INORGANIC CHEMISTRY

NEET

CRASH COURSE

METALLURGY

SMART ACHIEVERS

JEE | NEET | FOUNDATION

587, Nitikhand-1, Indirapuram, Gzb.

7292077839 / 7292047839 | smartachievers.online

A Unit of SMARTACHIEVERS LEARNING Pvt. Ltd., Delhi

SUMMARY

Metals are required for a variety of purposes. For this, we need their extraction from the minerals in which they are present and from which their extraction is commercially feasible.These minerals are known as ores. Ores of the metal are associated with many impurities. Removal of these impurities to certain extent is achieved in concentration steps. The concentrated ore is then treated chemically for obtaining the metal. Usually the metal compounds (e.g., oxides, sulphides) are reduced to the metal. The reducing agents used are carbon, CO or even some metals.

In these reduction processes, the thermodynamic and electrochemical concepts are given due consideration. The metal oxide reacts with a reducing agent; the oxide is reduced to the metal and the reducing agent is oxidised. In the two reactions, the net Gibbs energy change is negative, which becomes more negative on raising the temperature. Conversion of the physical states from solid to liquid or to gas, and formation of gaseous states favours decrease in the Gibbs energy for the entire system. This concept is graphically displayed in plots of ΔG^0 vs T (Ellingham diagram) for such oxidation/reduction reactions at different temperatures. The concept of electrode potential is useful in the isolation of metals (e.g., Al, Ag, Au) where the sum of the two redox couples is +ve so that the Gibbs energy change is negative.

The metals obtained by usual methods still contain minor impurities. Getting pure metals require refining. Refining process depends upon the differences in properties of the metal and the impurities. Extraction of aluminium is usually carried out from its bauxite ore by leaching it with NaOH. Sodium aluminate, thus formed, is separated and then neutralised to give back the hydrated oxide, which is then electrolysed using cryolite as a flux. Extraction of iron is done by reduction of its oxide ore in blast furnace. Copper is extracted by smelting and heating in a reverberatory furnace. Extraction of zinc from zinc oxides is done using coke. Several methods are employed in refining the metal. Metals, in general, are very widely used and have contributed significantly in the development of a variety of industries.

Aluminium	1. Bauxite, $Al_2O_3 . x H_2O$ 2. Cryolite, Na_3AlF_6	Electrolysis of Al_2O_3 dissolved in molten Na_3AlF_6	For the extraction, a good source of electricity is required.
Iron	1. Haematite, Fe_2O_3 2. Magnetite, Fe_3O_4	Reduction of the oxide with CO and coke in Blast furnace	Temperature approaching 2170 K is required.
Copper	1. Copper pyrites, $CuFeS_2$ 2. Copper glance, Cu_2S 3. Malachite, $CuCO_3.Cu(OH)_2$ 4. Cuprite, Cu_2O	Roasting of sulphide partially and reduction	It is self reduction in a specially designed converter. The reduction takes place easily. Sulphuric acid leaching is also used in hydrometallurgy from low grade ores.
Zinc	1. Zinc blende or Sphalerite, ZnS 2. Calamine, $ZnCO_3$ 3. Zincite, ZnO	Roasting followed by reduction with coke	The metal may be purified by fractional distillation.

METALLURGY

Q.1 The process of removing lighter gangue particles by washing in a current of water is called :
(1) levigation (2) liquidation (3) leaching (4) cupellation.

Q.2 Which of the following metal is obtained by leaching process using a solution of NaCN and then precipitating the metal by addition of zinc dust –
(1) Copper (2) Silver (3) Nickel (4) Iron

Q.3 The rocky and silicious matter associated with an ore is called :
(1) slag (2) mineral (3) matrix or gangue (4) flux

Q.4 "Fool's gold" is
(1) iron pyrites (2) horn silver (3) copper pyrites (4) bronze

Q.5 Which of the following set of metals mostly found as sulphide ores :
(1) Zn, Cu, Mg (2) Zn, Cu, Pb (3) Fe, Al, Sn (4) Cu, Ag, Au

Q.6 Corundum is –
(1) SiC (2) Al_2O_3 (3) $Al_2O_3 \cdot 2H_2O$ (4) $KAlSi_3O_8$

Q.7 Which mineral has been named incorrectly ?
(1) Bauxite : $Al_2O_3.2H_2O$ (2) Corundum : Al_2O_3
(3) Cryolite : $3NaF.AlF_3$ (4) Felspar : $Be_3Al_2Si_6O_{18}$

Q.8 Chemical leaching is useful in the concentration of:
(1) copper pyrites (2) bauxite (3) galena (4) cassiterite

Q.9 Chemical leaching is useful in the concentration of :
(1) carnallite (2) bauxite (3) calamine (4) haematite

Q.10 Copper is extracted from :
(1) stefinite (2) dolomite (3) galena (4) malachite

Q.11 Identify M in the equation : $4M + 8CN^- + 2H_2O + O_2 \rightarrow 4[M(CN)_2]^- + 4OH^-$ -
(1) Copper (2) Iron (3) Silver (4) Zinc

Q.12 NaCN is sometimes added in the froth flotation process as a depressant when ZnS and PbS minerals are expected because :
(1) $Pb(CN)_2$ is precipitated while no effect on ZnS.
(2) ZnS forms soluble complex $Na_2[Zn(CN)_4]$ while PbS forms froth
(3) PbS forms soluble complex $Na_2[Pb(CN)_4]$ while ZnS forms froth.
(4) NaCN is never added in froth floatation process.

Q.13 An ore of tin containing $FeWO_4$ is concentrated by –
(1) Magnetic separation (2) Froth floatation
(3) Electrostatic (4) Gravity separation

Q.14 Cryolite is :
(1) magnesium silicate (2) magnesium borofluoride
(3) sodium aluminofluoride (4) aluminium silicate

Q.15 In froth-floatation process, palm oil functions as
(1) activator (2) frother (3) collector (4) agitator

Q.16 The composition of matte is :
(1) Cu_2S and FeS (2) CuS and Fe_2S_3 (3) Cu_2S and FeO (4) Cu_2O and FeO

Q.17 In the alumino thermite process, Al acts as
(1) An oxidising agent (2) A flux (3) A reducing agent (4) A solder

Q.18 Poling process :
(1) reduces SnO_2 to Sn.
(2) involves the liberation of reducing gases like hydrocarbons.
(3) uses poles of freshly cut green wood.
(4) all of the above are correct.

Q.19 Carbon reduction method is employed for commercial extraction of
(1) haematite (2) silver glance (3) iron pyrite (4) corundum

Q.20 High purity copper metal is obtained by :
(1) carbon reduction (2) hydrogen reduction
(3) electrolytic reduction (4) thermite reduction

Q.21 Purpose of smelting of an one ore is :
(1) To oxidise it (2) To reduce it
(3) To remove vaporisable impurities (4) To obtain an alloy

Q.22 The anode mud in the electrolytic refining of silver contains :
(1) Zn, Cu, Ag, Au (2) Zn, Ag, Au (3) Cu, Ag, Au (4) Au only

Q.23 The aim of addition of flux along with the ore during smelting is –
(1) To reduce the melting point of metal (2) For increasing boiling point of metal
(3) To make ore porous (4) To remove the impurities

Q.24 Specific gravity of slag is –
(1) Always higher than molten metal (2) Always less than molten metal
(3) Same as molten metal (4) None of these

Q.25 A reaction showing slag formation is –
(1) $Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$ (2) $ZnCO_3 \rightarrow ZnO + CO_2$
(3) $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ (4) $FeO + SiO_2 \rightarrow FeSiO_3$

Q.26 In the electro-refining, the impure metal is made as :
(1) anode (2) cathode (3) electrolytic-tank (4) none

Q.27 When a sulphide ore is roasted, the product obtained is usually –
(1) A metal (2) A sulphite (3) An oxide (4) A nitride

Q.28 The slag obtained during the extraction of copper pyrites is composed mainly of –
(1) Cu_2S (2) $FeSiO_3$ (3) $CuSiO_3$ (4) SiO_2

Q.29 Which of the following reactions represents the smelting process ?
(1) $2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$ (2) $PbCO_3 \xrightarrow{\Delta} PbO + CO_2$
(3) $Fe_3O_4 + CO \xrightarrow{\Delta} 3Fe + 4CO_2$ (4) $MgCl_2.6H_2O \xrightarrow[\text{Dry HCl}]{\Delta} MgCl_2 + 6H_2O\uparrow$

Q.30 A flux is often added to remove impurities from an ore in a blast furnace. In the reaction, $CaO + SiO_2 \longrightarrow CaSiO_3$ the slag and the flux are –
(1) $CaSiO_3$ and SiO_2 (2) $CaSiO_3$ and CaO (3) CaO and SiO_2 (4) SiO_2 and $CaSiO_3$

Q.31 In the extraction of silver from argentite air is passed through aqueous solution because :
(1) it converts Ag_2S to Ag_2O.
(2) it shifts the reaction equilibrium to forward direction by converting Na_2S formed into Na_2SO_4 and sulphur.
(3) it converts Ag_2S into Ag and SO_2.
(4) it helps in removing the excess of CN^- ions.

Q.32 Aluminium is obtained by :
(1) Reducing Al_2O_3 with coke (2) Electrolysing Al_2O_3 dissolved in Na_3AlF_6
(3) Reducing Al_2O_3 with cryolite (4) Heating Al_2O_3 and cryolite

Q.33 Aluminium vessels should not be washed with material containing washing soda because :
(1) Washing soda is expensive
(2) Washing soda is easily decomposed
(3) Washing soda reacts with aluminium to form soluble aluminate
(4) Washing soda reacts with aluminium to form insoluble aluminium oxide

Q.34 Hoope's process is used in the refining of :
(1) Al (2) Zn (3) Ag (4) Cu

Q.35 In the extraction of aluminium
Process X : employed for red bauxite to remove iron oxide (main impurity)
Process Y : (Serpeck`s process) : used for white bauxite to remove Z (main impurity) then,
Select correct option for the process X and impurity Z.
(1) X = Hall and Heroult`s process and Z = SiO_2
(2) X = Bayer`s process and Z = SiO_2
(3) X = Serpeck`s process and Y = iron oxide
(4) X = Bayer`s process and Y = iron oxide

Q.36 Red hot steel rod on suddenly immersing in water becomes :
(1) Soft and malleable (2) Hard and brittle
(3) Tough and ductile (4) Fibrous

Q.37 Which of the following statements is correct regarding the slag obtained during the extraction of a metal like copper or iron ?
(1) The slag is lighter and has lower melting point than the metal
(2) The slag is heavier and has lower melting point than the metal
(3) The slag is lighter and has higher melting point than the metal
(4) The slag is heavier and has higher melting point than the metal

Q.38 Select correct statement
(1) In the decomposition of an oxide into oxygen and gaseous metal, entropy increases.
(2) Decomposition of an oxide is an endothermic change.
(3) To make ΔG° negative, temperature should be high enough so that $T\Delta S^\circ > \Delta H^\circ$.
(4) All are correct statements.

Q.39 When ore is heated below its melting point in the absence of air, the process is called :-
(1) Roasting (2) Calcination (3) Smelting (4) Reduction

Q.40 The complex ion is formed in the extraction of :
(1) Copper (2) Silver (3) Iron (4) Sodium

Q.41 The process of bringing the metal or its ore into solution by the action of a suitable chemical reagent followed by extraction of the metal either by electrolysis or by a suitable precipitating agent i.e. more electropositive metal is called :
(1) electrometallurgy (2) hydrometallurgy (3) electro-refining (4) zone refining.

Q.42 A sulphide ore like ZnS is first roasted into its oxide prior to reduction by carbon because :
(1) a sulphide ore cannot be reduced to metal at all
(2) no reducing agent is found suitable for reducing a sulphide ore.
(3) the Gibb's free energy of formation of most sulphides are greater than that for CS_2.
(4) a metal oxide is generally less stable than the metal sulphide.

Q.43 Choose the set of carbonate ore : (a) Galena (b) Siderite (c) Copper pyrites (d) Malachite
Answer is-
(1) a, c (2) b, d (3) b, c (4) a, d

Q.44 Chemical reduction method is not used for :
(1) the extraction of Mg from anhydrous magnesium chloride.
(2) the extraction of Cu from cuprite.
(3) the extraction of Fe from haematite.
(4) the extraction of Zn from zincite.

Q.45 Which of the following is not a refining process
(1) Bayer Process (2) Van-arkel process (3) Cementation (4) Poling

Q.46 In electrolysis of Al_2O_3 by Hall-Heroult process :
(1) cryolite $Na_3[AlF_6]$ lowers the melting point of Al_2O_3 and increases its electrical conductivity.
(2) Al is obtained at cathode and probably CO_2 at anode.
(3) oxygen liberated at anode reacts with carbon anode liberating CO and CO_2.
(4) All of the above are correct.

Q.47 The method of zone refining of metals is based on the principle of:
(1) Greater mobility of the pure metal than that of impurity.
(2) Higher melting point of the impurity than that of the pure metal.
(3) Greater noble character of the solid metal than that of the impurity
(4) Greater solubility of the impurity in the molten state than in the solid

Q.48 The extraction of zinc from zinc blende involves :
(1) the electrolytic reduction.
(2) the roasting followed by reduction with carbon.
(3) the calcination followed by reduction with another metal.
(4) the roasting at molten temperature.

Q.49 Thomas slag is:
(1) Calcium silicate
(2) Calcium phosphate
(3) Tricalcium phosphate and calcium silicate
(4) Calcium ammonium phosphate

Q.50 In the extractive metallurgy of iron, the highest temperature in the blast furnance is found :
(1) in the upper most part where reduction takes place.
(2) in the lower part where fusion takes place.
(3) in the middle part where slag formation takes place.
(4) in the lower most part where combustion of carbon takes place.

Q.51 The incorrect statement is :
(1) generally the calcination is done in reverberatory furance
(2) the sandy and rocky materials associated with ore are called matrix
(3) froth floatation process is suitable for sulphide ores
(4) substance that reacts with gangue to form fusible mass is called slag

Q.52 Formation of metallic copper from the sulphide ore in the commercial thermo-metallurgical process essentially involves which one of the following reaction:

(1) $Cu_2S + \frac{3}{2}O_2 \longrightarrow Cu_2O + SO_2$; $CuO + C \longrightarrow Cu + CO$

(2) $Cu_2S + \frac{3}{2}O_2 \longrightarrow Cu_2O + SO_2$; $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$

(3) $Cu_2S + 2O_2 \longrightarrow CuSO_4$; $CuSO_4 + Cu_2S \longrightarrow 3Cu + 2SO_2$

(4) $Cu_2S + \frac{3}{2}O_2 \longrightarrow Cu_2O + SO_2$; $Cu_2O + CO \longrightarrow 2Cu + CO_2$

Q.53 Aluminium oxide is not reduced by chemical reactions since :-
(1) Aluminium oxide is highly stable
(2) Aluminium oxide is reactive
(3) Reducing agents contaminate
(4) The process pollutes the environment

Q.54 Ellingham diagram represents :
(1) change of ΔG with temperature.
(2) change of ΔH with temperature.
(3) change of ΔG with pressure.
(4) change of $(\Delta G - T\Delta S)$ with temperature.

Q.55 Iron rust in the presence of :
(1) O_2 and N_2 (2) O_2 and moisture (3) moisture only (4) O_2 only

Q.56 Stainless steel does not rust because :
(1) Nickel present in it does not rust
(2) Iron forms a hard chemical compound with chromium present in it
(3) Chromium and Nickel combine with iron
(4) Chromiurn forms an oxide layer that protects iron from rusting

Q.57 Which of the following statements is incorrect?
(1) Cassiterite and haematite are concentrated by hydraulic washing.
(2) Pure Al_2O_3 is obtained from the bauxite ore by leaching in the Bayer's process.
(3) Sulphide ore is concentrated by calcination method.
(4) Roasting can convert sulphide into oxide and part of sulphide may also act as a reducing agent.

Q.58 Pig iron is converted in to steel by reducing the amount of carbon contained in it in a :
(1) Blast furnace (2) Pyrite burner
(3) Bessemer converter (4) None of these

Q.59 When copper is placed in the atmosphere for sufficient time, a green crust is formed on its surface the composition of green crust is :
(1) $Cu(OH)_2$ (2) CuO (3) $CuCO_3$ (4) $CuCO_3.Cu(OH)_2$

Q.60 Blister copper is :
(1) impure copper. (2) obtained in self reduction process during bessemerisation.
(3) both (1) and (2) are correct. (4) none is correct.

ASSERTION AND REASON

Directions : Each of these questions contains an Assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If both assertion and reason are false.

Q.61 **Assertion :** Wolframite impurities are separated from cassiterite by electromagnetic separation.
Reason : Cassiterite being magnetic is attracted by the magnet and forms a separate heap.

Q.62 **Assertion :** Zone refining is used to obtain metals in high degree of purity.
Reason : During electrorefining pure metal is liberated at cathode.

Q.63 **Assertion :** All ores are minerals.
Reason : All minerals are ores.

Q.64 **Assertion :** During calcination, the ore is heated well below its melting point in the limited supply of oxygen.
Reason : The process of calcination is carried out for sulphide ores.

Q.65 **Assertion :** From a solution of $CuSO_4$, The iron is used to recover copper
Reason : In the solution $FeSO_4$ is formed

Q.66 **Assertion :** All the ores are mineral
Reason : Ores contains metals in combined state

Q.67 **Assertion :** Ores are generally converted into oxides, prior to reduction
Reason : Metal oxides can be easily reduced

Q.68 **Assertion :** In the extraction of Ag the complex Na $[Ag(CN)_2]$ is reacted with Zn
Reason : Zn is transition metal according to electronic theory

Q.69 **Assertion :** Thermite mixture Fe_2O_3 + Al (powder) is used in the welding
Reason : Al is a good reductant

Q.70 **Assertion :** In froth floatation process sodium ethyl xanthate is used as frothing agent
Reason : Sulphide ores are water soluble

Q.71 **Assertion :** Cryolite is used in electrolytic extraction of Al from alumina.
Reason : It dissolves alumina

Q.72 **Assertion :** $CuFeS_2$ is concentrated by froath floatation method
Reason : $CuFeS_2$ is main ore of copper

Q.73 **Assertion :** Lead, tin and bismuth are purified by liquation method
Reason : Lead, tin and bismuth have low m.p. as compared to impurities

Q.74 **Assertion :** In the smelting of copper ore coke is added in the blast furnace.
Reason : Coke reduces, CuO into Cu.

Q.75 **Assertion :** Extraction of iron metal from iron oxide ore is carried out by heating with coke.
Reason : The reaction : $Fe_2O_3(s) \longrightarrow Fe(s) + 3/2O_2(g)$ is a spontaneous process.

Q.75 Match items of Column I with the items of Column II and assign the correct code : **[NEET-I 2016]**

Column I	**Column II**
(a) Cyanide process	(i) Ultrapure Ge
(b) Froth floatation process	(ii) Dressing of ZnS
(c) Electrolytic reduction	(iii) Extraction of Al
(d) Zone refining	(iv) Extraction of Au
	(v) Purification of Ni

Code

	(a)	**(b)**	**(c)**	**(d)**		**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iii)	(iv)	(v)	(i)	(2)	(iv)	(ii)	(iii)	(i)
(3)	(ii)	(iii)	(i)	(v)	(4)	(i)	(ii)	(iii)	(iv)

Q.76 Oil used as frothing agent in froth **[AIIMS 2016]**

(1) pine oil (2) mustard oil (3) coconut oil (4) olive oil

Q.77 Extraction of gold and silver involves leaching with CN^- ion. Silver is later recovered by : **[NEET 2017]**

(1) liquation (2) distillation (3) zone refining (4) displacement with Zn

ANSWER KEY

Q.1	1	Q.2	2	Q.3	3	Q.4	1	Q.5	2	Q.6	2	Q.7	4
Q.8	2	Q.9	2	Q.10	4	Q.11	3	Q.12	2	Q.13	1	Q.14	3
Q.15	2	Q.16	1	Q.17	3	Q.18	4	Q.19	1	Q.20	3	Q.21	2
Q.22	4	Q.23	4	Q.24	2	Q.25	4	Q.26	1	Q.27	3	Q.28	2
Q.29	3	Q.30	2	Q.31	2	Q.32	2	Q.33	3	Q.34	1	Q.35	2
Q.36	2	Q.37	1	Q.38	4	Q.39	2	Q.40	2	Q.41	2	Q.42	3
Q.43	2	Q.44	1	Q.45	1	Q.46	3	Q.47	4	Q.48	2	Q.49	2
Q.50	4	Q.51	4	Q.52	2	Q.53	1	Q.54	1	Q.55	2	Q.56	4
Q.57	3	Q.58	3	Q.59	4	Q.60	3	Q.61	3	Q.62	2	Q.63	3
Q.64	3	Q.65	1	Q.66	2	Q.67	2	Q.68	3	Q.69	2	Q.70	3
Q.71	1	Q.72	2	Q.73	1	Q.74	3	Q.75	3				