

General principles and processes of Isolation of Elements

A few elements are available in free state in nature.

Metal like copper, non-metals like carbon, sulphur and inert gas like Helium and others are available in free form in nature.

Many more metals and non-metals other than these are available naturally in combined form in the crust of the earth.

Processes like extraction, isolation involving physico chemical principles can be used to obtain metal.

By metallurgy obtained metals are based on the economical and industrial aspects.

Mineral is the substance available in nature which is present in the crust of the earth.

“The mineral from which metals can be obtained in good proportion is called ore.”

“There may not be only the element to be obtained being present but undesirable and certain earthy substances are present which can be called impurities this is called gangue.”

The main steps to obtain metal from the ore are as follow :

(1) Concentration of ore (2) Isolation of metal from concentrated ore (3) Purification of metal.

“The total procedure to isolate metals from their scientific and industrial processes is called Metallurgy.”

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1. Which of the following metal is available in free state ?
(A) Fe (B) Zn (C) Cu (D) Al
 2. Which of the following metals are available in free state in nature ?
(A) C, S (B) P, S (C) C, P (D) P, Cl
 3. From which type of ore, Aluminium can not be obtained ?
(A) Hydroxide (B) oxide (C) Carbonate (D) Silicate
 4. What is metallurgy used for ?
(A) to obtain pure non metals. (B) to obtain pure metals.
(C) to obtain pure compounds. (D) to obtain pure ideal gas.
 5. What is meant by ore ?
(A) to obtained metals from mineral. (B) to obtained non-metals from minerals.
(C) to obtained more metals from minerals. (D) to obtained compound from minerals.
 6. What is meant by gangue ?
(A) undesirable or earthy substance are called impurities.
(B) Combined form of pure metals.
(C) non-metals found in combine form from earth's crust
(D) metals found in combined form from earth's crust.
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7. Which of the following is steps to obtain metal from the ore ?
 (A) Concentration of ore. (B) Isolation of metal from concentrated ore.
 (C) Purification of metal. (D) All above
8. Which of the following metal is not available in free state in nature ?
 (A) Au (B) Pt (C) Fe (D) S
9. Which of the following metal is available in free state in nature ?
 (A) Au (B) Ag (C) Cu (D) Na
10. On which principles metallurgy do work to form metal ?
 (A) thermodynamical (B) electro chemical (C) reduction (D) above all

Answers : 1. (C), 2. (A), 3. (C), 4. (B), 5. (C), 6. (A), 7. (D), 8. (C), 9. (A), 10. (D)

● Occurrence of metals

The abundance of aluminium is the highest. Its place is 3rd in the elements available from the earth's crust. It is about 8.3% by weight.

Its chief minerals are mica and china clay.

Some of the gem stones are impure forms of Al_2O_3 .

Ruby contains Cr as impurity, and sapphire contains Cd as impurity.

The element available at second place is iron.

It is present in combined form in the haemoglobin present in blood in our body.

Metal	Ore	Composition proportion
(1) Aluminium	Bauxite Kaolinite	$\text{AlO}_x(\text{OH})_{3-2x}$ where $0 < x < 1$ $[\text{Al}_2(\text{OH})_4\text{Si}_2\text{O}_3]$
(2) Copper	Copper pyrites Malachite Cuprite Copper glance	CuFeS_2 $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ Cu_2O Cu_2S
(3) Iron	Haematite Magnetite Siderite Iron pyrites	Fe_2O_3 Fe_3O_4 FeCO_3 FeS_2
(4) Zinc	Zinc blende or Sphalerite Calamine Zincite	ZnS - ZnCO_3 ZnO

The oxide mineral is preferably selected to obtain metal from ores because SO_2 gas evolved from sulphide minerals causes pollution and their reduction is also difficult.

11. Abundance of which metal is highest in earth's crust ?
 (A) Fe (B) Cu (C) Al (D) Zn
12. Which is place of aluminium and % by mass of aluminium in earth's crust ?
 (A) 2nd, 10 % (B) 3rd, 8.3 % (C) 4th, 7.5 % (D) 5th, 5 %
13. Which is found as impurities in gem stone ?
 (A) Al_2O_3 (B) Cr (C) Cd (D) Fe
14. In which of the following ore impurities of Cr is found ?
 (A) Cu (B) Cr (C) Cd (D) Fe
15. Sapphire contain impurity of which metal ?
 (A) Cu (B) Cr (C) Cd (D) Fe
16. Which element is in combined form in the haemoglobin present in blood in our body ?
 (A) Mg (B) Fe (C) Al (D) Cu
17. Which element occur at second position in earth's crust ?
 (A) Al (B) Fe (C) Zn (D) Cu
18. Which of the following is ore of aluminium ?
 (A) Calamine (B) Kaolinite (C) Malachite (D) Siderite
19. Which is formula of malachite ore ?
 (A) CuFeS_2 (B) Cu_2O (C) Cu_2S (D) $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$
20. Siderite is ore of which metal ?
 (A) Fe (B) Zn (C) Cu (D) Al
21. What is composition proportion of bauxite ore of aluminium ?
 (A) $\text{AlO}_x(\text{OH})_{3-x}$ where, $0 < X > 1$ (B) $\text{AlO}_x(\text{OH})_{3-2x}$ where, $0 < X < 1$
 (C) $\text{AlO}_{3-x}(\text{OH})_{3-x}$ where, $0 < X < 1$ (D) $\text{Al}_x\text{O}_x(\text{OH})_{3-2x}$ where, $0 < X > 1$
22. **Assertion (A)** : The oxide mineral is preferably selected to obtain metal from ores.
Reason (R) : SO_2 gas obtained from sulphide minerles causes pollution.
 (A) (A) and (R) both are correct statement (R) gives explanation of statement A.
 (B) Statement (A) and (R) both are correct but statement (R) does not give explanation of statement (A).
 (C) Statement (A) is correct and statement (R) is wrong.
 (D) Statement (A) is wrong and statement (R) is correct.
23. Which of the following is not ore ?
 (A) Bauxite (B) Malachite (C) Zinc blande (D) Pig ron
24. Which of the following is oxide ore ?
 (A) Malachite (B) Feldspar (C) Bauxite (D) Zinc bland
25. Which of the following metal will be highest obtained from earth's crust ?
 (A) Fe (B) Al (C) Ca (D) Na

26. Which ore contain formula of $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$?
 (A) cuprite (B) copperglance (C) copperpyrites (D) malachite
27. What is molecular formula of siderite ?
 (A) Fe_2O_3 (B) Fe_3O_4 (C) FeS_2 (D) FeCO_3

Answers : 11. (C), 12. (B), 13. (A), 14. (D), 15. (C), 16. (B), 17. (B), 18. (B), 19. (D), 20. (A), 21. (B), 22. (B), 23. (D), 24. (C), 25. (B), 26. (D), 27. (D)

● Concentration of ores

As we have seen earlier, there are impurities in the ores. viz. Sand, clay etc. To obtain ore by removal of impurities as much as possible is called concentration. The selection of these steps depends on the physical properties of ore and the properties of the gangue.

(1) **Hydraulic Washing** : The principle of relative density of ore and gangue is involved.

(2) **Magnetic Separation** : The principle of magnetic properties of the components of the ore is involved.

(3) **Froth Floataion Method** : Ores of sulphide can be seperated by forming foam.

(4) **Leaching** : This method is used when the ore is soluble in some suitable solvent.

Ex. Leaching of alumina from bauxite, leaching of silver by NaCN and leaching of gold by KCN.

28. To remove impurities like sand and clay from minerals that process called
 (A) calcination (B) electronation (C) concentration (D) extraction
29. Selection of steps of concentration depends upon
 (A) physical properties of ores (B) chemical properties of ore
 (C) properties of gangue (D) Both (A) and (C)
30. Which of the following have principle of relative density of ore and gangue ?
 (A) Hydraulic washing (B) Magnetic separation (C) Froth floatation (D) Leaching
31. Which of the following is added as froth stabilisers in froth floating method ?
 (A) Cresol, Phenol (B) Phenol, Aniline (C) Aniline, Cresol (D) Phenol, Benzene
32. Which of the following added as depressant in ores containing ZnS and PbS ?
 (A) NaOH (B) KCN (C) NaCl (D) NaCN
33. **Assertaion (A)** : NaCN is added as depressant to the ore containing ZnS and PbS, then PbS skims off on the upper part with the froth.

Reason (R) : ZnS form water soluble $\text{Na}_2[\text{Zn}(\text{CN})_4]$ complex.

- (A) (A) and (R) both are correct statement (R) gives explanation of statement (A).
 (B) (A) and (R) both are correct but statement (R) does not give explanation of statement (A).
 (C) Statement (A) is correct and statement (R) is wrong.

(D) Statement (A) is wrong and statement (R) is correct.

34. Which method is used when the ore is soluble in some suitable solvent ?
(A) Hydraulic washing (B) Calcination (C) Leaching (D) Froth Floatation
35. In metallurgy Leaching of which metal is carried out by NaCN in presence of oxygen ?
(A) Au (B) Ag (C) Cu (D) Al
36. Which method is used in concentration of bauxite ore ?
(A) Hydraulic washing (B) Magnetic separation (C) Leaching (D) Froth floatation
37. Which substances are added to sulphide ore to produce froth and concentrate the ore ?
(A) Fatty acids (B) Xanthates compound (C) Turpentine (D) Above all
38. $X + CN^- + H_2O + O_2 \rightarrow Y + OH^-$
 $Y + Zn \rightarrow Z + X$
indicate X, Y and Z from equation
(A) $X = Ag, Y = [Ag(CN)_2]^{2-}, Z = [Zn(CN)_4]^-$ (B) $X = Ag, Y = [Ag(CN)_2]^{2-}, Z = [Zn(CN)_4]^{2-}$
(C) $X = Au, Y = [Au(CN)_2]^-$, $Z = [Zn(CN)_4]^{2-}$ (D) $X = Au, Y = [Au(CN)_2]^{2-}, Z = [Zn(CN)_4]^-$
39. In Froth floatation method why mineral particle is floating on upper surface ?
(A) They are light in weight. (B) Surface of them are not wet by water.
(C) They are insoluble. (D) they can't form electrolyte.
40. In which ores the principles of magnetic properties used for concentration of ores ?
(A) Horn silver (B) Calamine (C) Haematite (D) Bauxite
41. Which of the following method is used in concentration of ores ?
(A) Distillation (B) Liquefaction (C) Froth floatation (D) Electrolysis

Answers : 28. (C), 29. (D), 30. (A), 31. (C), 32. (D), 33. (A), 34. (C), 35. (B), 36. (C), 37. (D), 38. (C), 39. (B), 40. (C), 41. (C)

● Extraction of Crude Metal from the concentrated ore

The metal to be obtained is in ionic form of the compound of concentrated ore. So that they can be obtained by reduction.

The concentrated ore has to be converted into the suitable form so that it can be reduced.

Steps to obtain metal from the ore can be divided into two parts :

(1) Conversion to oxide (2) Reduction of oxide to metal.

(1) Two process for conversion to oxide

(A) **Calcination** : The ore is heated very strongly during calcination so that all volatile substances are removed and metal oxide is left out.

(B) **Roasting** : The ore is heated below the melting point of the metal in a reverberatory furnace by introducing air continuously.

The roasting of sulphide containing ore takes place in reverbetory furnace.

If the ore is iron containing, then silica is added to it before heating so that iron oxide combines with silica and forms iron silicate (FeSiO_3). It is known as slag.

A mixture of Cu_2S and FeS is called matte.

(2) Reduction of oxide of Ore to Metal :

During Reduction reaction suitable reducing agent like Co or C or any other metal is used with the ore. Reducing Agent like carbon combines with oxide of metal and reduces the metal oxide giving metal.

Metal oxides can be reudced easily or with difficulty depending upon their stabilities.

The reduction reaction by accepting electron is called electronation.

Heat is required during reduction reaction.

The study of metallurgy with changes in temperature is called pyrometallurgy.

42. If metal is in ion form in concentrated ore of metal then which process is used ?
(A) Reduction (B) Froth floatation (C) Oxidation (D) Electrolysis
43. What is done in calcination process ?
(A) Heat vary to ore of metal. (B) Heating in reverbetory furnace.
(C) Used proper reducing Agent. (D) Convert it into dust and suspention in water.
44. When will be slag form ?
(A) Heating sulphide containg ore into reverberatory furnace.
(B) Heating iron containg ore into reverberatory furnace.
(C) Silica is added before Heating in sulphide containg ore.
(D) Silica is added before Heating in iron containg ore.
45. What is called the study of metallurgy with change in temperature ?
(A) Rosting (B) Pyrometallurgy (C) Heat metallurgy (D) Metallurgy
46. Which reducing agent is used to convert metal ore into metal ?
(A) Carbon (B) Carbonmonoxide (C) Silicon (D) Both (A) and (B)
47. Which of the following reaction is called electronation ?
(A) $2\text{Al}_{2}\text{O}_{3(s)} + 3\text{C}_{(s)} \rightarrow 4\text{Al}_{(s)} + 3\text{CO}_{2(g)}$ (B) $\text{Fe}_2\text{O}_{3(s)} + \text{CO}_{(g)} \rightarrow 2\text{FeO}_{(s)} + \text{CO}_{2(g)}$
(C) $\text{FeO}_{(s)} + \text{C}_{(s)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{(g)}$ (D) $\text{FeO}_{(s)} + \text{CO}_{(s)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{2(g)}$
48. Which of the following reaction is called calcination ?
(A) $2\text{ZnS}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{ZnO}_{(s)} + 2\text{SO}_{2(g)}$ (B) $\text{ZnCO}_{3(s)} \rightarrow \text{ZnO}_{(s)} + \text{CO}_{2(g)}$
(C) $\text{ZnO}_{(s)} + \text{C}_{(s)} \xrightarrow{\Delta} \text{Zn}_{(s)} + \text{CO}_{(g)}$ (D) $2\text{CuS}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{Cu}_2\text{O}_{(s)} + 2\text{SO}_{2(g)}$
49. Which type of ores are required for roasting ?
(A) oxide ore (B) silicate ore (C) sulphide ore (D) carbonate ore
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50. Which of the following is common method for obtaining metal from ore ?
- (A) Reduction by hydrogen (B) Reduction by Aluminium
(C) Reduction by carbon (D) By Electrolysis reaction

Answers : 42. (A), 43. (A), 44. (D), 45. (B), 46. (D), 47. (A), 48. (B), 49. (C), 50. (C)

● Thermodynamic principles of metallurgy

It is essential to have information about certain principles like chemical equilibrium, equilibrium constant, Gibb's free energy entropy and enthalpy.

Gibbs-Helmholtz equation $\Delta G = \Delta H - T\Delta S$.

Relation with equilibrium constant $\Delta G^\circ = -RT \ln K$.

Three values of ΔG° can be possible positive, zero and negative. If the value of ΔG° is Negative then the reaction will spontaneous. If it is zero reaction will be equilibrium state and if it is positive then reaction will not be spontaneous.

the value of $K < 1$ then proportion of products will be less in comparison to reactants.

the value of $K = 1$ then proportion of both will be equal.

the value of $K > 1$ then proportion of product obtained will be more.

The value of ΔG° is constant at standard state.

Scientist Ellingham had studied the relations by plotting graphs of ΔG° versus T and so these graphs are known as Ellingham diagrams.

The function of reducing agent is to make the value of ΔG° negative.

We can have combination of temperature, pressure and reducing agent in such a manner that the optimum state can be formulated and maximum product. i.e. maximum amount of metal can be obtained by reduction.

Thermodynamical principles are also called physicochemical principles.

51. Which term of thermodynamics is essential to have information about to understand metallurgy principles ?
(A) Chemical equilibrium (B) Gibb's free energy (C) Entropy (D) All of the mentioned
52. What is value of gibb's free energy for spontaneous process ?
(A) positive (B) negative (C) zero (D) infinite
53. What is value of K in $\Delta G^\circ = -RT \ln K$ in case of higher products in chemical reaction ?
(A) $K > 1$ (B) $K < 1$ (C) $K = 1$ (D) $K = 0$
54. Which graphs are known as Ellingham diagrams ?
(A) $\Delta G^\circ \rightarrow \Delta H$ (B) $\Delta G^\circ \rightarrow \Delta S$ (C) $\Delta G^\circ \rightarrow \Delta T$ (D) $\Delta G^\circ \rightarrow T$
55. Which of the following statement is false ?
(A) Value of ΔG° is positive than value of k is more than 1.
(B) Value of ΔG° is negative than value of k is less than 1.
(C) Value of free energy of oxidation reduction process become zero when ΔG° 's value become negative.
(D) $\Delta G = \Delta H - T\Delta S$ in this equation value of T increases, product increases

56. How does optimum state can be formulated ?
 (A) By combining Temperature, pressure and concentration.
 (B) By combining Temperature, concentration and reducing agent.
 (C) By combining Temperature, pressure and reducing agent.
 (D) By combining Temperature and reducing agent.
57. Value of equilibrium constant more than “one” then
 (A) product will be less. (B) product will be more.
 (C) concentration of product and reactant become equal. (D) product can't form.

Answers : 51. (D), 52. (B), 53. (A), 54. (D), 55. (A), 56. (C), 57. (B)

● Electrochemical principles of metallurgy

The principles of electrochemistry can be useful for reduction of metal ions present in the aqueous solutions or in molten states.

Electrolysis or addition of some other metal and ions of the metals can be reduced and metal can be obtained.

The equation combining thermodynamics and electrochemistry is $\Delta G^\circ = -nFE^\circ$.

The oxidation potentials of the electrodes doing reactions will be very high and positive so their reduction potentials will be very low and negative and so their reduction will be very difficult.

If the value of E° is positive, the value of ΔG° will be negative and so the reaction will be spontaneous.

The electrolysis of molten solid can be carried out as above but if the melting point of molten solid is very high, some substances are added to bring it down which is known of flux.

Ex., Cryolite (Na_3AlF_6) or calcium fluoride (CaF_2) is added in the process of obtaining Al from Al_2O_3 .

● Oxidation-Reduction

Oxidation-Reduction method is mostly for non-metals.

Oxidation-Reduction method is used for obtain chlorine from sea water.



The value of $\Delta G^\circ = +422 \text{ KJ}$ for this reaction if we calculate the value of E° from this by the equation $\Delta G^\circ = -nFE^\circ$ then, its value obtained is -2.186 V . As we have studied earlier the value of E° being negative, the reaction will not occur in forward direction. Hence if we apply external e.m.f. higher than -2.186 V , then the reaction will occur and Cl_2 gas will be obtained on anode and NaOH will remain in solution because H_2 will be obtained as gas at cathode.

If we electrolyse molten NaCl then Cl_2 will be obtained on anode and Na metal will be obtained on cathode.

Sodium cyanide (NaCN) is used to obtain gold and silver by oxidation reactions, cyanide complex ions of gold and silver will be obtained respectively. It can be reduced by zinc metal and so gold and silver metals can be obtained.

58. Which principles can be useful for reduction of metal ions present in the aqueous solution or in molten states ?
 (A) By using Reducing Agent like carbon (B) By electrolysis
 (C) By formation of optimum state (D) By adding flux

59. When will be reduction of reaction become tough ?
 (A) Value of reduction potential low and negative.
 (B) Value of oxidation potential high and negative.
 (C) Value of reduction potential low and positive.
 (D) Value of oxidation potential high and negative.
60. When will be reaction become spontaneous ?
 (A) Value of E° is positive and ΔG° positive. (B) Value of E° negative and ΔG° negative.
 (C) Value of E° negative and ΔG° negative. (D) Value of E° positive and ΔG° negative.
61. What is meaning by flux ?
 (A) Melting point of molten solid is very low, some substance are added to make it high.
 (B) Melting point of molten solid is very high. So some substance are added to bring it low.
 (C) Some substance are added to make temperature high of Reaction.
 (D) Some substance are added to make Rate higher of Reaction.
62. For which of the following oxidation-Reduction process mainly used ?
 (A) Metal (B) Non-metal (C) Semi-metal (D) Above all.
63. Which of the following reaction is to obtain chlorine from sea water ?
 (A) $2\text{Cl}^-_{(\text{aq})} \rightarrow \text{Cl}_{2(\text{g})} + 2\text{e}^-$ (B) $\text{NaCl}_{(\text{l})} \rightarrow \text{Na}_{(\text{s})} + \frac{1}{2}\text{Cl}_{2(\text{g})}$
 (C) $2\text{Cl}^-_{(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})} \rightarrow \text{H}_{2(\text{g})} + \text{Cl}_{2(\text{g})} + 2\text{OH}^-$ (D) above all
64. Which of the following substance obtain at anode and cathod and which retain in solution in electrolysis of sea water ?
 (A) $\text{H}_{2(\text{g})}$ at anode, $\text{Cl}_{2(\text{g})}$ at cathod and NaOH in solution
 (B) $\text{Cl}_{2(\text{g})}$ at anode, $\text{O}_{2(\text{g})}$ at cathod and NaOH in solution
 (C) $\text{O}_{2(\text{g})}$ at anode, $\text{H}_{2(\text{g})}$ at cathod and NaCl in solution
 (D) $\text{Cl}_{2(\text{g})}$ at anode, $\text{H}_{2(\text{g})}$ at cathod and NaOH in solution
65. Ag and Au are form by leaching of which compound ?
 (A) KCN (B) NaCN (C) (A) and (B) both (D) Zn
66. By which of the following metal is used for reduction of $[\text{Au}(\text{CN})_2]^-$ complex ion to form Au ?
 (A) Fe (B) Al (C) Cu (D) Zn
67. What is value of ΔG° and ΔE° of reaction of formation of Cl_2 gas from sea water ?
 (A) +422 KJ, -2.186 V (B) +422 J, +2.186 V (C) -422 KJ, -2.186 V (D) -422 J, +2.186 V
68. Which of the following can be extracted by electrolysis method ?
 (A) transition metals (B) High active metals (C) ideal Gas (D) Soft metals

Answers : 58. (B), 59. (A), 60. (D), 61. (B), 62. (B), 63. (C), 64. (D), 65. (B), 66. (D), 67. (A), 68. (B)

● Refining of Impure metals

There is a possibility to have impurity in the metals obtained by any of the methods or processes discussed earlier. Hence to obtain very pure metals, their refining can be carried out and refining as high as possible can be obtained. For this the methods used for refining are applied after taking into consideration the properties of the metal impurities present in it etc. Some of these are listed below :

● Refining Methods

(1) Distillation, (2) Liquation, (3) Electrolysis, (4) Zone Refining, (5) Vapour Phase Refining
(6) Chromatographic Method.

(1) Distillation : This refining method is used for metals like zinc and mercury which have comparatively low melting points.

(2) Liquation : This method is used for the refining of metals like tin which have low melting points.

(3) Electrolysis : In this method the impure metal is made anode and the strip of pure metal is made cathode. Now, these two electrodes are dipped in the aqueous solution of proper salt. If suitable electric current is passed in the solution electrolysis takes place and pure metal is deposited on the cathode and the impure metal on the anode undergoes oxidation and enters into the solutions as ions. Some noble metals are collected near the anode in the form of mud which is called anodic mud. In this method the principle of metals like zinc and copper can also be obtained in pure form by this method.

(4) Zone Refining : Semi metals like silicon and germanium can be refined by this method.

The principle of this method is that the impurities of some metals are more soluble in molten state but is less soluble in solid state.

(5) Vapour Phase Refining : In this method, the impure metal is reacted with suitable substance then this volatile compound is decomposed so that pure metal is obtained. ex. Mond carbonyl process for refining of nickel.



Metals like zirconium or titanium can be refined by using Van Arkel method.

By this method, oxygen and nitrogen present in the form of impurities in metals can be removed.

The metal iodides obtained in this way are heated electrically on tungsten filament at 1800 K temperature so that they are decomposed and the pure metal is deposited on the wire.

(6) Chromatographic Method : In this method the principle of adsorption is involved.

If solid substance like Al_2O_3 is used then it is filled in a glass tube and it can be used, so that the glass tube will become one column and so this chromatography is called column chromatography.

If we cut filter paper strip and carry out separation of metal ions by suitable solvent on it, it is called paper chromatography.

If on any suitable support gaseous substance is used and separation is carried out it is called gas chromatography.

Some dyes, cations, anions etc. can be separated by suitable chromatographic method.

69. Which of the following method is used for refining of zinc like metals which have low melting points ?

(A) Liquation (B) Zone refining (C) Distillation (D) Vapour phase refining

70. Distillation method is used for purification of which of the following metals ?

(A) Zn (B) Hg (C) Ti (D) Sn

71. When will pure metal deposit on cathode by reduction of metal ion in solution by electrolysis ?
 (A) Reduction potential will high and positive.
 (B) Reduction potential will low and negative.
 (C) Value of ΔG° positive.
 (D) Value of E° negative .
72. Which of the following principle is used for zone refining ?
 (A) Impurities of some metals are soluble in their aqueous solutions.
 (B) Impurities of some metals are more soluble in their molten stage but less soluble in solid state.
 (C) Impurities of some metals are insoluble in their aqueous solution.
 (D) Impurities of some metals are partially soluble in their molten stage.
73. Which of the following metals are purified by zone refining method ?
 (A) Si, Ge, Ti, Zn, Cu (B) Si, Ge, Ti, B, Hg
 (C) Si, Ga, B, Cu, Sn (D) Si, Ga, B, In, Ge.
74. Which of the following process is for refining pure nickel ?
 (A) Van Arkel (B) Mond Carbonyl (C) Electrolysis (D) Liquation
75. Pure nickel $\xrightarrow{X}$ tetra nickel carbonyl $\xrightarrow{Y}$ pure nickel indicates X and Y in following reaction.
 (A) $X = \text{CO}_2, 300 - 350 \text{ K}$ $Y = 400 - 450 \text{ K}$
 (B) $X = \text{CO}, 300 - 350 \text{ K}$ $Y = 400 - 450 \text{ K}$
 (C) $X = \text{CO}, 330 - 350 \text{ K}$ $Y = 450 - 1470 \text{ K}$
 (D) $X = \text{CO}_2, 330 - 350 \text{ K}$ $Y = 450 - 470 \text{ K}$
76. Which of the following metal can be purified by Van Arkel method ?
 (A) Zr, Ti (B) Ti, Zn (C) Zn, B (D) In, Ga
77. Which type of impurity are present in titanium ?
 (A) Oxygen (B) Nitrogen (C) Sulphur (D) Both (A) and (B)
78. Which of the following principle is involved in chromatography method ?
 (A) Precipitation (B) Hydrolysis (C) Decomposition (D) Adsorption
79. Which of the following is used as adsorbate in chromatography method ?
 (A) Al_2O_3 (B) ideal gas (C) filter paper (D) All of these
80. Which of the following can be separated in chromatography method ?
 (A) Dyes (B) Cation (C) Anion (D) All of these
81. Zone refining process is useful for which process ?
 (A) For concentration of ore (B) For oxidation-Reduction of metal
 (C) Purification of metals (D) For purification of ore

82. Which of the following process is used for silicon which is used in semi-conductor ?
 (A) Heating method (B) Froth flotation method (C) distillation (D) zone refining method
83. In purification by electrolysis pure metal form on which electrode ?
 (A) positive (B) negative
 (C) non-reactive (D) Both positive and negative
84. Which purification method is shown by following equation ?

$$\text{Ti}_{(\text{impure})} + 2\text{I}_2 \xrightarrow{500\text{K}} \text{TiI}_4 \xrightarrow{1675\text{K}} \text{Ti}_{(\text{pure})} + 2\text{I}_2$$
 (A) Zone refining (B) Van Arkel (C) Vapour phase refining (D) None of above

Answers : 69. (C), 70. (D), 71. (A), 72. (B), 73. (D), 74. (B), 75. (C), 76. (A), 77. (D), 78. (D), 79. (D), 80. (D), 81. (C), 82. (D), 83. (A), 84. (B)

● **Extraction of metals : (1) Al, (2) Cu, (3) Fe, (4) Zn**

Aluminium (Al)

(1) The extraction of aluminium can be divided into two parts.

(A) To obtain pure alumina (Al_2O_3) from ore.

(B) To obtain aluminium metal by reduction of alumina.

(A) To obtain pure alumina from ore : Silica, oxides of iron and titanium dioxide are impurities in impure bauxite.

The mineral bauxite is grinded and converted to small particles, then it is digested with 6 to 8% concentrated NaOH solution at 473-523 K temperature and 35-36 bar pressure. Because of this soluble hydrated sodium aluminate complex $\text{Na}[\text{Al}(\text{OH})_4]$ is formed. The remaining components also dissolve in sodium hydroxide and form soluble sodium silicate but hydroxides of iron and titanium being insoluble get precipitated.

By filtering solution, by neutralising the solution by passing CO_2 gas, hydrated Al_2O_3 gets precipitated.

Sodium silicate remains in solution. Insoluble hydrated alumina is filtered. On heating it at 1470 K temperature, pure alumina is obtained.

(B) To obtain pure aluminium from alumina. Al_2O_3 does not conduct electricity and its melting points is very high. Hence substance like cryolite (Na_3AlF_6) or CaF_2 are added to Al_2O_3 by electrolysis aluminium metal is obtained on graphite cathode by reduction.

The system formed is such that the value of ΔG° becomes more negative.

Carbon of graphite act as a reducing agent.

That process is known as Hall-Heroult process.

Uses : It is used in the preparation of parts of aeroplane, household vessels, parts of car for race, electric wire, as reducing agent and to form alloy, parts of scientific balances, coinage, thin sheets are used in cigarette cases and used in packaging. Carbon is chewed up at anode. 0.5 kg carbon is chewed up per 1 kg of aluminium.

85. From which ore aluminium can be formed ?
 (A) Bauxite (B) Kaolinite (C) Calamine (D) Malachite

86. Which of following impurities are not their in impure bauxite ?
 (A) TiO_2 (B) FeO (C) CuS (D) SiO_2
87. Which of the following is IUPAC Name of $\text{Na}[\text{Al}(\text{OH})_4]$?
 (A) Hydrated sodium aluminate (B) Sodium tetra hydroxy aluminate (III)
 (C) Sodium tetra hydrate aluminate (III) (D) Sodium tetra hydroxo aluminium (III)
88. To form precipitate of Al_2O_3 in solution of sodium aluminate which compound is added into it ?
 (A) Aqueous solution of NaOH (B) Freshly prepared aqueous Al_2O_3
 (C) Freshly prepared $\text{Al}(\text{OH})_3$ precipitate (D) Both (B) and (C)
89. Which of the following takes as electrolyte in Hall-Herout process ?
 (A) $\text{Al}_2\text{O}_3 + \text{NaOH}$ (B) Molten $\text{Al}_2\text{O}_3 + \text{Na}_3\text{AlF}_6$
 (C) Molten Al_2O_3 (D) Molten $\text{Al}_2\text{O}_3 + \text{NaOH}$
90. In which of the following uses aluminium is not used ?
 (A) Electronic instrument (B) Household vessel
 (C) Parts of cars of race (D) Measuring Tap
91. Which of the following not alloy of aluminium ?
 (A) Alnico (B) Magnalium (C) Constant (D) Duralumin
92. Which of the following metal is used to make parts of scientific balance ?
 (A) Al (B) Cu (C) Fe (D) Zn
93. Which of the following process is useful for extraction of aluminium metal ?
 (A) Molten alumina and electrolysis of cryolyte.
 (B) By heating Alumina with carbon.
 (C) By heating Alumina in Air.
 (D) By pyrometallurgy.
94. Which of the following is formula of bauxite ?
 (A) Al_2O_3 (B) $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ (C) $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (D) None of above
95. Which of the following is alloy of aluminium ?
 (A) Steel (B) German silver (C) Alnico (D) Delta metal
96. How much carbon reduce in formation of 1 kilogram aluminium at anode in Hall Heroult process ?
 (A) 0.5 gram (B) 0.5 kilogram (C) 5 gram (D) 0.25 kilogram

Answers : 85. (A), 86. (C), 87. (B), 88. (D), 89. (B), 90. (D), 91. (C), 92. (A), 93. (A), 94. (B), 95. (C), 96. (B)

● Extraction of Copper (Cu)

For the extraction of copper, copper pyrites is used.

Copper available in free state, is obtained as copper metal by removal of the impurities existing with it by this method 5% copper metal is obtained.

Wet metallurgical process is used for pyrites ores of lower grade; while dry metallurgical process is used for the higher grade of pyrites ores.

As copper has more attraction for sulphur, its reduction is difficult.

Dry metallurgical method can be divided into five steps :

(1) Concentration, (2) Roasting, (3) Smelting, (4) Bessemerisation, (5) Refining.

(1) Concentration : About 2% copper is present in copper sulphide minerals available in nature. Froth flotation process is used for concentration of ore. The grinded mineral is suspended in water and turpentine oil or cryolite oil is added to it. By concentrating in this way about 25% copper containing ore is obtained.

(2) Roasting : The ore obtained by froth floatation is roasted in air so that moisture as steam, sulphur and arsenic as their oxides. During roasting, until iron sulphide is not iron oxide, cuprous sulphide is not converted to its oxide.

(3) Smelting : The ore obtained by roasting is smelted with sand (SiO_2) in blast furnace so that sand and iron oxide combine to form iron silicate which is called slag. As it is light floats in the mixture and so it is repeatedly removed. This iron oxide is removed as slag during the smelting mixture of iron sulphide and cuprous sulphide is called matte.

(4) Bessemerisation : The iron left out in the mixture is removed by this method.

The fluid obtained by smelting is poured in Bessemer's converter and required amount of sand is added then the converter is kept in vertical position. Air at high pressure is introduced into it. So that iron sulphide is converted to iron oxide which combines with sand and form iron silicate. When cuprous oxide is formed in the sufficient proportion introduction of air is stopped. As this copper gets cold bubbles of sulphur dioxide gas from fluid are evolved. Hence it appears that blisters are there on the surface of Cu and is called blister copper. This copper is about 95% pure. Mainly impurities of sulphur and iron are present in it. Impurities like Zn, Si, As, Sb, Bi, Au, Pt are present in trace amounts.

(5) Refining

(A) Thermal Refining : Blister copper is heated in presence of air in furnace. So that volatile oxides of As, Sb etc. are removed, silicates of Fe, Bi, Zn etc. float as slag on copper. The remaining impurities like Ag, au, Pt can not be removed.

During this some cuprous oxide is produced which dissolves in copper and so it becomes brittle. Hence to stop this powder of coal is spread on the fluid copper and the fluid is shaken with the freshly cut branches of tree. Because of the heat of copper destructive distillation of branches of wood produces gas like methane. It reduces cuprous oxide to copper. Copper obtained this way is about 99.5% pure.

(B) Electrolysis : Solution of copper sulphate in dilute H_2SO_4 is taken as an electrolyte in a vessel. In this small strips or rod of impure copper is dipped as the anode and strip of pure copper is dipped as cathode. Pure copper will deposited on cathode. As noble metals like Ag, Au and Pt metals oxidized they are collected below the anode which is known as anode mud. The purity of copper obtained at the cathode is about 99.96 to 99.99%.

Uses : Copper is used in preparation of electrical appliances, tubes of boiler, sheet, household vessels, currency coins and also it is added to gold ornaments so that they become strong.

It is also used for obtaining metals like Ag and Au from their ions in the solution of their salts.

97. From which of the following main ores copper mainly extrated ?

(A) Cuprite

(B) Copper glance

(C) Copper pyrites

(D) Malachite

98. Which of the following statement is wrong ?
 (A) 2% copper is available in copper sulphide ores in nature.
 (B) 5% copper obtained by remove impurities from free form of copper.
 (C) Wet metallurgical process is used for pyrites ores of lower grade.
 (D) Copper has low attraction towards sulphur so that's why it is easily reduced.
99. In extraction of copper which compound form slag ?
 (A) Sand and Iron oxide (B) Silica and Iron oxide
 (C) Iron oxide and cuprous sulphide (D) Sand and Cuprous oxide.
100. Which impurities are in 95% pure copper ?
 (A) Mainly-sulphur, Iron, Trace amount : As, Sb, Zn, Bi, Si, Au, Pt
 (B) Mainly sulphur, Zinc, Trace amount : As, Sb, Fe, Bi, Ag, Au, Pt
 (C) Mainly - Iron, zinc, Trace amount : Al, Ag, Au, Pt, Sn
 (D) Mainly sulphur, Trace amount : Zn, Sb, Fe, Si, As, Au
101. Which of the following is not done during heating Blister copper in presence of air in furnace ?
 (A) Silicates of Fe, Bi, Zn etc. Float as slag on copper.
 (B) Volatile oxides of As and Sb are remove.
 (C) During this some aqrous oxide is produced.
 (D) Copper become brittle.
102. In which of the following uses copepr is not used ?
 (A) Scientific balance (B) Tubes of boiler
 (C) Currency coins (D) Electrical appliances
103. Which of the following is alloy of copper ?
 (A) Duralamin (B) Aluminium bronze (C) Alnico (D) Magnalium
104. Which of the following is not alloy of copper ?
 (A) Delta metal (B) Muhtz metal (C) Constantant (D) magnalium
105. In Extraction of copper what is matte ?
 (A) Copper (II) sulphide and Iron (II) sulphide (B) Copper (II) sulphide and Iron (III) sulphide
 (C) Copper (I) sulphide and Iron (II) sulphide (D) Copper (I) sulphide and Iron (III) sulphide
106. Why copper become brittle during thermal refining ?
 (A) Because methan gas is obtained.
 (B) Because powder of coal is spread on the fluid copper
 (C) Because cuprose oxide is formed which is dissolve in copper
 (D) Because of destructive distilation of branches of wood.

107. Heating pyrites for removing sulphur that process called ?
 (A) Roasting (B) Calcination (C) smelting (D) Bessemerisation
108. Cu metal is reduced from what in extraction of copper from copper sulphide ore ?
 (A) FeS (B) Cu_2O (C) SO_2 (D) SO_3
109. By heating Cu_2O and Cu_2S which product is obtained ?
 (A) $\text{Cu} + \text{SO}_2$ (B) $\text{CuO} + \text{CuS}$ (C) $\text{Cu} + \text{SO}_3$ (D) Cu_2SO_3

Answers : 97. (C), 98. (D), 99. (B), 100. (A), 101. (C), 102. (A), 103. (B), 104. (D), 105. (C), 106. (C), 107. (A), 108. (B), 109. (A)

● Extraction of Iron metal (Fe)

Haematite (Fe_2O_3) is used to obtain iron.

There are total 3 steps for this.

(1) Roasting and Calcination : The oxide form ore containing iron is first roasted by heating with some coal in furnace so that the volatile impurities are removed. Ferrous oxide is oxidised to ferric oxide which does not combine with silica and does not form slag.

(2) Reduction and Smelting : The porous mixture obtained by roasting is mixed with lime stone, coke etc. are added into the blast furnace from the upper part. Here oxide is reduced to iron metal. Thermodynamics is useful in understanding the reactions occurring in blast furnace. Blast furnace is very tall furnace and there are different temperatures at different heights in the furnace. Iron obtained from blast furnace contains 4% carbon and many impurities like S, P, Si, Mn, etc. in trace. It is called Pig iron. It can be casted into different shapes. Cast iron is different from pig iron. Cast iron can be prepared by blowing hot air in the mixture of pig iron, iron scrap and coke. The proportion of carbon in it is comparatively less. It is hard and brittle.

(3) Refining : Wrought iron or malleable iron is the purest form of general iron. Wrought iron is prepared from cast iron in reverberatory furnace in which there is a layer of haematite. Limestone is added as a flux and is removed with oxidation of sulphur, silicon and phosphorus.

Uses :

Cast iron : Used in stoves, rails of railway, pipes of gutter, toys etc.

Wrought iron : Preparation of anchors, wires, bolts, chains, agricultural tools etc.

Steel containing Nickel : Used in ropes, automobiles, parts of aeroplanes, pendulums, measurement tap etc.

Steel containing chromium : Used in machines for cutting and grinding and stainless steel is used in cycles, automobiles, vessels, pans etc.

110. Mainly from which ores iron can be extracted ?
 (A) Iron pyrites (B) Magnetite (C) Haematite (D) Siderite
111. Which of the following reaction is seen during calcination process ?
 (A) Convert iron sulphide into iron oxide.
 (B) Conversion of cuprous oxide into cuprous sulphide
 (C) Conversion of cuprous sulphide into cuprous oxide
 (D) Conversion of ferrous oxide into ferric oxide

112. Reaction occurring in blast furnace working on which principle ?
 (A) Thermodynamics (B) Electrochemical laws (C) Le-chatelier (D) Electronation
113. Which of the following process is done in blast furnace at 500-800 K temperature ?
 (A) $\text{FeO}_{(s)} + \text{CO}_{(g)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{2(g)}$ (B) $\text{Fe}_2\text{O}_{3(s)} + \text{CO}_{(g)} \rightarrow 2\text{FeO}_{(s)} + \text{CO}_{2(g)}$
 (C) $\text{FeO}_{(s)} + \text{C}_{(s)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{(g)}$ (D) $\text{CaO}_{(s)} + \text{SiO}_{2(s)} \rightarrow \text{CaSiO}_3$
114. $\text{FeO}_{(s)} + \text{CO}_{(g)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{2(g)}$ this reaction is done at which temperature at blast furnace ?
 (A) 500 – 600 K, (B) 500 – 900 K,
 (C) 500 – 800 K, (D) 900 – 1500 K,
115. At which temperature pig iron is formed ?
 (A) 1270 K (B) 2170 K and high temperature
 (C) 2170 K (D) 1270 K – 2170 K
116. When will be cast iron formed ?
 (A) By passing hot air in mixture of pig iron and coke.
 (B) By heating pig iron at high temperature.
 (C) By heating pig iron and iron scrap at high temperature.
 (D) By heating mixture of pig iron, iron scrap and coke at very high temperature.
117. Which of the following statement is wrong for conversion of cast iron into wrought iron ?
 (A) layer of graphite in blast furnace.
 (B) addition of limestone as a flux.
 (C) oxidation of S, Si and P and they are removed with slag.
 (D) conversion of hematite carbon into carbon monoxide.
118. Which of the following is used by cast iron ?
 (A) Wire (B) Chains (C) Vessel (D) Toys
119. Which of the following is use of wrought iron ?
 (A) Both (B) Stove (C) Ropes (D) Cycle
120. Which of the following is use of nickel containing steel ?
 (A) grinding machines (B) parts of plane
 (C) agricultural tools (D) preparations of anchors
121. Which of the following is use of steel containing chromium ?
 (A) Cutting machines (B) Automobile (C) Toys (D) Pen
122. Which of the following is use of stainless steel ?
 (A) Automobile (B) Cycle (C) Measuring Tap (D) Pen
123. Which of the following reaction is not possible in blast furnace ?
 (A) $2\text{Fe}_2\text{O}_{3(s)} + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ (B) $\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$
 (C) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ (D) $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$

Answers : 110. (C), 111. (D), 112. (A), 113. (B), 114. (D), 115. (B), 116. (D), 117. (A),
 118. (D), 119. (A), 120. (B), 121. (A), 122. (C), 123. (A)

● Extraction of Zinc

Zinc blende is mostly used for extraction of zinc.

extraction takes place in four different steps :

(1) Concentration : Zns which is the sulphide containing ore of zinc, froth floatation process is used for its concentration. It contains galena and send etc. as the impurities.

If mineral is calamine this method is not necessary because the ore does not contain galena.

(2) Roasting : Concentrated ore Zns or calamine is roasted in presence of air so that it is converted to oxide from ZnO.

(3) Reduction : Zinc oxide obtained by roasting is mixed with powder form coal or anthracite coal and heated in the cylindrical retort which is made up of fire clay bricks. So, strongly that it becomes red hot. One end of the retort is closed and other retort is joined with the other open part so that it works as a condensor and cools the vapour of zinc that is coming out. This metal is taken out and is casted into blocks, the zinc metal that we get on commercial basis is called spelter.

(4) Refining : Zinc obtained by reduction which is called spelter contains impurities like Fe, Al, As, Sb etc., which can be removed by repeated distillation. But zinc is reacted with dilute H_2SO_4 so as to obtain pure zinc. Cadmium is precipitated by zinc dust. Iron is converted to ferric state. Al, Sb and As are separated from solutions of suitable acidity electrolysis of Zinc sulphate which filtered out. The electrolyte is zinc sulphate solution containing dilute H_2SO_4 .

Uses :

Zinc is used in preparation of electrical cells, in electroplating of zinc and in galvanising. It is used in certain alloys like brass, german silver and by reduction with zinc Ag and Au can form.

124. Which of the following ore is mainly used for extraction of zinc ?

- (A) Zinc blende (B) Calamine (C) zincite (D) above all

125. Which ore of zinc is concentrated by froth floatation method ?

- (A) zinc blende (B) calamine (C) zincite (D) siderite

126. Which of the following matter is important during roasting of Zns ?

- (A) minimum ZnO occur. (B) maximum ZnO can occur.
(C) SO_2 gas can librate. (D) $ZnSO_4$ can form.

127. Which of the following impurities are there in spelter form by reduction ?

- (A) Fe, Al, Cu, Si (B) Fe, Cu, Si, Sb (C) Al, Sb, Bi, As (D) Al, As, Sb, Fe

128. By reacting with whom pure zinc sulphate solution can form ?

- (A) dilute HCl (B) dilute H_2SO_4 (C) aqueous NaOH (D) $CuSO_4$

129. Which of the following method is used for extraction of pure zinc from spelter ?

- (A) By reacting with dilute H_2SO_4 .
(B) By precipitation of Cd by Zinc dust
(C) Al, Sb and As are separated from solutions of suitable acidity.
(D) Above all.

130. Which of the following use of zinc metal ?

- (A) electrical cell. (B) to prepare german silver alloy.
(C) extraction of Ag and Au by reduction. (D) above all

131. In purification of zinc by electrolysis...

- (A) graphite is act as anode. (B) impure metal as cathod.
(C) metal ion reduced at anode. (D) acidic ZnSO_4 act as electrolyte.

132. How to extract zinc from zinc bland ?

- (A) By electrolytic reduction and roasting (B) reduction and roasting by carbon
(C) reduction and roasting by other metal (D) self reduction.

133. Match Column-I with Column-II.

Column-I (A) (Metal)	Column-II (B) (ore)
(1) Aluminium	(P) Magnetite
(2) Copper	(Q) Siderite
(3) Iron	(R) Kaolinite
(4) Zinc	(S) Calamine
	(T) Malachite

- (A) (1)-(S), (2)-(Q), (3)-(T), (4)-(R)
(B) (1)-(R), (2)-(T), (3)-(P), (Q), (4)-(S)
(C) (1)-(R), (2)-(T), (Q), (3)-(P), (4)-(S)
(D) (1)-(S), (2)-(R), (3)-(Q), (4)-(T)

134.

Column-I (A) (ore)	Column-II (B) (formula)
(1) Kaolinite	(P) Cu_2O
(2) Cuprite	(Q) ZnO
(3) Siderite	(R) Fe_3O_4
(4) Zincite	(S) FeCO_3
	(T) $[\text{Al}_2(\text{OH})_4\text{Si}_2\text{O}_5]$

- (A) (1)-(T), (2)-(R), (3)-(S), (4)-(Q)
(B) (1)-(T), (2)-(S), (3)-(R), (4)-(Q)
(C) (1)-(T), (2)-(P), (3)-(S), (4)-(Q)
(D) (1)-(T), (2)-(P), (3)-(R), (4)-(Q)

135.

Column-I (A) (Method)	Column-II (B) (Reaction)
(1) Calcination	(P) $2\text{FeS}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{FeO}_{(s)} + 2\text{SO}_{2(g)}$
(2) Roasting	(Q) $\text{Fe}_2\text{O}_{3(s)} + \text{CO}_{(g)} \rightarrow 2\text{FeO}_{(s)} + \text{CO}_{2(g)}$
(3) Smelting	(R) $\text{ZnCO}_{3(s)} \rightarrow \text{ZnO}_{(s)} + \text{CO}_{2(g)}$
	(S) $2\text{CuFeS}_{2(s)} + 4\text{O}_{2(g)} \rightarrow \text{Cu}_2\text{S}_{2(l)} + 2\text{FeO}_{(g)} + 3\text{SO}_{2(g)}$

- (A) (1)-(R), (2)-(S), (3)-(P) (B) (1)-(Q), (2)-(P), (3)-(S)
(C) (1)-(S), (2)-(R), (3)-(Q) (D) (1)-(R), (2)-(Q), (3)-(P)

136.	Column-A (Method)	Column-B (refining)
	(1) Liquation (2) Leaching (3) Distillation	(P) Purification for titanium (Q) Metals like Hg which contain lower boiling point (R) Metals like Tin which contain lower boiling point (S) Ores in proper solvent

- (A) (1)-(R), (2)-(P), (3)-(S) (B) (1)-(Q), (2)-(S), (3)-(P)
(C) (1)-(Q), (2)-(R), (3)-(S) (D) (1)-(R), (2)-(S), (3)-(Q)

137.	Column-(A) (Metal)	Column-(B) (Method)
	(1) Zirconium (2) Nickel (3) Indium	(P) Mond carbonyl (Q) Distillation (R) Zone refining (S) Van arkel

- (A) (1)-(Q), (2)-(R), (3)-(S)
(B) (1)-(S), (2)-(P), (3)-(R)
(C) (1)-(S), (2)-(Q), (3)-(R)
(D) (1)-(Q), (2)-(P), (3)-(S)

138.	Column (A) (Temperature)	Column (B) (Reaction)
	(1) 500 – 800 K (2) 900 – 1500 K (3) 500 – 900 K (4) 1270 K	(P) $\text{FeO}_{(s)} + \text{CO}_{(g)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{2(g)}$ (Q) $\text{FeO}_{(s)} + \text{C}_{(s)} \rightarrow \text{Fe}_{(s)} + \text{CO}_{(g)}$ (R) $\text{Fe}_2\text{O}_{3(s)} + \text{CO}_{(g)} \rightarrow 2\text{FeO}_{(s)} + \text{CO}_{2(g)}$ (S) $\text{CaO}_{(s)} + \text{SiO}_{2(g)} \rightarrow \text{CaSiO}_{3(s)}$ (T) $\text{Fe}_3\text{O}_{4(s)} + \text{CO}_{(g)} \rightarrow 3\text{FeO}_{(s)} + \text{CO}_{2(g)}$

- (A) (1)-(R), (T), (2)-(P), (3)-(S), (T), (4)-(P), (Q) (B) (1)-(R), (2)-(Q), (3)-(T), (P), (4)-(Q), (S)
(C) (1)-(T), (2)-(R), (3)-(S), (P), (4)-(P) (D) (1)-(T), (2)-(P), (S), (3)-(T), (4)-(P), (R)

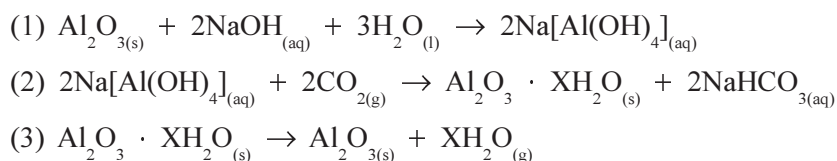
139.	Column (A) (Metal)	Column (B) (uses)
	(1) Aluminium (2) Copper (3) Iron (4) Zinc	(P) Electrical cell (Q) Toys (R) Parts of racing Cars (S) Currency coin (T) Measuring tap

- (A) (1)-(T), (2)-(S), (P), (3)-(Q), (4)-(S), (P) (B) (1)-(S), (2)-(T), (P), (3)-(P), (4)-(R)
(C) (1)-(Q), (S), (2)-(S), (3)-(Q), (T), (4)-(P) (S) (D) (1)-(Q), (2)-(P), (T), (3)-(T), (4)-(R), (S)

140.	Column (A) (Metal)	Column (B) (Alloy)
	(1) Aluminium (2) Copper (3) Iron (4) Zinc	(P) German silver (Q) Aluminium Bronze (R) Delta Metal (S) Alnico (T) Steel

- (A) (1)-(S), (2)-(Q), (3)-(R), (P), (4)-(T), (S)
(B) (1)-(Q), (S), (2)-(R), (Q), (P), (3)-(T), (4)-(P)
(C) (1)-(S), (R), (2)-(R), (3)-(T), (4)-(P)
(D) (1)-(Q), (2)-(S), (Q), (3)-(R), (4)-(T), (P)

141. Pure alumina from bauxite ore can be shown by following reaction ?



choose proper option from above equation and method.

(1) Process in equation (1) is done at what temperature and pressure ?

- (A) 473–573 K, 35–40 bar (B) 450–550 K, 30–35 bar
(C) 473–523 K, 35–36 bar (D) 450–573 K, 30–40 bar

(2) In equation (2) by doing what we can increase proportion of Al_2O_3 ?

- (A) By adding Al_2O_3
(B) Addition of freshly solution of Al_2O_3 or $\text{Al}(\text{OH})_3$.
(C) By adding $\text{Al}(\text{OH})_3$.
(D) By adding aqueous solution of Al_2O_3 and $\text{Al}(\text{OH})_3$.

(3) What is temperature of equation (3) ?

- (A) 1200 K (B) 1400 K (C) 1450 K (D) 1470 K

142. Select true or false option from following statements :

- (i) Calamine is a carbonate ore of zinc.
(ii) Leaching of gold is done by NaCN.
(iii) Sulphide ores are very useful for extraction for metals.
(iv) Purification of zinc is done by distillation.

- (A) TTTF (B) TFFT (C) FTFT (D) FTTF

143. Select true and false statement from below :

- (i) Wet metallurgical process is used for pyrites ores of higher grade.
(ii) Mixture of iron sulphide and cuprus sulphide called matte.
(iii) German silver is alloy of copper.
(iv) 4 % of carbon is present in wrought iron.
(v) Galena is present as impurities in calamine ore.

- (A) TTFFT (B) FTTFT (C) TFTFT (D) FTTF

144. Check balancing of following four reaction is true or false state that. (T = True, F = Wrong)

- (i) $\text{M}_x\text{O}_y + \text{YC} \rightarrow \text{XM} + \text{YCO}$
(ii) $2\text{Al}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Al} + 3\text{CO}_2$
(iii) $\text{FeO} + \text{SiO}_2 \rightarrow \text{FeSiO}_3$
(iv) $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \rightarrow 6\text{Cu} + \text{SO}_2$

- (A) TTTT (B) TTTF (C) TTF (D) TTFT

145. Select proper option in case of X, Y and Z

(i) Heat refining is used for purification of X metal.

(ii) Zone refining is used for purification of Y metal.

(iii) Separation of dyes Z is useful.

(A) X = Iron Y = Ge Z = Mond Carboxyl process

(B) X = Iron Y = Ge Z = Van Arkel Method

(C) X = Copper Y = Si Z = Chromatography Method

(D) X = Copper Y = Si Z = Liquation

146. Match Column-I with Column-II.

Column (A)	Column (B)
(1) $\text{PbS} \rightarrow \text{PbO}$	(P) Rosting
(2) $\text{CaCO}_3 \rightarrow \text{CaO}$	(Q) Calcination
(3) $\text{ZnS} \rightarrow \text{Zn}$	(R) Carbon Reduction
(4) $\text{Cu}_2\text{O} \rightarrow \text{Cu}$	(S) Self Reduction

(A) (1)-(P), (2)-(Q), (3)-(P),(R), (4)-(P),(R),(S)

(B) (1)-(P), (2)-(Q), (3)-(P), (Q), (4)-(R), (S)

(C) (1)-(P), (2)-(P), (Q), (3)-(Q), (4)-(P)

(D) (1)-(P), (2)-(P),(R),(S) (3)-(S),(Q), (4)-(P), (R)

Answers : 124. (A), 125. (A), 126. (B), 127. (D), 128. (B), 129. (D), 130. (D), 131. (D), 132. (B), 133. (B), 134. (C), 135. (A), 136. (D), 137. (B), 138. (A), 139. (C), 140. (B), 141. (1)-(C), (2)-(B), (3)-(D), 142. (B), 143. (D), 144. (A), 145. (C), 146. (A).

