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12th Standard

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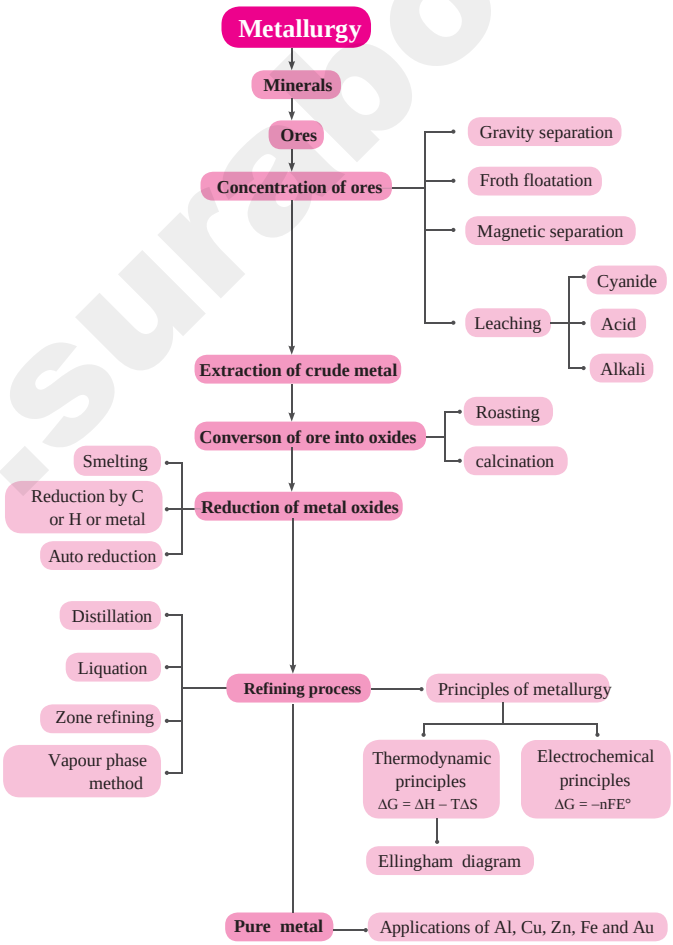
*Removed as per Reduced Syllabus for 2021-22.

VOLUME - I

UNIT 1

METALLURGY

CONCEPT MAP



FORMULAE TO REMEMBER

Metal	Ore	Composition	Metal	Ore	Composition
Aluminium	Bauxite	$Al_2O_3.nH_2O$	Zinc	Zinc blende or Sphalerite	ZnS
	Diaspore	$Al_2Si_2O_5(OH)_4$		Calamine	$ZnCO_3$
	Kaolinite	Al_2O_3		Zincite	ZnO
Iron	Haematite	Fe_2O_3	Lead	Galena	PbS
	Magnetite	Fe_3O_4		Anglesite	$PbSO_4$
	Siderite	$FeCO_3$		Cerrusite	$PbCO_3$
	Iron pyrite	FeS_2	Tin	Cassiterite (Tin stone)	SnO_2
	Limonite	$Fe_2O_3.3H_2O$	Silver	Silver glance (Argentite)	Ag_2S
Copper	Copper pyrite	$CuFeS_2$		Pyrargyrite (Ruby silver)	Ag_3SbS_3
	Copper glance	Cu_2S		Chlorargyrite (Horn Silver)	AgCl
	Cuprite	Cu_2O		Stefinite	Ag_5SbS_4
	Malachite	$CuCO_3.Cu(OH)_2$		Proustite	Ag_3AsS_3
	Azurite	$2CuCO_3.Cu(OH)_2$			

MUST KNOW DEFINITIONS

Mineral : A naturally occurring substance obtained by mining which contains the metal in free state or in the form of compounds like oxides, sulphides etc... is called a **mineral**.

Ores : Minerals that contains a high percentage of metal, from which it can be extracted conveniently and economically are called **ores**.

Concentration of Ore : The preliminary step in metallurgical process is removal of impurities. This removal process is known as **concentration of ore**.

Roasting : **Roasting** is the method, usually applied for the conversion of sulphide ores into their oxides. The concentrated ore is oxidised by heating it with excess of oxygen in a suitable furnace below the melting point of the metal.

Calcination : **Calcination** is the process in which the concentrated ore is strongly heated in the absence of air.

Refining process : Removal of unreacted oxide ore, other metals, non-metals associated with the isolated crude metal is called **refining process**.

Ellingham diagram	:	The graphical representation of variation of the standard Gibbs free energy of reaction for the formation of various metal oxides with temperature is called **Ellingham diagram.**
Application of Ellingham diagram	:	**Ellingham diagram** helps us to select a **suitable reducing agent** and **appropriate temperature** range for reduction.
Electrolytic refining	:	In electrolytic refining of the metal : **Cathode** : Pure metal **Anode** : Impure metal **Electrolyte** : Acidified aqueous solution of salt of the metal

EVALUATION

Choose The Correct Answer

1. Bauxite has the composition *[HY. 2019]*

a) Al_2O_3 b) $Al_2O_3.nH_2O$
c) $Fe_2O_3.2H_2O$ d) None of these

[Ans. **(b) $Al_2O_3.nH_2O$]**

2. Roasting of sulphide ore gives the gas (A). (A) is a colourless gas. Aqueous solution of (A) is acidic. The gas (A) is

a) CO_2 b) SO_3 c) SO_2 d) H_2S

[Ans. **(c) SO_2]**

3. Which one of the following reaction represents calcination?

a) $2Zn + O_2 \longrightarrow 2ZnO$
b) $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$
c) $MgCO_3 \longrightarrow MgO + CO_2$
d) Both (a) and (c)

[Ans. **(c) $MgCO_3 \longrightarrow MgO + CO_2$]**

4. The metal oxide which cannot be reduced to metal by carbon is

a) PbO b) Al_2O_3 c) ZnO d) FeO

[Ans. **(b) Al_2O_3]**

5. Which of the metal is extracted by Hall-Heroult process?

a) Al b) Ni c) Cu d) Zn

[Ans. **(a) Al]**

6. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?

a) ΔG_f° of sulphide is greater than those for CS_2 and H_2S.
b) ΔG_r° is negative for roasting of sulphide ore to oxide
c) Roasting of the sulphide to its oxide is thermodynamically feasible.
d) Carbon and hydrogen are suitable reducing agents for metal sulphides.

[*Ans.* (d) Carbon and hydrogen are suitable reducing agents for metal sulphides.]

7. Match items in column - I with the items of column – II and assign the correct code.

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

	A	B	C	D	
(a)	(i)	(ii)	(iii)	(iv)	
(b)	(iii)	(iv)	(v)	(i)	
(c)	(iv)	(ii)	(iii)	(i)	
(d)	(ii)	(iii)	(i)	(v)	**[Ans. (c) (iv) (ii) (iii) (i)]**

8. **Wolframite ore is separated from tinstone by the process of** *[PTA - 2; Mar.-2020]*

a) Smelting
b) Calcination
c) Roasting
d) Electromagnetic separation

[Ans. **(d) Electromagnetic separation]**

9. **Which one of the following is not feasible**

a) $Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$
b) $Cu_{(s)} + Zn^{2+}_{(aq)} \longrightarrow Zn_{(s)} + Cu^{2+}_{(aq)}$
c) $Cu_{(s)} + 2Ag^{+}_{(aq)} \longrightarrow Ag_{(s)} + Cu^{2+}_{(aq)}$
d) $Fe_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Cu_{(s)} + Fe^{2+}_{(aq)}$

[Ans. **(b)** $Cu_{(s)} + Zn^{2+}_{(aq)} \longrightarrow Zn_{(s)} + Cu^{2+}_{(aq)}$**]**

10. **Electrochemical process is used to extract**

a) Iron b) Lead
c) Sodium d) Silver

[Ans. **(c) Sodium]**

11. **Flux is a substance which is used to convert**

a) Mineral into silicate
b) Infusible impurities to soluble impurities
c) Soluble impurities to infusible impurities
d) All of these *[Ans.* **(b) Infusible impurities to soluble impurities]**

12. **Which one of the following ores is best concentrated by froth – floatation method?** *[Govt.MQP_2019]*

a) Magnetite b) Hematite
c) Galena d) Cassiterite

[Ans. **(c) Galena]**

13. **In the extraction of aluminium from alumina by electrolysis, cryolite is added to**

a) Lower the melting point of alumina
b) Remove impurities from alumina
c) Decrease the electrical conductivity
d) Increase the rate of reduction

[Ans. **(a) Lower the melting point of alumina]**

14. **Zinc is obtained from ZnO by**

a) Carbon reduction
b) Reduction using silver
c) Electrochemical process
d) Acid leaching *[Ans.* **(a) Carbon reduction]**

15. **Extraction of gold and silver involves leaching with cyanide ion. Silver is later recovered by** *(NEET-2017)*

a) Distillation b) Zone refining
c) Displacement with zinc
d) liquation

[Ans. **(c) Displacement with zinc]**

16. **The following set of reactions are used in refining Zirconium**

$$Zr\,(impure) + 2I_2 \xrightarrow{523K} ZrI_4.$$

$$ZrI_4 \xrightarrow{1800K} Zr\,(pure) + 2I_2$$

This method is known as

a) Liquation b) Van Arkel process
c) Zone refining d) Mond's process

[Ans. **(b) van Arkel process]**

17. **Which of the following reduction is not thermodynamically feasible?** *[PTA - 3]*

a) $Cr_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Cr$
b) $Al_2O_3 + 2Cr \longrightarrow Cr_2O_3 + 2Al$
c) $3TiO_2 + 4Al \longrightarrow 2\,Al_2O_3 + 3Ti$
d) none of these

[Ans. **(b)** $Al_2O_3 + 2Cr \longrightarrow Cr_2O_3 + 2Al$**]**

Q&A Answer the Following Questions

1. **What is the difference between minerals and ores?** *[QY_2019; Sep.-2020]*

Ans.

Minerals	Ores
A naturally occurring substance obtained by mining which contain the metal in free state or in the form of compounds.	Ore contains a high percentage of metal, from which it can be extracted conveniently and economically.
All minerals are not ores	All ores are Minerals
It contains a low percentage of metal.	It contains a high percentage of metals
Ex : Mineral of Al is bauxite and china clay	**Ex :** Ore of Al is bauxite

2. What are the various steps involved in extraction of pure metals from their ores?

Ans. The various steps involved in the extraction of pure metals from their ores are

(i) concentration of the ore

(ii) extraction of crude metal

(iii) refining of crude metal

3. What is the role of Limestone in the extraction of Iron from its oxide Fe_2O_3?

Ans. *(i)* Lime stone acts as a Flux.

(ii) It combine with silica and get converted into Calcium silicate called as slag.

$$\underset{\text{Flux}}{CaO_{(s)}} + \underset{\text{Gangue}}{SiO_{2(s)}} \longrightarrow \underset{\text{Slag}}{CaSiO_{3(s)}}$$

4. Which type of ores can be concentrated by froth floatation method? Give two examples for such ores.

Ans. *(i)* Sulphide ores can be concentrated by froth floatation method.

(ii) **Ex :** Lead sulphide **galena** (PbS) and zinc blende (ZnS).

5. Describe a method for refining nickel.

Ans. **Mond process for refining nickel :** *[PTA - 3]*

(i) The impure metal is heated in a stream of carbon monoxide at around 350K.

(ii) The nickel reacts with the CO to form a highly volatile nickel tetra carbonyl.

(iii) The solid impurities are left behind.

$$Ni_{(s)} + 4CO_{(g)} \xrightarrow{350\ K} [Ni(CO)_4]_{(g)}$$

(iv) On heating the nickel tetracarbonyl around 460K, the complex decomposes to give pure metal.

$$[Ni(CO_4)]_{(g)} \xrightarrow{460\ K} Ni_{(s)} + 4CO_{(g)}$$

6. Explain zone refining process with an example. *[PTA - 6; Mar.-2020]*

Ans. *(i)* Zone refining method is based on principles of Fractional Crystallisation. When an impure metal is melted and allowed to solidify, the impurities will prefer to remain in the molten region.

(ii) The impure metal is taken in the form of a rod.

(iii) When the metal rod is heated with a heater the metal melts.

(iv) The heater is slowly moved from one end to the other end.

(v) The impurity dissolves in the molten zone.

(vi) When the heater moves, the molten zone also moves.

(vii) This process is repeated again and again to get pure metal.

(viii) The process is carried in an inert gas atmosphere to prevent oxidation of metal.

Example :

(i) Elements such as Germanium (Ge), Silicon (Si) and Galium (Ga) are refined using this process.

7. Give the uses of zinc. *[PTA - 4]*

Ans. *(i)* Metallic zinc is used in **galvanising** metals such as iron and steel structures to protect them from rusting and corrosion.

(ii) Zinc is also used to produce die-castings in the automobile, electrical and hardware industries

(iii) Zinc oxide is used in the manufacture of many products such as paints, rubber, cosmetics, pharmaceuticals, plastics, inks, batteries, textiles and electrical equipment.

(iv) Zinc sulphide is used in making luminous paints, fluorescent lights and x-ray screens.

(v) Brass an alloy of zinc is used in water valves and communication equipment as it is highly resistant to corrosion.

8. Explain the following terms with suitable examples. *[PTA - 2; Sep.-2020]*

(i) Gangue (ii) Slag

Ans. *(i)* **Gangue :** The non-metallic impurities, rocky materials and siliceous matter, associated with the ore is called gangue.

Example : SiO_2 is the gangue present in the iron ore.

(ii) **Slag :** Slag is the fusible product formed when flux reacts with gangue during the extraction of metal.

Example :

$$\underset{\text{Flux}}{CaO_{(s)}} + \underset{\text{Gangue}}{SiO_2} \longrightarrow \underset{\text{(slag)}}{CaSiO_3}$$

9. Give the basic requirement for vapour phase refining.

Ans. *(i)* The metal should form a volatile compound when treated with a suitable reagent.

(ii) Then the volatile compound is decomposed to give the pure metal.

10. Describe the role of the following in the process mentioned.

(i) Silica in the extraction of copper.

(ii) Cryolite in the extraction of aluminium. *[QY_2019]*

(iii) Iodine in the refining of Zirconium. *[QY_2019]*

(iv) Sodium cyanide in froth floatation.

Ans. *(i)* Silica, is used as an acidic flux is used to remove slag during the process of roasting.

(ii) Lowers the melting point to 1173K and improves the electrical conductivity of the aluminium.

(iii) To form a volatile compound which on further heating decomposes to give pure Zn.

(iv) Sodium cyanide is used as an depressing agent in froth flotation. It prevents other metal sulphides coming to the froth.

For Example, when impurities such as ZnS is present in galena (PbS), sodium cyanide (NaCN) is added to depresses the flotation property of ZnS by forming a layer of zinc complex $Na_2[Zn(CN)_4]$ on the surface of zinc sulphide.

11. Explain the principle of electrolytic refining with an example. *[HY_2019]*

Ans. *(i)* Electrolytic refining is carried out in an electrolytic cell.

(ii) **Anode** : Impure metal
Cathode : Thin strips of pure metal
Electrolyte : Aqueous solution of the salts of the metal.

(iii) The metal of interest dissolves from the anode, pass into the solution while the same amount of metal ions from the solution will be deposited at the cathode.

(iv) During electrolysis, the less electropositive impurities in the anode, settle down at the bottom and are removed as anode mud.

(v) Electrolytic refining of silver as an example.
Cathode : Pure silver
Anode : Impure silver rods
Electrolyte : Acidified aqueous solution of silver nitrate.

(vi) When a current is passed through the electrodes the following reactions will take place

Reaction at anode

$$Ag_{(s)} \longrightarrow Ag^{+}_{(aq)} + 1e^{-}$$

Reaction at cathode

$$Ag^{+}_{(aq)} + 1e^{-} \longrightarrow Ag_{(s)}$$

(vii) During electrolysis, at the anode the silver atoms lose electrons and enter the solution.

(viii) The positively charged silver cations migrate towards the cathode and get discharged by gaining electrons and deposited on the cathode.

Evaluate Yourself

1. Write the equation for the extraction of silver by leaching with sodium cyanide and show that the leaching process is a redox reaction.

Ans. $Ag_2S + 4NaCN \longrightarrow 2Na[Ag(CN)_2] + Na_2S$

$2Na[Ag(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2Ag$

(i) Silver is leached with an aqueous solution of NaCN to form soluble sodium dicyano argentite.

(ii) Silver is recovered from dicyano argentite. Silver is reduced to its elemental state.

2. Magnesite (Magnesium carbonate) is calcined to obtain magnesia, which is used to make refractory bricks. Write the decomposition reaction.

Ans. $MgCO_3 \xrightarrow{\Delta} MgO + CO_{2(g)} \uparrow$

PTA Model Questions And Answers

Choose the Correct Answer — 1 mark

1. Sulphide ores of metals are usually concentrated by froath floatation process. Which one of the following sulphide ore offers an exception and is concentrated by chemical leaching. *[PTA - 4]*

a) Argentite b) galena
c) Copper pyrites d) Sphalerite

[*Ans.* (a) Argentite]

2. Which method of purification represented by the equation? *[PTA - 5]*

$$Ti(impure) + 2I_2 \xrightarrow{550K} TiI_4$$
$$\xrightarrow{1800K} Ti(pure) + 2I_2$$

a) Cupellation
b) Zone refining
c) Van - Arkel method
d) Mond's process

[*Ans.* (c) Van - Arkel method]

3. The process of converting hydrated aluminia into anhydrous alumina is called. *[PTA - 6]*

a) Roasting b) Smelting
c) Auto-reduction d) Calcination

[*Ans.* (d) Calcination]

Answer The Questions — 2 marks

1. What is the role of depressing agent in froath floatation process? *[PTA - 1]*

Ans. When impurities such as ZnS is present in galena (PbS), sodium cyanide (NaCN) is added to depresses the flotation property of ZnS by forming a layer of zinc complex $Na_2[Zn(CN)_4]$ on the surface of zinc sulphide.

2. Describe the underlying principle of froth floatation process. *[PTA - 3]*

Ans. Froth floatation process is based on the principle that the ore particles are wetted by oil and the gangue particles by water. This is used for the concentration of sulphide ores.

Answer The Questions — 3 marks

1. Define roasting. *[PTA - 4]*

Ans. In roasting, the concentrated ore is oxidised by heating it with excess of oxygen in a suitable furnace below the melting point of the metal.

$$2Pbs + 3O_2 \xrightarrow{\Delta} 2PbO + 2SO_2 \uparrow$$

2. Explain calcination with an example. *[PTA - 4]*

Ans. *(i)* Calcination is the process in which the concentrated ore is strongly heated in the absence of air.

(ii) During this process, the water of crystallisation present in the hydrated oxide escapes as moisture.

(iii) Any organic matter (if present) also get expelled leaving behind a porous ore.

(iv) This method can also be carried out with a limited supply of air.

(v) During calcination of carbonate ore, carbon dioxide is expelled

$$PbCO_3 \xrightarrow{\Delta} PbO + CO_2\uparrow$$

Answer The Questions — 5 marks

1. Explain electrolytic refining of silver. *[PTA - 5]*

Ans. *(i)* Electrolytic refining of silver as an example.

Cathode : Pure silver
Anode : Impure silver rods
Electrolyte : Acidified aqueous solution of silver nitrate.

(ii) When a current is passed through the electrodes the following reactions will take place

Reaction at anode

$$Ag_{(s)} \longrightarrow Ag^+_{(aq)} + 1e^-$$

Reaction at cathode

$$Ag^+_{(aq)} + 1e^- \longrightarrow Ag_{(s)}$$

2. Explain extraction of copper from copper pyrites. *[PTA - 5]*

Ans. *(i)* In this method, a flux (a chemical substance that forms an easily fusible slag with gangue) and a reducing agent such as carbon, carbon monoxide (or) aluminium is added to the concentrated ore and the mixture is melted by heating at an elevated temperature (above the melting point of the metal) in a smelting furnace.

(ii) For example the oxide of iron can be reduced by carbon monoxide as follows.

$$Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)}\uparrow$$

(iii) In this extraction, a basic flux, limestone (CaO) is used. Since the silica gangue present in the ore is acidic in nature, the limestone combines with it to form calcium silicate (slag).

$$\underset{\text{Flux}}{CaO_{(s)}} + \underset{\text{Gangue}}{SiO_{2(s)}} \longrightarrow \underset{\text{Slag}}{CaSiO_{3(s)}}$$

(iv) In the extraction of copper from copper pyrites, the concentrated ore is heated in a reverberatory furnace after mixing with silica, an acidic flux.

(v) The ferrous oxide formed due to melting is basic in nature and it combines with silica to form ferrous silicate (slag).

(vi) The remaining metal sulphides Cu_2S and FeS are mutually soluble and form a copper matte.

$$2CuFeS_{2(s)} + O_{2(g)} \longrightarrow 2FeS_{(l)} + Cu_2S_{(l)} + SO_{2(g)}$$

$$2FeS_{(l)} + 3O_{2(g)} \longrightarrow 2FeO_{(l)} + 2SO_{2(g)}$$

$$\underset{\text{Flux}}{FeO_{(s)}} + \underset{\text{Gangue}}{SiO_{2(s)}} \longrightarrow \underset{\text{Slag}}{FeSiO_{3(s)}}$$

(vii) The matte is separated from the slag and fed to the converting furnace.

(viii) During conversion, the FeS present in the matte is first oxidised to FeO.

(ix) This is removed by slag formation with silica.

(x) The remaining copper sulphide is further oxidised to its oxide which is subsequently converted to metallic copper.

$$2Cu_2S_{(l,s)} + 3O_{2(g)} \longrightarrow 2Cu_2O_{(l,s)} + 2SO_{2(g)}$$

$$2Cu_2O_{(l)} + Cu_2S_{(l)} \longrightarrow 6Cu_{(l)} + SO_{2(g)}$$

(xi) The metallic copper is solidified and it has blistered appearance due to evolution of SO_2 gas formed in this process. This copper is called blistered copper.

Government Exam Questions And Answers

Choose the Correct Answer — 1 mark

1. The metal which is used in packing metarial for food items : *[Sep.-2020]*

(a) Zn (b) Zr (c) Al (d) A

[Ans. (c) Al]

Answer The Questions — 2 marks

1. Oxides like Ag_2O and HgO undergo self reduction. Why? *[QY_2019]*

Ans. Decomposition temperature of Ag_2O and HgO are 600 and 700 K respectively.

These oxides are unstable at moderate temperature so undergo self reduction.

2. Name the collector and depressing agent used in froth flotation process. *[HY_2019]*

Ans. *(i)* Sodium ethyl xanthate acts as a collector.

(ii) Sodium cyanide, Sodium carbonate are used as depressing agents in froth flotation process.

Answer The Questions — 3 marks

1. Explain how gold ore is leached by cyanide process *[Govt.MQP_2019]*

Ans. *(i)* Gold is usually found in native state.

(ii) The leaching process is intended to concentrate the gold metal.

$$4Au_{(s)} + 8\,NaCN^-_{(aq)} + 2H_2O_{(aq)} + O_{2(g)} \longrightarrow 4\,Na\,[Au(CN)_2]^-_{(aq)} + 4NaOH^-_{(aq)}$$

$$2Na\,[Au(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2Au\downarrow$$

(iii) In this reaction, gold is reduced to its elemental state and the process is called cementation.

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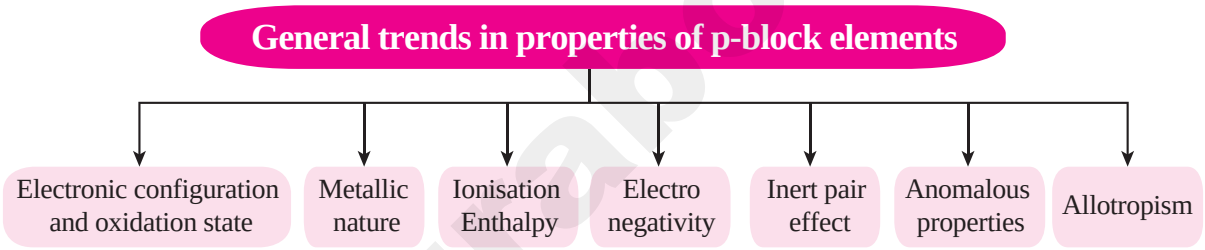
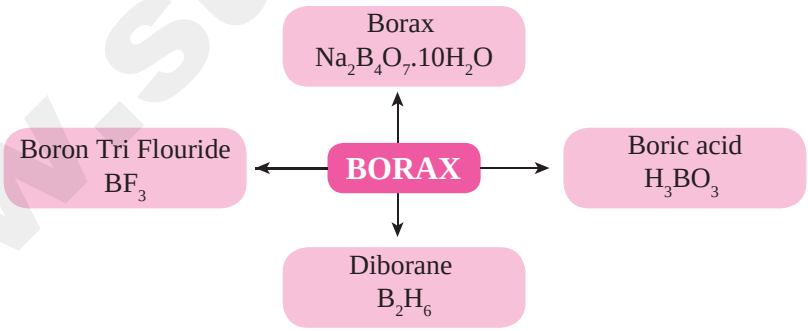
UNIT 2

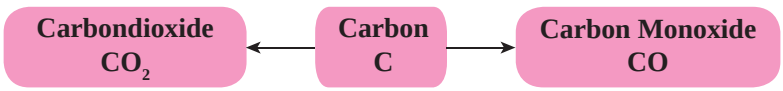
p-Block Elements - I

CONCEPT MAP





Preparation, Properties, Structure and uses of the above compounds.



Preparation, Properties, Structure and uses.

FORMULAE TO REMEMBER

Borax	:	$Na_2B_4O_7.10H_2O$
Boric acid	:	H_3BO_3 or $B(OH)_3$
Di Borane	:	B_2H_6
Boron Fluoride	:	BF_3
Aluminium Chloride	:	$AlCl_3$
Silicon tetrachloride	:	$SiCl_4$
Silicones	:	R_2SiO
Potash Alum	:	$K_2SO_4.Al_2(SO_4)_3.\ 24H_2O$
Sodium Alum	:	$Na_2SO_4.Al_2(SO_4)_3.24H_2O$
Ammonium Alum	:	$(NH_4)_2SO_4.Al_2(SO_4)_3.24H_2O$
Chrome Alum	:	$K_2SO_4.Cr_2(SO_4)_3.24H_2O$
Nickel Tetra Carbonyl	:	$[Ni(CO)_4]$
Iron Penta Carbonyl	:	$[Fe(CO)_5]$
Chromium Hexa Carbonyl	:	$[Cr(CO)_6]$
Thortveitite	:	$Sc_2Si_2O_7$
Spodumene	:	$LiAl(SiO_3)_2$

MUST KNOW DEFINITIONS

Metallic Character	:	The tendency of an element to form a cation by loosing electrons is known as **electropositive** or **metallic character.**
Allotropism	:	Some elements exist in more than one crystalline or molecular forms in the same physical state. This property is called **allotropism**.
Hydroboration	:	Diborane adds on to alkenes and alkynes in ether solvent at room temperature. This reaction is called **hydroboration**.
Catenation	:	**Catenation** is an ability of an element to form chain of atoms.
Silcones	:	**Silicones or poly siloxanes** are organo silicon polymers with general empirical formula (R_2SiO).
Silicates	:	The mineral which contains silicon and oxygen in tetrahedral $[SiO_4]^{4-}$ units linked together in different patterns are called **silicates**.
Zeolites	:	Zeolites are three dimensional crystalline solids containing aluminium, silicon, and oxygen in their regular three dimensional framework.
Inert pair effect	:	In heavier post-transition metals, the outer s electrons (ns) have a tendency to remain inert and show reluctance to take part in the bonding, which is known as inert pair effect.

EVALUATION

Choose The Correct Answer

1. An aqueous solution of borax is

a) neutral b) acidic
c) basic d) amphoteric

[Ans. (c) basic]

2. Boric acid is an acid because its molecule *(NEET)*

a) contains replaceable H^+ ion
b) gives up a proton
c) combines with proton to form water molecule
d) accepts OH^- from water, releasing proton.

[Ans. (d) accepts OH^- from water, releasing proton]

3. Which among the following is not a borane?

a) B_2H_6 b) B_3H_6
c) B_4H_{10} d) none of these

[Ans. (b) B_3H_6]

4. Which of the following metals has the largest abundance in the earth's crust?

a) Aluminium b) Calcium
c) Magnesium d) Sodium

[Ans. (a) Aluminium]

5. The element that does not show catenation among the following p-block elements is

a) Carbon b) silicon
c) Lead d) germanium

[Ans. (c) Lead]

6. Carbon atoms in fullerene with formula C_{60} have

a) sp^3 hybridised b) sp hybridised
c) sp^2 hybridised
d) partially sp^2 and partially sp^3 hybridised

[Ans. (c) sp^2 hybridised]

7. Oxidation state of carbon in its hydrides

a) +4 b) −4 c) +3 d) +2

[Ans. (a) +4]

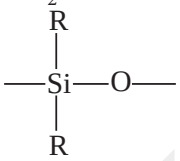
8. The basic structural unit of silicates is *(NEET) [PTA-1]*

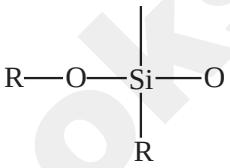
a) $(SiO_3)^{2-}$ b) $(SiO_4)^{2-}$
c) $(SiO)^-$ d) $(SiO_4)^{4-}$

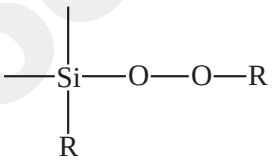
[Ans. (d) $(SiO_4)^{4-}$]

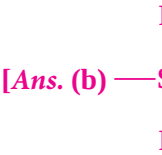
9. The repeating unit in silicone is

a) SiO_2

b) 

c) 

d) 

[Ans. (b)  *]*

10. Which of these is not a monomer for a high molecular mass silicone polymer?

a) Me_3SiCl b) $PhSiCl_3$
c) $MeSiCl_3$ d) Me_2SiCl_2

[Ans. (a) Me_3SiCl]

11. Which of the following is not sp^2 hybridised?

a) Graphite b) graphene
c) Fullerene d) dry ice

[Ans. (d) dry ice]

12. The geometry at which carbon atom in diamond are bonded to each other is

a) Tetrahedral b) hexagonal
c) Octahedral d) none of these

[Ans. (a) Tetrahedral]

13. **Which of the following statements is not correct?**

a) Beryl is a cyclic silicate
b) Mg_2SiO_4 is an orthosilicate
c) SiO_4^{4-} is the basic structural unit of silicates
d) Feldspar is not aluminosilicate

[*Ans.* (d) Feldspar is not aluminosilicate]

14. **Match items in column - I with the items of column – II and assign the correct code.**

Column - I		Column - II	
A	Borazole	**1**	$B(OH)_3$
B	Boric acid	**2**	$B_3N_3H_6$
C	Quartz	**3**	$Na_2[B_4O_5(OH)_4]\ 8H_2O$
D	Borax	**4**	SiO_2

	A	B	C	D
(a)	2	1	4	3
(b)	1	2	4	3
(c)	1	2	3	4
(d)	None of these			

[Ans. (a) 2, 1, 4, 3]

15. **Duralumin is an alloy of**

a) Cu, Mn
b) Cu, Al, Mg
c) Al, Mn
d) Al, Cu, Mn, Mg

[*Ans.* (d) Al, Cu, Mn, Mg]

16. **The compound that is used in nuclear reactors as protective shields and control rods is**

a) Metal borides
b) Metal oxides
c) Metal carbonates
d) Metal carbide

[*Ans.* (a) Metal borides]

17. **The stability of +1 oxidation state increases in the sequence** *[QY_2019]*

a) Al < Ga < In < Tl
b) Tl < In < Ga < Al
c) In < Tl < Ga < Al
d) Ga< In < Al < Tl

[*Ans.* (a) Al < Ga < In < Tl]

Answer the Following Questions

1. **Write a short note on anomalous properties of the first element of p-block.** *[Sep.-2020]*

Ans. **Anomalous properties of the first element of p-block :** In p-block elements, the first member of each group differs from the other elements of the corresponding group. The following factors are responsible for this anomalous behaviour.

(i) Small size of the first member.
(ii) High ionisation enthalpy and high electronegativity.
(iii) Absence of d-orbitals in their valance shell.

2. **Describe briefly allotropism in p- block elements with specific reference to carbon.**

Ans. **Allotropism in p- block elements :**

(i) Some elements exist in more than one crystalline or molecular forms in the same physical state.
(ii) Carbon exists as diamond and graphite. This phenomenon is known as allotropism.
(iii) Other important allotropes of carbon are graphite, fullerenes, carbon nanotubes.

3. **Give the uses of Borax.** *[HY_2019]*

Ans. *(i)* Borax is used for the identification of coloured metal ions.
(ii) In the manufacture optical and borosilicate glass, enamels and glazes for pottery.
(iii) It is also used as a flux in metallurgy and also acts as a preservative.

4. **What is catenation? Describe briefly the catenation property of carbon.** *[Sep.-2020]*

Ans. *(i)* Catenation is an ability of an element to form chain of atoms.
(ii) The following conditions are necessary for catenation. *Mar.-2020]*
(a) The valency of element is greater than or equal to two,
(b) Element should have an ability to bond with itself
(c) The self bond must be as strong as its bond with other elements
(d) Kinetic inertness of catenated compound towards other molecules.

Unit 2

(iii) Carbon possesses all the above properties and forms a wide range of compounds with itself and with other elements such as H, O, N, S and halogens.

5. Give the uses of silicones.

Ans. *(i)* Silicones are used for low temperature lubrication and in vacuum pumps, high temperature oil baths etc.

(ii) They are used for making water proofing clothes.

(iii) They are used as insulting material in electrical motor and other appliances.

(iv) They are mixed with paints and enamels to make them resistant towards high temperature, sunlight, dampness and chemicals.

6. Give one example for each of the following

(i) icosogens (ii) tetragen

(iii) prictogen (iv) chalcogen

Ans. *(i)* icosogens - Boron

(ii) tetragen - Carbon

(iii) prictogen - Nitrogen

(iv) chalcogen - Oxygen

7. Write a note on metallic nature of p-block elements.

Ans. *(i)* The tendency of an element to form a cation by losing electrons is known as electropositive or metallic character.

(ii) This character depends on the ionisation energy.

(iii) Generally on moving down a group ionisation energy decreases and hence the metallic character increases.

(iv) In p-block, the elements present in lower left part are metals while the elements in the upper right part are non metals.

Group	Metals	Non-metals	Metalloids
13	Al, Ga, In, Tl	B	-
14	Sn, pb	C	Si, Ge
15	Bi	O, S, Se	Te, Po
16	-	F, Cl, Br, I	-
17	-	He, Ne, Ar, Kr, Xe	-

8. Complete the following reactions

a. $B(OH)_3 + NH_3 \longrightarrow$

b. $Na_2B_4O_7 + H_2SO_4 + H_2O \longrightarrow$

c. $B_2H_6 + 2NaOH + 2H_2O \longrightarrow$

d. $B_2H_6 + CH_3OH \longrightarrow$

e. $BF_3 + 9H_2O \longrightarrow$

f. $HCOOH + H_2SO_4 \longrightarrow$

g $SiCl_4 + NH_3 \longrightarrow$ *[QY_2019]*

h. $SiCl_4 + C_2H_5OH \longrightarrow$

i. $B + NaOH \longrightarrow$ *[QY_2019]*

j. $H_2B_4O_7 \xrightarrow{\text{Red hot}}$

Ans. **a.** $B(OH)_3 + NH_3 \xrightarrow{\Delta} BN + 3H_2O$

b. $Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$

c. $B_2H_6 + 2NaOH + 2H_2O \longrightarrow 2NaBO_2 + 6H_2$

d. $B_2H_6 + 6CH_3OH \longrightarrow 2B(OCH_3)_3 + 6H_2$

e. $4BF_3 + 3H_2O \longrightarrow H_3BO_3 + 3HBF_4$

f. $HCOOH + H_2SO_4 \longrightarrow CO + H_2O + H_2SO_4$

g $2SiCl_4 + NH_3 \xrightarrow[\text{ether}]{335K} Cl_3Si - NH - SiCl_3$

h. $SiCl_4 + 4C_2H_5OH \longrightarrow Si(OC_2H_5)_4 + 4HCl$

i. $2B + 6NaOH \longrightarrow 2Na_3BO_3 + 3H_2$

j. $H_2B_4O_7 \xrightarrow{\text{Red hot}} 2B_2O_3 + H_2O$

9. How will you identify borate radical?

[PTA - 5; Govt.MQP_2019; QY_2019]

Ans. *(i)* When boric acid or borate salt is heated with ethyl alcohol in presence of conc. sulphuric acid, an ester, triethylborate is formed.

(ii) The vapour of this ester burns with a green edged flame and this reaction is used to identify the presence of borate.

$$H_3BO_3 + 3C_2H_5OH \xrightarrow[H_2SO_4]{\text{Conc.}} B(OC_2H_5)_3 + 3H_2O$$

10. Write a note on zeolites. *[PTA - 2; QY_2019]*

Ans. *(i)* Zeolites are three-dimensional crystalline solids containing aluminium, silicon, and oxygen in their regular three dimensional framework.

(ii) They are hydrated sodium alumino silicates with general formula $Na_2O.(Al_2O_3).x(SiO_2).yH_2O$ (x = 2 to 10; y = 2 to 6).

(iii) Zeolites have porous structure in which the monovalent sodium ions and water molecules are loosely held.

(iv) The Si and Al atoms are tetrahedrally coordinated with each other through shared oxygen atoms.

(v) Zeolites are similar to clay minerals but they differ in their crystalline structure.

(vi) Zeolites have a three dimensional crystalline structure looks like a honeycomb consisting of a network of interconnected tunnels and cages.

(vii) Water molecules moves freely in and out of these pores but the zeolite framework remains rigid.

(viii) Another special aspect of this structure is that the pore/channel sizes are nearly uniform, allowing the crystal to act as a molecular sieve.

(ix) The removal of permanent hardness of water using zeolites.

11. How will you convert boric acid to boron nitride? *[PTA - 3]*

Ans. Fusion of urea with $B(OH)_3$, in an atmosphere of ammonia at 800 - 1200 K gives boron nitride.

$$B(OH)_3 + NH_3 \xrightarrow{\Delta} BN + 3H_2O$$

12. A double salt which contains fourth period alkali metal (A) on heating at 500K gives (B). aqueous solution of (B) gives white precipitate with $BaCl_2$ and gives a red colour compound with alizarin. Identify A and B.

Ans. *(i)* A double salt which contains 4th period alkali metal (A) is

$K_2SO_4.Al_2(SO_4)_3.24H_2O$

(ii) $K_2SO_4Al_2(SO_4)_3.24H_2O \xrightarrow{500K} K_2SO_4.Al_2(SO_4)_3 + 24H_2O$

A	$K_2SO_4.Al_2(SO_4)_3 24H_2O$	Potash alum
B	$K_2SO_4.Al_2(SO_4)_3$.	Burnt alum

Evaluate Yourself

1. Why group 18 elements are called inert gases? Write the general electronic configuration of group 18 elements.

Ans. *(i)* Group 18 consists of 6 elements, helium, neon, argon, krypton, xenon and radon. All these are gases and almost chemically inert. Since they have completely filled valence shell. (least reactive elements). Hence they are called inert gases.

(ii) The general electronic configuration of group 18 elements is ns^2, np^6.

PTA Model Questions And Answers

Choose the Correct Answer — 1 mark

1. Elements like silicon and Germanium to be used as a semiconductor is purified by *[PTA - 1]*

a) heating under vaccum b) Van - Arkel method

c) Zone refining d) Electrolysis **[*Ans.* (c) Zone refining]**

2. The basicity of hypophosphorus acid is *[PTA - 2]*

a) 1 b) 2 c) 3 d) 4 **[*Ans.* (a) 1]**

Unit 2

3. Ortho boric acid on dehydration at 373 K produces mainly *[PTA - 3]*

a) metaboric acid b) boric anhydride

c) Boron metal and Oxygen

d) tetraboric acid. **[*Ans.* (a) metaboric acid]**

4. On hydrolysis BF_3 gives Boric acid and converted to fluroboric acid. The fluoroboric acid contains the species. *[PTA - 6]*

a) H^+, F^- & BF_3 b) H^+ & $[BF_4]^-$

c) $[H\,BF_3]^+$ & F^- d) H^+, B^{3+} & F^-

[*Ans.* (b) H^+ & $[BF_4]^-$]

Answer The Questions 2 mark

1. Nitrogen does not form any penta halides like phosphorus. why? *[PTA - 4]*

Ans. Nitrogen does not form penta halides because it cannot extend its valency upto 5 due to unavailability of d-orbitals.

2. Why formic acid act as strong reducing agent? Give one equation to show its reducing property. *[PTA - 6]*

Ans. *(i)* Formic acid (HCOOH) is unique because it contains both an aldehyde group and carboxyl group also.

(ii) Hence it can act as a **reducing agent**. It reduces Fehling's solution Tollen's reagent and decolourises pink coloured $KMnO_4$ solution.

(iii) Whereas in acetic acid, there is no aldehyde group and it cannot act as reducing agent.

(iv) Formic acid reduces ammoniacal silver nitrate solution **(Tollen's reagent)** to metallic silver.

$$HCOOH + Ag_2O \longrightarrow H_2O + CO_2 + 2Ag\downarrow \text{(metallic silver)}$$

(v) Formic acid reduces Fehling's solution. It reduces blue coloured cupric ions to red coloured cuprous ions.

$$\underset{\text{(blue)}}{HCOO^- + 2Cu^{2+} + 5OH^-} \longrightarrow \underset{\text{(red)}}{CO_3^{2-} + Cu_2O} + 3H_2O$$

Answer The Questions 3 marks

1. $AlCl_3$ is more stable where as $TlCl_3$ is highly unstable. Why? *[PTA - 2]*

Ans. **(i)** Aluminium(III)chloride is stable whereas thallium(III)chloride is highly unstable and disproportionates to thallium(I) chloride and chlorine gas.

(ii) This shows that in thallium the stable lower oxidation state corresponds to the loss of np electrons only and not ns electrons.

(iii) Thus in heavier posttransition metals, the outer s electrons (ns) have a tendency to remain inert and show reluctance to take part in the bonding, which is known as inert pair effect.

2. How is potash Alum prepared? *[PTA - 4]*

Ans. The alunite the alum stone is the naturally occurring form and it is $K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3$. When alum stone is treated with excess of sulphuric acid, the aluminium hydroxide is converted to aluminium sulphate. A calculated quality of potassium sulphate is added and the solution is crystallised to generate potash alum. It is purified by recrystallisation.

$$K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3 + 6H_2SO_4 \longrightarrow K_2SO_4 + 3Al_2(SO_4)_3 + 12H_2O$$

$$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3.24H_2O$$

3. What are amphiboles? Give example. *[PTA - 5]*

Ans. **Double chain silicates (or amphiboles):** These silicates contains $[Si_4O_{11}]_n^{6n-}$ ions. In these silicates there are two different types of tetrahedra :

(a) Those sharing 3 vertices

(b) those sharing only 2 vertices.

Examples :

Asbestos : These are fibrous and non-combustible silicates.

Government Exam Questions And Answers

Choose the Correct Answer 1 mark

1. All the elements of group 17 and 18 are : *[HY_2019]*

(a) metalloids (b) metals
(c) non-metals (d) both (a) and (b)

[*Ans.* (c) non-metals]

2. Sodium Salt of tetraboric acid is known as : *[Sep.-2020]*

(a) B_2H_6 (b) Na_2BO_3
(c) H_3BO3 (d) $Na_2B_4O_7.10H_2O$

[*Ans.* (d) $Na_2B_4O_7.10H_2O$]

Answer The Questions 2 mark

1. Although Graphite and Diamond are allotropes of carbon, graphite is soft whereas diamond is hard. why? *[QY_2019]*

Ans. Both diamond and graphite are made of carbon. In diamond, each carbon atom forms 4 covalent bonds in a tetrahedral structure. Whereas, in graphite the carbon atoms only form 3 covalent bonds, creating hexagonally packed sheets of carbon. The sheets of carbon become bonded by weaker intermolecular forces. Which makes layers of graphite slide over each other, making the overall substance softer than diamond.

2. Give the uses of Potash alum. *[QY_2019]*

Ans. *(i)* It is used for purification of water.
(ii) It is also used for water proofing and textiles. It is used in dyeing, paper and leather tanning industries.
(iii) It is employed as a styptic agent to arrest bleeding.

3. What is inert pair effect? *[QY_2019]*

Ans. *(i)* In heavier post-transition metals, the outer s electrons (ns) have a tendency to remain inert and show reluctance to take part in the bonding, which is known as inert pair effect.
(ii) This effect is also observed in groups 14, 15 and 16.

Answer The Questions 3 marks

1. There is only a marginal difference in decrease in ionisation enthalpy from Aluminium to Thallium - Explain why? *[Mar._2020]*

Ans. This is due to the presence of inner d and f-electrons which has poor shielding effect compared to s and p-electrons.

Answer The Questions 5 marks

1. Write the preparation of potash alum. *[HY_2019]*

Ans. $K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3 + 6H_2SO_4 \longrightarrow K_2SO_4 + 3Al_2(SO_4)_3 + 12H_2O$

$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3.24H_2O$

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Unit 2