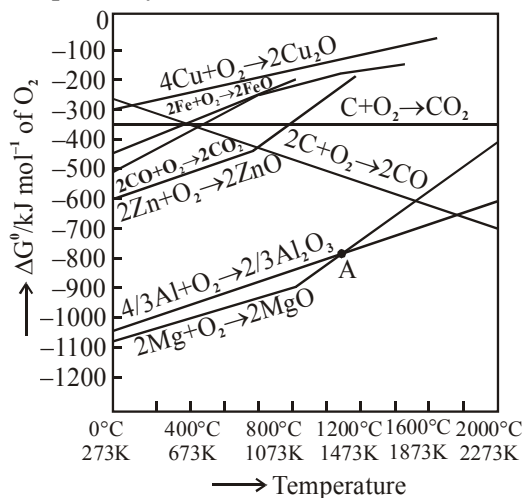
List - I (Ore)	List - II (Element Present)
(a) Kernite	(i) Tin
(b) Cassiterite	(ii) Boron
(c) Calamine	(iii) Fluorine
(d) Cryolite	(iv) Zinc

Choose the most appropriate answer from the options given below.  
 (1) (a) → (i), (b) → (iii), (c) → (iv), (d) → (ii)  
 (2) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)  
 (3) (a) → (ii), (b) → (iv), (c) → (i), (d) → (iii)  
 (4) (a) → (iii), (b) → (i), (c) → (ii), (d) → (iv)
- Match List-I with List-II.  

List-I	List-II
(a) Siderite	(i) Cu
(b) Calamine	(ii) Ca
(c) Malachite	(iii) Fe
(d) Cryolite	(iv) Al
	(v) Zn

Choose the correct answer from the options given below :  
 (1) (a)→(iii), (b)→(i), (c)→(v), (d)→(ii)  
 (2) (a)→(i), (b)→(ii), (c)→(v), (d)→(iii)  
 (3) (a)→(iii), (b)→(v), (c)→(i), (d)→(iv)  
 (4) (a)→(i), (b)→(ii), (c)→(iii), (d)→(iv)
- The process that involves the removal of sulphur from the ores is :  
 (1) Smelting (2) Roasting  
 (3) Leaching (4) Refining
- Which of the following reduction reaction CANNOT be carried out with coke ?  
 (1)  $Al_2O_3 \rightarrow Al$  (2)  $ZnO \rightarrow Zn$   
 (3)  $Fe_2O_3 \rightarrow Fe$  (4)  $Cu_2O \rightarrow Cu$

12. The point of intersection and sudden increase in the slope, in the diagram given below, respectively, indicates :



- (1)  $\Delta G = 0$  and melting or boiling point of the metal oxide  
 (2)  $\Delta G > 0$  and decomposition of the metal oxide  
 (3)  $\Delta G < 0$  and decomposition of the metal oxide  
 (4)  $\Delta G = 0$  and reduction of the metal oxide

13. Match List-I and List-II :

List-I	List-II
(a) Haematite	(i) $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
(b) Bauxite	(ii) $\text{Fe}_2\text{O}_3$
(c) Magnetite	(iii) $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$
(d) Malachite	(iv) $\text{Fe}_3\text{O}_4$

Choose the correct answer from the options given below :

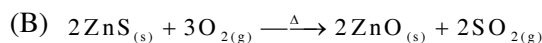
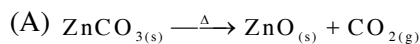
- (1) (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv)  
 (2) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)  
 (3) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)  
 (4) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
14. The chemical that is added to reduce the melting point of the reaction mixture during the extraction of aluminium is :
- (1) Cryolite                      (2) Bauxite  
 (3) Calamine                    (4) Kaolite

15. Match list-I with list-II :

List-I	List-II
(a) Mercury	(i) Vapour phase refining
(b) Copper	(ii) Distillation refining
(c) Silicon	(iii) Electrolytic refining
(d) Nickel	(iv) Zone refining

Choose the most appropriate answer from the option given below :

- (1) a-i, b-iv, c-ii, d-iii      (2) a-ii, b-iii, c-i, d-iv  
 (3) a-ii, b-iii, c-iv, d-i      (4) a-ii, b-iv, c-iii, d-i
16. The metal that can be purified economically by fractional distillation method is :
- (1) Fe      (2) Zn      (3) Cu      (4) Ni
17. Consider two chemical reactions (A) and (B) that take place during metallurgical process :



The **correct** option of names given to them respectively is :

- (1) (A) is calcination and (B) is roasting  
 (2) Both (A) and (B) are producing same product so both are roasting  
 (3) Both (A) and (B) are producing same product so both are calcination  
 (4) (A) is roasting and (B) is calcination
18. Sulphide ion is soft base and its ores are common for metals.

(a) Pb      (b) Al      (c) Ag      (d) Mg

Choose the **correct** answer from the options given below :

- (1) (a) and (c) only      (2) (a) and (d) only  
 (3) (a) and (b) only      (4) (c) and (d) only
19. In the leaching of alumina from bauxite, the ore expected to leach out in the process by reacting with NaOH is :

(1)  $\text{TiO}_2$                               (2)  $\text{Fe}_2\text{O}_3$   
 (3) ZnO                                (4)  $\text{SiO}_2$

20. Match List I with List II : (Both having metallurgical terms)

	List-I		List-II
(a)	Concentration of Ag ore	(i)	Reverberatory furnace
(b)	Blast furnace	(ii)	Pig iron
(c)	Blister copper	(iii)	Leaching with dilute NaCN solution
(d)	Froth floatation method	(iv)	Sulfide ores

Choose the correct answer from the options given below :

- (1) (a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)
- (2) (a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)
- (3) (a)–(iv), (b)–(i), (c)–(iii), (d)–(ii)
- (4) (a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)

21. The statement that is INCORRECT about Ellingham diagram is

- (1) provides idea about the reaction rate.
- (2) provides idea about free energy change.
- (3) provides idea about changes in the phases during the reaction.
- (4) provides idea about reduction of metal oxide.

22. The addition of silica during the extraction of copper from its sulphide ore :-

- (1) converts copper sulphide into copper silicate
- (2) converts iron oxide into iron silicate
- (3) reduces copper sulphide into metallic copper
- (4) reduces the melting point of the reaction mixture

23. Given below are two statements.

**Statement I:** The choice of reducing agents for metals extraction can be made by using Ellingham diagram, a plot of  $\Delta G$  vs temperature.

**Statement II:** The value of  $\Delta S$  increases from left to right in Ellingham diagram.

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

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

24. Given below are two statements :

**Statement I :** Sphalerite is a sulphide ore of zinc and copper glance is a sulphide ore of copper.

**Statement II :** It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants' in a froth floatation method.

Choose the **most appropriate** answer from the options given below :

- (1) **Statement I** is true but **Statement II** is false.
- (2) Both **Statement I** and **Statement II** are true.
- (3) **Statement I** is false but **Statement II** is true.
- (4) Both **Statement I** and **Statement II** are false.

25. Which refining process is generally used in the purification of low melting metals ?

- (1) Chromatographic method
- (2) Liqueation
- (3) Electrolysis
- (4) Zone refining

26. Match List-I with List – II :

List-I (Name of ore/mineral)	List-II (Chemical formula)
(a) Calamine	(i) Zns
(b) Malachite	(ii) $\text{FeCO}_3$
(c) Siderite	(iii) $\text{ZnCO}_3$
(d) Sphalerite	(iv) $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$

Choose the **most appropriate** answer from the options given below :

- (1) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)
- (2) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
- (3) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)
- (4) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

27. In the electrolytic refining of blister copper, the total number of main impurities, from the following, removed as anode mud is \_\_\_\_\_

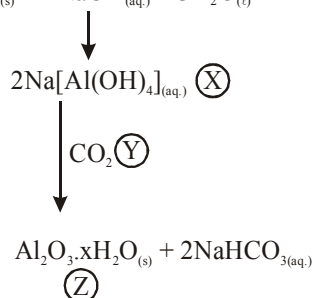
Pb, Sb, Se, Te, Ru, Ag, Au and Pt

28. Calamine and Malachite, respectively, are the ores of :

- (1) Nickel and Aluminium
- (2) Zinc and Copper
- (3) Copper and Iron
- (4) Aluminium and Zinc

**SOLUTION****1. Official Ans. by NTA (1)****Sol.** Sphalerite ore : ZnSCalamine ore : ZnCO<sub>3</sub>Siderite ore : FeCO<sub>3</sub>Malachite ore : Cu(OH)<sub>2</sub>·CuCO<sub>3</sub>

It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants'. In case of an ore containing ZnS and PbS, the depressant used is NaCN.

**2. Official Ans. by NTA (2)****Sol.** Al<sub>2</sub>O<sub>3(s)</sub> + 2NaOH<sub>(aq)</sub> + 3H<sub>2</sub>O<sub>(l)</sub>

So

X : Na[Al(OH)<sub>4</sub>]Y : CO<sub>2</sub>Z : Al<sub>2</sub>O<sub>3</sub>·xH<sub>2</sub>O**3. Official Ans. by NTA (2)****Sol.** The major components in "Gun Metal" are

Cu : 87%

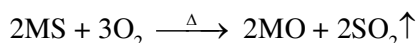
Zn : 3%

Sn : 10%

**4. Official Ans. by NTA (4)****Sol.** Siderite – FeCO<sub>3</sub>Calamine – ZnCO<sub>3</sub>Kaolinite – Al<sub>2</sub>(OH)<sub>4</sub>·Si<sub>2</sub>O<sub>5</sub>Malachite – Cu(OH)<sub>2</sub>·CuCO<sub>3</sub>**5. Official Ans. by NTA (2)****Sol.** Ellingham diagram is a graphical representation of ΔG vs T when metal heated with oxygen to form metal oxide**6. Official Ans. by NTA (3)****Sol.** Major components of German silver are:

Cu, Zn, Ni

(50%) (30%) (20%)

**7. Official Ans. by NTA (3)****Sol.** Zone refining is used for the purification of indium.**8. Official Ans. by NTA (2)****Sol.** Kernite = Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub>·4H<sub>2</sub>OCassiterite = SnO<sub>2</sub>Calamine = ZnCO<sub>3</sub>Cryolite = Na<sub>3</sub>AlF<sub>6</sub>**9. Official Ans by NTA (3)****Sol.** (a) Siderite = FeCO<sub>3</sub> = Fe-metal(b) Calamine = ZnCO<sub>3</sub> = Zn-metal(c) Malachite = Cu(OH)<sub>2</sub>·CuCO<sub>3</sub> = Cu-metal(d) Cryolite = Na<sub>3</sub>AlF<sub>6</sub> = Al-metal**10. Official Ans. by NTA (2)****Sol.** In roasting process, metal sulphide (MS) ore are converted into metal oxide and sulphur is removed in the form of SO<sub>2</sub> gas.**11. Official Ans. by NTA (1)****Sol.** Reduction of Al<sub>2</sub>O<sub>3</sub> → Al is carried out by electrolytic reduction of its fused salts.ZnO, Fe<sub>2</sub>O<sub>3</sub> & Cu<sub>2</sub>O can be reduced by carbon.**12. Official Ans. by NTA (2)****Sol.** i = 10A, A = 5 mm<sup>2</sup> = 5 × 10<sup>-6</sup> m<sup>2</sup>and v<sub>d</sub> = 2 × 10<sup>-3</sup> m/s

We know, i = neAvd

$$\therefore 10 = n \times 1.6 \times 10^{-19} \times 5 \times 10^{-6} \times 2 \times 10^{-3}$$

$$\Rightarrow n = 0.625 \times 10^{28} = 625 \times 10^{25}$$

**13. Official Ans. by NTA (4)**

<b>Sol.</b>	<b>Ore</b>	<b>Formula</b>
(a)	Haematite	Fe <sub>2</sub> O <sub>3</sub>
(b)	Bauxite	Al <sub>2</sub> O <sub>3</sub> ·xH <sub>2</sub> O
(c)	Magnetite	Fe <sub>3</sub> O <sub>4</sub>
(d)	Malachite	CuCO <sub>3</sub> ·Cu(OH) <sub>2</sub>

**14. Official Ans. by NTA (1)****Sol.** To reduce the melting point of reaction mixture, cryolite is added.**15. Official Ans. by NTA (3)****Sol.** (a) Mercury → Distillation refining

(b) Copper → Electrolytic refining

(c) Silicon → Zone refining

(d) Nickel → Vapour phase refining

**16. Official Ans. by NTA (2)**

**Sol.** Zinc can be purified economically by fractional distillation.

**17. Official Ans. by NTA (1)**

**Sol.** (A)  $\text{ZnCO}_3(\text{s}) \xrightarrow{\Delta} \text{ZnO}(\text{s}) + \text{CO}_2(\text{g})$

Heating in absence of oxygen in calcination.

(B)  $2\text{Zn}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{ZnO}(\text{g}) + 2\text{SO}_2(\text{g})$

heating in presence of oxygen in roasting

Hence (A) is calcination while (B) in roasting.

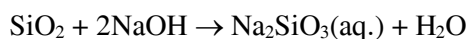
**18. Official Ans. by NTA (1)**

**Sol.** Pb and Ag commonly exist in the form of sulphide ore like PbS (galena) and  $\text{Ag}_2\text{S}$  (Argentite)

'Al' is mainly found in the form of oxide ore whereas 'Mg' is found in the form of halide ore.

**19. Official Ans. by NTA (4)**

**Sol.** In bauxite impurities of  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$  and  $\text{SiO}_2$  are present,  $\text{Fe}_2\text{O}_3$  and  $\text{TiO}_2$  are basic oxides therefore does not reacts with or dissolve in NaOH whereas  $\text{SiO}_2$  is acidic oxide it gets dissolve in NaOH, hence leach out

**20. Official Ans. by NTA (1)**

- Sol.** (a) Concentration of Ag is performed by leaching with dilute NaCN solution  
 (b) Pig iron is formed in blast furnace  
 (c) Blister Cu is produced in Bessemer converter  
 (d) Froth floatation method is used for sulphide ores.

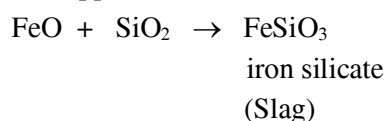
**Note :** During extraction of Cu reverberatory furnace is involved.

**21. Official Ans. by NTA (1)**

**Sol.** Ellingham diagram is a plot between  $\Delta G^\circ$  and T and does not give any information regarding rate of reaction

**22. Official Ans. by NTA (2)**

**Sol.** Silica is used to remove FeO impurity from the ore of copper

**23. Official Ans. by NTA (4)**

**Sol.** Given statement-I is true as in a number of processes, one element is used to reduce the oxide of another metal. Any element will reduce the oxide of other metal which lie above it in the Ellingham diagram because the free energy change will become more negative.

**Given statement-II** is false as the value of  $\Delta S$  is decreases from left to right in Ellingham diagram.

**24. Official Ans. by NTA (2)**

**Sol.** Sphalerite-ZnS, copper glance -  $\text{Cu}_2\text{S}$  two sulphide ores can be separated by adjusting proportions of oil to water or by using 'Depressants'

**25. Official Ans. by NTA (2)**

**Sol.** Liquation method is used to purify those impure metals which has lower melting point than the melting point of impurities associated.

$\therefore$  This method is used for metal having low melting point.

**26. Official Ans. by NTA (1)**

**Sol.** (Name of ore/mineral)

- (a) Calamine  $\text{ZnCO}_3$   
 (b) Malachite  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$   
 (c) Siderite  $\text{FeCO}_3$   
 (d) Sphalerite  $\text{ZnS}$

**27. Official Ans. by NTA (6)**

**Sol.** Anode mud contains Sb, Se, Te, Ag, Au and Pt

**28. Official Ans. by NTA (2)**

**Sol.** Calamine  $\Rightarrow \text{ZnCO}_3$   
 Malachite  $\Rightarrow \text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$