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Preface

"Nothing in life is to be feared, it is only to be understood.
Now is the time to understand more, so that we may fear less."

– Marie Curie

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With due respect to Teachers, I would like to mention that this guide will serve as a teaching companion to qualified teachers. Also, this guide will be an excellent learning companion to students with exhaustive exercises and in-text questions in addition to precise answers for textual questions.

In complete cognizance of the dedicated role of Teachers, I completely believe that our students will learn the subject effectively with this guide and prove their excellence in Board Examinations.

I once again sincerely thank the Teachers, Parents and Students for supporting and valuing our efforts.

God Bless all.

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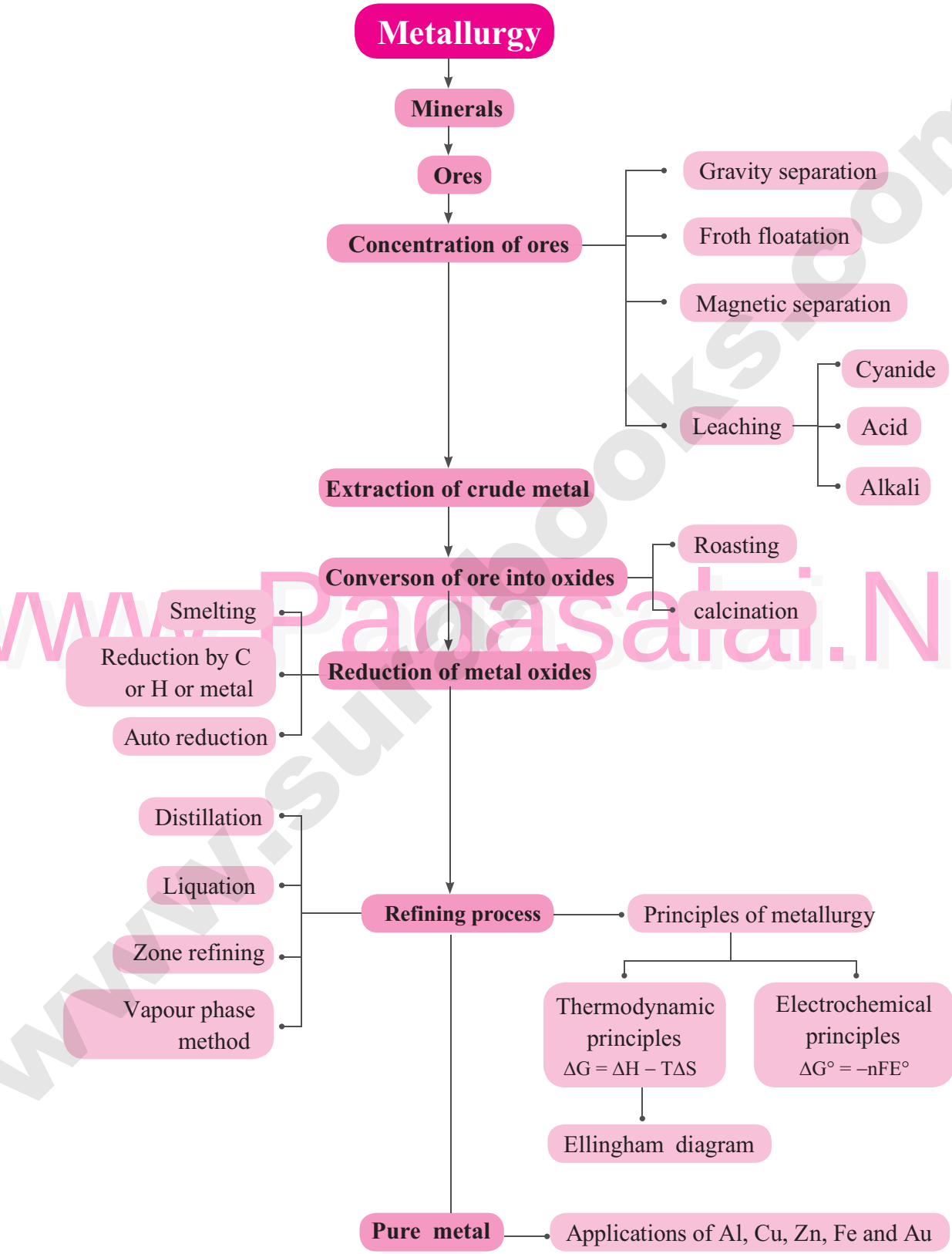
VOLUME - I

UNIT 1

METALLURGY

CHAPTER SNAPSHOT

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 these 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 such impurities 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

[Please refer to the Textbook Page No. 234 for the explanatory answers for MCQs.]

1. Bauxite has the composition *[HY. '19; May-'22]*

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 *[FRT-'22]*

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

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

3. Which one of the following reaction represents calcinations?

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) A - (iv), B - (ii), C - (iii), D - (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) $Cu_{(s)} + 2Ag^{+}_{(aq)} \longrightarrow 2Ag_{(s)} + Cu^{2+}_{(aq)}$
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_'19; FRT-'22]*

a) Magnetite b) Haematite
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** *[FRT & July '22]*

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-'17)*

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

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

16. **Considering Ellingham diagram, which of the following metals can be used to reduce alumina?** *(NEET-'18)*

a) Fe b) Cu c) Mg d) Zn

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

17. **The following set of reactions are used in refining Zirconium** *[Aug-'21]*

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

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

This method is known as

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

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

18. **Which of the following is used for concentrating ore in metallurgy?**

a) Leaching b) Roasting
c) Froth floatation d) Both (a) and (c)

[Ans. **(d) Both (a) and (c)]**

19. **The incorrect statement among the following is** *[QY. '19; Sep-2020]*

a) Nickel is refined by Mond's process.
b) Titanium is refined by Van Arkel's process.
c) Zinc blende is concentrated by froth floatation.
d) In the metallurgy of gold, the metal is leached with dilute sodium chloride solution.

[Ans. **(d) In the metallurgy of gold, the metal is leached with dilute sodium chloride solution]**

20. **In the electrolytic refining of copper, which one of the following is used as anode?**

a) Pure copper b) Impure copper
c) Carbon rod d) Platinum electrode

[Ans. **(b) Impure copper]**

21. **Which of the following plot gives Ellingham diagram?**

a) ΔS Vs T b) ΔG° Vs T

c) ΔG° Vs $\frac{1}{T}$ d) ΔG° Vs T^2

[Ans. (b) ΔG° Vs T]

22. **In the Ellingham diagram, for the formation of carbon monoxide**

a) $\left(\frac{\Delta S^\circ}{\Delta T}\right)$ is negative

b) $\left(\frac{\Delta G^\circ}{\Delta T}\right)$ is positive

c) $\left(\frac{\Delta G^\circ}{\Delta T}\right)$ is negative

d) initially $\left(\frac{\Delta T}{\Delta G^\circ}\right)$ is positive, after 700°C, $\left(\frac{\Delta G^\circ}{\Delta T}\right)$ is negative

[Ans. (c) $\left(\frac{\Delta G^\circ}{\Delta T}\right)$ *is negative]*

23. **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) $Al_2O_3 + 2Cr \longrightarrow Cr_2O_3 + 2Al$*]*

24. **Which of the following is not true with respect to Ellingham diagram?**

a) Free energy changes follow a straight line. Deviation occurs when there is a phase change.

b) The graph for the formation of CO_2 is a straight line almost parallel to free energy axis.

c) Negative slope of CO shows that it becomes more stable with increase in temperature.

d) Positive slope of metal oxides shows that their stabilities decrease with increase in temperature.

[Ans. (b) The graph for the formation of CO_2 *is a straight line almost parallel to free energy axis.]*

Q&A Answer the Following Questions

1. **What are the differences between minerals and ores?** *[QY_'19; Sep-2020; FRT, May-'22]*

Ans.

Minerals	Ores
A naturally occurring substance obtained by mining which contains 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 extraction of crude metals from the concentrated ores is carried out in two steps namely,

(i) conversion of the ore into oxides of the metal of interest and

(ii) Reduction of the metal oxides to elemental metals.

3. **What is the role of quick lime in the extraction of Iron from its oxide Fe_2O_3?**

Ans. *(i)* Quick lime 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.** *[FRT-'22]*

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. *[PTA - 3; May-'22]*

Ans. **Mond process for refining nickel :**

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

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

(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; FRT-'22]*

Ans. *(i)* This method is based on the Fractional Crystallisation. The impure metal is melted and allowed to solidify, the impurities 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 the oxidation of metals.

Example :

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

7. Using the Ellingham diagram,

(A) Predict the conditions under which

(i) Aluminium might be expected to reduce magnesia.

(ii) Magnesium could reduce alumina.

(B) It is possible to reduce Fe_2O_3 by coke at a temperature around 1200 K.

Ans. **(A) (i)**

- Ellingham diagram for the formation of Al_2O_3 and MgO intersects around 1600 K.
- Above this temperature aluminium lines lies below the magnesium line.
- Hence we can use aluminium to reduce magnesia above 1600 K.

(ii)

- In Ellingham diagram below 1600 K magnesium line lies below aluminium line.
- Hence, below 1600 K magnesium can reduce alumina.

(B)

(i) In Ellingham diagram above 1000 K carbon line lies below the iron line.

(ii) Hence, it is possible to reduce Fe_2O_3 by coke at a temperature around 1200 K.

8. 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.

9. Explain the electrometallurgy of aluminium. *[Govt.MQP_'19]*

Ans. **Hell - Herold Process :**

Cathode : Iron tank lined with carbon

Anode : Carbon blocks

Electrolytes : 20% solution of alumina obtained from bauxite + Molten cryolite + Calcium chloride (lowers the melting point of the mixture)

Temperature : Above 1270 K

Ionisaiton of alumina

$$Al_2O_3 \longrightarrow 2Al^{3+} + 3O^{2-}$$

Reaction at cathode

$$2Al^{3+}\ (melt) + 6e^- \longrightarrow 2Al_{(l)}$$

Reaction at anode

$$6O^{2-}\ (melt) \longrightarrow 3O_2 + 12e^-$$

(i) Since carbon acts as anode the following reaction takes place.

$$C_{(s)} + O^{2-}\ (melt) \longrightarrow CO + 2e^-$$

$$C_{(s)} + 2O^{2-}\ (melt) \longrightarrow CO_2 + 4e^-$$

(ii) During electrolysis anodes are slowly consumed due to the above two reactions.

(iii) Aluminium is formed at the cathode and settles at the bottom.

(iv) Net electrolysis reaction is

$$4Al^{3+}\ (melt) + 6O^{2-}\ (melt) + 3C_{(s)} \longrightarrow 4Al_{(l)} + 3CO_{2(g)}$$

10. Explain the following terms with suitable examples. *[PTA - 2; Sep-2020; FRT-'22]*

(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 :

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

11. 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.

12. 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_'19]*

(iii) Iodine in the refining of Zirconium. *[QY_'19]*

(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.

13. Explain the principle of electrolytic refining with an example. *[HY-'19; July-'22]*

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.

UNIT TEST

Time : 40 min Marks : 25

I. Choose the Correct Answer (5 × 1 = 5)

1. The chemical name of Horn silver is _____.

a) Chlorargyrite b) Silver glance
c) Prousitite d) Pyrargyrite

2. During the cyanide leaching of gold, the insoluble gangue formed is

a) gold cyanide b) aluminosilicate
c) gold silicate d) gold aluminosilicate

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

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

4. Removal of unreacted oxide ore, other metals, non metals associated with isolated crude metal is called _____

a) leaching b) bleaching
c) refining d) liquation

5. Match the following Metal with their Melting points.

	Metals		Melting points
1	Lead	a	545 K
2	Mercury	b	904 K
3	Tin	c	234 K
4	Bismuth	d	600 K

	1	2	3	4
(a)	d	c	b	a
(b)	a	b	c	d
(c)	b	c	a	d
(d)	c	b	a	d

II. Short Answer (2 × 2 = 4)

1. Give the basic requirement for vapour phase refining.
2. What is the role of Silica in the extraction of copper.

III. Answer In Paragraph (2 × 3 = 6)

1. Describe the method for refining nickel.
2. Give the uses of zinc.

IV. Long Answer (2 × 5 = 10)

1. Give the limitations of Ellingham diagram.
2. Write a short note on electrochemical principles of metallurgy.

☆ ☆ ☆

Answer Key

I. 1. a) Chlorargyrite
2. b) aluminosilicate
3. b) Al_2O_3
4. c) refining
5. a) d c b a

II. 1. *Refer Sura's Guide Book Back, Q.No. 11*
2. *Refer Sura's Guide Additional 2 Marks, Q.No. 17*

III. 1. *Refer Sura's Guide Book Back, Q.No. 5*
2. *Refer Sura's Guide Book Back, Q.N o. 8*

IV. 1. *Refer Sura's Guide Book Back, Q.No. 15*
2. *Refer Sura's Guide Book Back, Q.No. 16*

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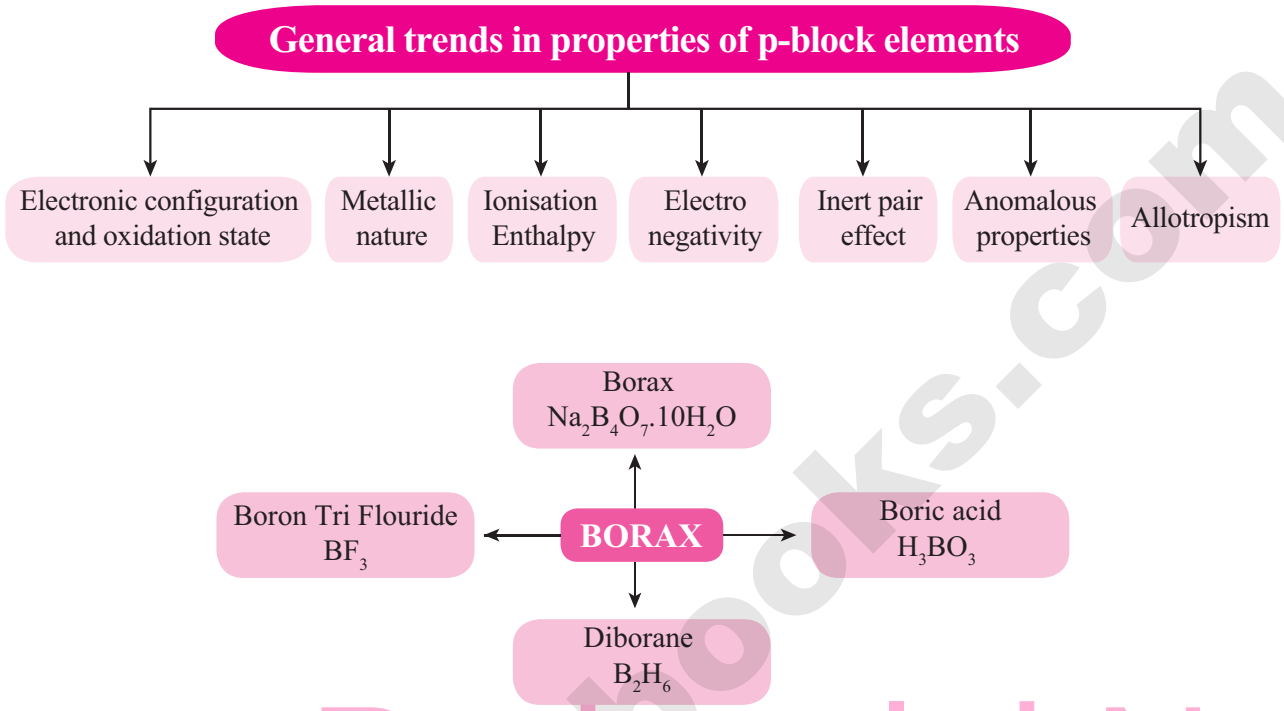
UNIT 2

p-Block Elements - I

CHAPTER SNAPSHOT

CONCEPT MAP



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.
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

[Please refer to the Textbook Page No. 234 -235 for the explanatory answers for MCQs.]

1. An aqueous solution of borax is *[May-'22]*

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. **In diborane, the number of electrons that accounts for banana bonds is**

a) six b) two c) four d) three

[Ans. (c) four]

6. **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]

7. **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]

8. **Oxidation state of carbon in its hydrides**

a) +4 b) –4 c) +3 d) +2

[Ans. (a) +4]

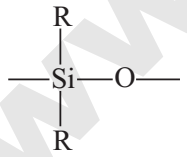
9. **The basic structural unit of silicates is** *[NEET; PTA-1]*

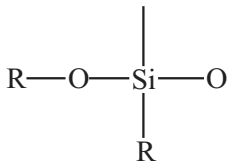
a) $(SiO_3)^{2-}$ b) $(SiO_4)^{2-}$
c) $(SiO)^{-}$ d) $(SiO_4)^{4-}$

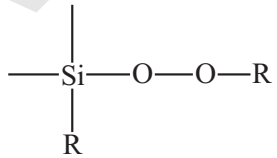
[Ans. (d) $(SiO_4)^{4-}$]

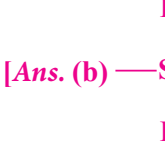
10. **The repeating unit in silicone is**

a) SiO_2

b) 

c) 

d) 

[Ans. (b)  *]*

11. **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]

12. **Which of the following is not sp^2 hybridised?** *[Aug-'21]*

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

[Ans. (d) dry ice]

13. **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]

14. **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]

15. **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]

16. **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]

17. **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]

18. The stability of +1 oxidation state increases in the sequence *[QY_'19]*

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]

Q&A Answer the Following Questions

1. Write a short note on anamolous properties of the first element of p-block.

[Sep-2020; Aug-'21]

Ans. **Anamolous 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 graphene, fullerenes, carbon nanotubes.

3. Give the uses of Borax. *[HY-'19; Aug-'21]*

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.

[Mar, Sep-2020; July-'22]

Ans. *(i)* Catenation is an ability of an element to form chain of atoms.

(ii) The following conditions are necessary for catenation.

(a) The valency of element should be 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.

(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. Write a note on Fischer tropsch synthesis.

[PTA - 4]

Ans. **Fischer Tropsch synthesis :**

The reaction of carbon monoxide with hydrogen at a pressure of less than 50 atm using metal catalysts at 500 - 700 K yields saturated and unsaturated hydrocarbons.

$$nCO + (2n+1)H_2 \longrightarrow C_nH_{(2n+2)} + nH_2O$$

$$nCO + 2nH_2 \longrightarrow C_nH_{2n} + nH_2O$$

6. Give the structure of CO and CO_2.

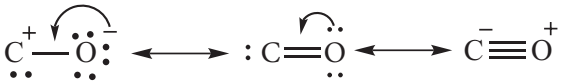
Ans. **Structure of CO :**

(i) It has a linear structure.

(ii) Three electron pairs are shared between carbon and oxygen.

(iii) C-O bond distance is 1.128Å.

(iv) The structure can be considered as the resonance hybrid of the following two canonical forms.



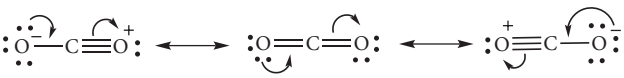
Structure of CO_2 :

(i) It has a liner structure.

(ii) Equal bond distance for the both C-O bonds.

(iii) There is two C-O sigma bond.

(iv) In addition there is 3c-4e covering all the three atoms.



7. Give the uses of silicones.

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

UNIT TEST

Time : 40 min | Marks : 25

I. Choose the Correct Answer (5 × 1 = 5)

1. Silicones are _____.
a) Water repelling in nature
b) High in thermal stability
c) Both a & b
d) None of these

2. All the elements of group 17 and 18 are ____
a) Metalloids b) Metals
c) non-metals d) all the above

3. Duralumin is an alloy of _____
a) Cu, Mn b) Cu, Al, Mg
c) Al, Mn d) Al, Cu, Mn, Mg

4. Formula for phosgene is _____
a) $COCl_2$ b) $CaOCl_2$
c) $CaCO_3$ d) COCl

5. Assertion : In diborane containing eight B–H bonds on the plane.
Reason : Boron in B_2H_6 is sp^2 hybridised.
a) Both assertion and reason are true and the reason is the correct explanation of the assertion.
b) Both the assertion and reason are true but the reason is not the correct explanation of the assertion.
c) Assertion is true statement but reason is false.
d) Both assertion and reason are false statements.

II. Short Answer (2 × 2 = 4)

1. What are the uses of silicon tetra chloride?
2. Write a note on Fisher tropsch synthesis.

III. Answer In Paragraph (2 × 3 = 6)

1. Draw the structure of carbon dioxide.
2. Describe the structure of graphite.

IV. Long Answer (2 × 5 = 10)

1. Distinguish between diamond and graphite.
2. How are silicates classified? Give an example for each type of silicate.

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Answer Key

I.
1. c) Both a & b
2. c) non-metals
3. d) Al, Cu, Mn, Mg
4. a) $COCl_2$
5. c) Assertion is true statement but reason is false.

II.
1. *Refer Sura's Guide Additional 2 Marks, Q.No. 12*
2. *Refer Sura's Guide Book Back Questions, Q.No. 5*

III.
1. *Refer Sura's Guide Book Back Questions, Q.No. 6*
2. *Refer Sura's Guide Additional 3 Marks, Q.No. 9*

IV.
1. *Refer Sura's Guide Additional 5 Marks, Q.No. 3*
2. *Refer Sura's Guide Additional 5Marks,Q.No. 2.*

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UNIT 6

SOLID STATE

CHAPTER SNAPSHOT

FORMULAE TO REMEMBER

No. of atoms in a SC unit cell $= \left[\frac{N_c}{8}\right]$

No. of atoms in a bcc unit cell $= \left[\frac{N_c}{8}\right] + \left[\frac{N_b}{1}\right]$

No. of atoms in a fcc unit cell $= \left[\frac{N_c}{8}\right] + \left[\frac{N_f}{2}\right]$

Density of the unit cell ρ $= \frac{\text{Mass of the unit cell}}{\text{Volume of the unit cell}}$

$\rho = \frac{nM}{a^3 N_A}$

Packing fraction (or) efficiency $= \frac{\left\{\begin{array}{c}\text{Total volume occupied by} \\ \text{spheres in a unit cell}\end{array}\right\}}{\text{Volume of the unit cell}} \times 100$

MUST KNOW DEFINITIONS

Crystalline solid	:	A **crystalline solid** is one in which its constituents (atoms, ions or molecules), have an orderly arrangement extending over a long range.
Crystal lattice	:	Crystalline solid is characterised by a definite orientation of atoms, ions or molecules, relative to one another in a three dimensional pattern.
Unit cell	:	A basic repeating structural unit of a crystalline solid is called a unit cell.
Body centered cubic unit cell. (BCC)	:	In a body centered cubic unit cell, each corner is occupied by an identical particle and in addition to that one atom occupies the body centre. Those atoms which occupy the corners do not touch each other, however they all touch the one that occupies the body centre.
Face centered cubic unit cell. (FCC)	:	In a face centered cubic unit cell, identical atoms lie at each corner as well as in the centre of each face. Those atoms in the corners touch those in the faces but not each other.
Schottky defect	:	Schottky defect arises due to the missing of equal number of cations and anions from the crystal lattice.
Frenkel defect	:	Frenkel defect arises due to the dislocation of ions from its crystal lattice.
Metal excess defect	:	Metal excess defect arises due to the presence of more number of metal ions as compared to anions.
Metal deficiency defect	:	Metal deficiency defect arises due to the presence of less number of cations than the anions.

EVALUATION

Choose The Correct Answer

[Please refer to the Textbook Page No. 240-242 for the explanatory answers for MCQs.]

1. **Graphite and diamond are** *[July-'22]*

a) Covalent and molecular crystals
b) ionic and covalent crystals
c) both covalent crystals
d) both molecular crystals

[Ans. (c) both covalent crystals]

2. **An ionic compound A_xB_y crystallizes in fcc type crystal structure with B ions at the centre of each face and A ion occupying corners of the cube. The correct formula of A_xB_y is**

a) AB b) AB_3 c) A_3B d) A_8B_6

[Ans. (b) AB_3]

3. **The ratio of close packed atoms to tetra hedral hole in cubic packing is**

a) 1:1 b) 1:2 c) 2:1 d) 1:4

[Ans. (b) 1:2]

4. **Solid CO_2 is an example of** *[QY_2019; FRT-'22]*

a) Covalent solid b) metallic solid
c) molecular solid d) ionic solid

[Ans. (c) molecular solid]

5. **Assertion :** monoclinic sulphur is an example of monoclinic crystal system

Reason : for a monoclinic system, $a \neq b \neq c$ and $\alpha = \gamma = 90°, \beta \neq 90°$ *[FRT-'22]*

a) Both assertion and reason are true and reason is the correct explanation of assertion.
b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]

6. **In calcium fluoride, having the flurite structure the coordination number of Ca^{2+} ion and F^- Ion are** *(NEET)*

a) 4 and 2 b) 6 and 6
c) 8 and 4 d) 4 and 8

[Ans. (c) 8 and 4]

7. **The number of unit cells in 8 gm of an element X (atomic mass 40) which crystallizes in bcc pattern is (N_A is the Avogadro number)**

a) 6.023×10^{23} b) 6.023×10^{22}
c) 60.23×10^{23} d) $\left(\frac{6.023 \times 10^{23}}{8 \times 40}\right)$

[Ans. (b) 6.023×10^{22}]

8. **In a solid atom M occupies ccp lattice and $\left(\frac{1}{3}\right)$ of tetrahedral voids are occupied by atom N. Find the formula of solid formed by M and N.**

a) MN b) M_3N c) MN_3 d) M_3N_2

[Ans. (d) M_3N_2]

9. **The ionic radii of A^+ and B^- are 0.98×10^{-10}m and 1.81×10^{-10} m. The coordination number of each ion in AB is**

a) 8 b) 2 c) 6 d) 4

[Ans. (c) 6]

10. **CsCl has bcc arrangement, its unit cell edge length is 400pm, its inter atomic distance is** *[FRT-'22]*

a) 400pm b) 800pm
c) $\sqrt{3} \times 100$pm d) $\left(\frac{\sqrt{3}}{2}\right) \times 400$pm

[Ans. (d) $\left(\frac{\sqrt{3}}{2}\right) \times 400$pm]

11. **A solid compound XY has NaCl structure. If the radius of the cation is 100pm , the radius of the anion will be**

a) $\left(\frac{100}{0.414}\right)$ b) $\left(\frac{0.732}{100}\right)$
c) 100×0.414 d) $\left(\frac{0.414}{100}\right)$

[Ans. (a) $\left(\frac{100}{0.414}\right)$]

12. The vacant space in bcc lattice unit cell is *[Mar-2020]*

a) 48% b) 23% c) 32% d) 26%

[Ans. (c) 32%]

13. The radius of an atom is 300pm, if it crystallizes in a face centered cubic lattice, the length of the edge of the unit cell is *[QY_'19]*

a) 488.5pm b) 848.5pm
c) 884.5pm d) 484.5pm

[Ans. (b) 848.5pm]

14. The fraction of total volume occupied by the atoms in a simple cubic is *[Govt.MQP_'19]*

a) $\left(\frac{\pi}{4\sqrt{2}}\right)$ b) $\left(\frac{\pi}{6}\right)$
c) $\left(\frac{\pi}{4}\right)$ d) $\left(\frac{\pi}{3\sqrt{2}}\right)$

[Ans. (b) $\left(\frac{\pi}{6}\right)$]

15. The yellow colour in NaCl crystal is due to *[FRT-'22]*

a) excitation of electrons in F centers
b) reflection of light from Cl^- ion on the surface
c) refraction of light from Na^+ ion
d) all of the above

[Ans. (a) excitation of electrons in F centers]

16. If 'a' stands for the edge length of the cubic system ; sc , bcc, and fcc. Then the ratio of radii of spheres in these systems will be respectively.

a) $\left(\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{2}}{2}a\right)$
b) $\left(\sqrt{1}a : \sqrt{3}a : \sqrt{2}a\right)$
c) $\left(\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a\right)$
d) $\left(\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a\right)$

[Ans. (c) $\left(\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a\right)$]

17. If 'a' is the length of the side of the cube, the distance between the body centered atom and one corner atom in the cube will be

a) $\left(\frac{2}{\sqrt{3}}\right)a$ b) $\left(\frac{4}{\sqrt{3}}\right)a$
c) $\left(\frac{\sqrt{3}}{4}\right)a$ d) $\left(\frac{\sqrt{3}}{2}\right)a$

[Ans. (d) $\left(\frac{\sqrt{3}}{2}\right)a$]

18. Potassium has a bcc structure with nearest neighbor distance 4.52 Å . Its atomic weight is 39. its density will be

a) 915 kg m^{-3} b) 2142 kg m^{-3}
c) 452 kg m^{-3} d) 390 kg m^{-3}

[Ans. (a) 915 kg m^{-3}]

19. Schottky defect in a crystal is observed when

a) unequal number of anions and cations are missing from the lattice
b) equal number of cations and anions are missing from the lattice
c) an ion leaves its normal site and occupies an interstitial site
d) no ion is missing from its lattice.

[Ans. (b) equal number of cations and anions are missing from the lattice]

20. The cation leaves its normal position in the crystal and moves to some interstitial position, the defect in the crystal is known as

a) Schottky defect b) F center
c) Frenkel defect
d) non-stoichiometric defect

[Ans. (c) Frenkel defect]

21. **Assertion :** due to Frenkel defect, density of the crystalline solid decreases.
Reason : in Frenkel defect cation and anion leaves the crystal.

a) Both assertion and reason are true and reason is the correct explanation of assertion.
b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false

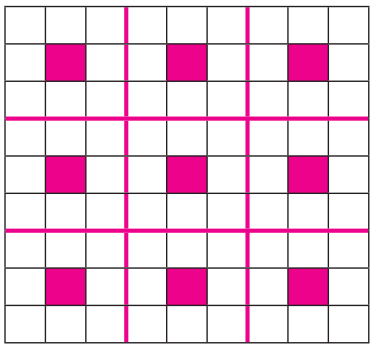
[Ans. (d) Both assertion and reason are false]

22. The crystal with a metal deficiency defect is *[PTA - 5; Aug-'21; May-'22]*

a) NaCl b) FeO c) ZnO d) KCl

[Ans. (b) FeO]

23. **A two dimensional solid pattern formed by two different atoms X and Y is shown below. The black and white squares represent atoms X and Y respectively. the simplest formula for the compound based on the unit cell from the pattern is**



a) XY_8 b) X_4Y_9 c) XY_2 d) XY_4

[Ans. (a) XY_8]

Answer the Following Questions

1. **Define unit cell.** *[Aug-'21; FRT&July-'22]*

Ans. A basic repeating structural unit of a crystalline solid is called a unit cell.

2. **Give any three characteristics of ionic crystals.** *[PTA - 4; FRT-'22]*

Ans. *(i)* Ionic solids have high melting points.

(ii) These solids do not conduct electricity, because the ions are fixed in their lattice positions.

(iii) They do conduct electricity in molten state (or) when dissolved in water because, the ions are free to move in the molten state or solution.

(iv) They are hard as only strong external force can change the relative positions of ions.

3. **Differentiate crystalline solids and amorphous solids.** *[PTA - 1; May-'22]*

Ans.

Crystalline Solids	Amorphous Solids
Long range orderly arrangement of constituents.	Short range, random arrangement of constituents.
Definite shape	Irregular shape
Generally crystalline solids are anisotropic in nature	They are isotropic* like liquids
They are true solids	They are considered as pseudo solids (or) super cooled liquids
Definite Heat of fusion	Heat of fusion is not definite
They have sharp melting points.	Gradually soften over a range of temperature and so can be moulded.
Eg: NaCl, diamond, etc	**Eg:** Rubber, plastics, glass, etc

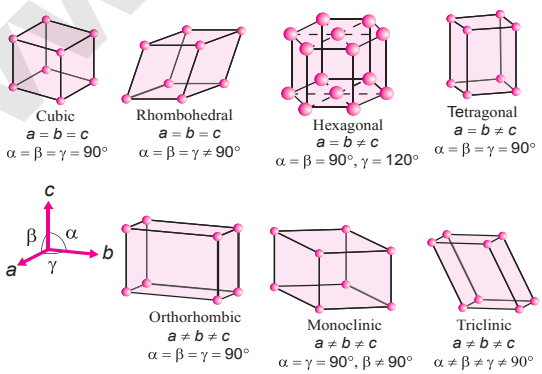
4. **Classify the following solids**

a. P_4 **b. Brass**
c. Diamond **d. NaCl**
e. Iodine

Ans.
a. P_4 - Molecular solid
b. Brass - Metallic solid
c. Diamond - Covalent solid
d. NaCl - Ionic solid
e. Iodine - Molecular solid.

5. **Explain briefly seven types of unit cell.** *[FRT-'22]*

Ans.



S.NO	Name of the unit cell	
1.	Cubic	NaCl
2.	Tetragonal	TiO_2
3.	Orthorhombic	$BaSO_4$
4.	Hexagonal	ZnO
5.	Monoclinic	$PbCrO_4$
6.	Triclinic	H_3BO_3
7.	Rhombohedral	Cinnabar cubic

Government Exam Questions And Answers

Choose the Correct Answer 1 mark

1. In Naphthalene, constituent molecules are held together by : *[HY_'19]*

(a) Electrostatic attraction
(b) London forces (c) Hydrogen bond
(d) Strong dipole - dipole interaction

[Ans. (b) London forces]

2. Packing efficiency of Body Centred Cube (BCC) : *[Sep-2020]*

(a) 52.31% (b) 68%
(c) 86% (d) 52.13% *[Ans. (b) 68%]*

3. Match the following : *[FRT-'22]*

(1)	Ionic solid	(i)	diamond
(2)	Covalent solid	(ii)	Cu - Zn
(3)	Non-polar molecular solid	(iii)	NaCl
(4)	Metallic solid	(iv)	Anthracene

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

[Ans. (a) (1)-(iii), (2)-(i), (3)-(iv), (4)-(ii)]

Answer The Questions 2 marks

1. If the no. of close packed sphere is 6, calculate the number of Octahedral voids and Tetrahedral voids generated. *[Mar-2020]*

Ans. If the number of close packed sphere is 6
Octahedral voids is 6 Tetrahedral voids is 12

2. Distinguish between Isotropy and Anisotropy in solids. *[Sep-2020; FRT-'22]*

	Isotropy	Anistropy
(i)	Isotropy means uniformity in all directions.	Anisotropy is the property which depends on the direction of measurement.
(ii)	In solid state isotropy means having identical values of physical properties such as refractive index, electrical conductance etc., in all directions.	Crystalline solids are anisotropic and they show different values of physical properties when measured along different directions.

3. Define covalent solids.. *[May-'22]*

Ans. In covalent solids, the constituents (atoms) are bound together in a three dimensional network entirely by covalent bonds. Examples: Diamond, silicon carbide etc.

4. What is metal deficiency defect? Give example. *[FRT-'22]*

Ans. Metal deficiency defect arises due to the presence of less number of cations than the anions. This defect is observed in a crystal in which, the cations have variable oxidation states.

Example : O^{2-}, Fe^{2+}, Fe^{3+}

5. ZnO is colourless at room temperature, but it turns yellow colour on heating, why? *[FRT-'22]*

Ans. ZnO is colourless at room temperature. When it is heated, it becomes yellow in colour. On heating, it loses oxygen and thereby forming free Zn^{2+} ions. The excess Zn^{2+} ions move to interstitial sites and the electrons also occupy the interstitial positions.

Answer The Questions 3 marks

1. Classify molecular crystals with an example for each type. *[QY_'19]*

Ans. *(i)* Non-polar molecular crystals.
Eg : Naphthalene, Anthracene
(ii) Polar molecular crystals solid.
Eg : Solid CO_2, Solid NH_3.
(iii) Hydrogen bonded molecular crystals
Eg: H_2O, glucose, urea.

2. Barium has a body centered cubic unit cell with a length of 508pm along an edge. What is the density of barium in gcm^{-3}? *[HY_'19]*

Ans. $\rho = \frac{nM}{a^3 N_A}$

In this case,

$n = 2$; $M = 137.3\ gmol^{-1}$;

$a = 508\ pm = 5.08 \times 10^{-8}\ cm$

$$\rho = \frac{2\ atoms \times 137.3\ g\ mol^{-1}}{(5.08\times10^{-8}\ cm)^3 (6.023\times10^{23}\ atoms\ mol^{-1})}$$

$$\rho = \frac{2\times137.3}{(5.08)^3\times10^{-24}\times6.023\times10^{23}}$$

$\rho = 3.5\ g\ cm^3$.

Additional Questions and Answers

Choose the Correct Answer 1 mark

1. Which of the following defects decreases the density of the crystal?
a) Interstitial defect b) Vacancy defect
c) Frankel defect d) None of these above
[Ans. (b) Vacancy defect]

2. In which of the following arrangements, octahedral voids are formed?
a) fcc b) bcc
c) simple cubic d) hcp *[Ans. (d) hcp]*

3. Which of the following cannot be regarded as molecular solid?
a) Silicon carbide b) AlN
c) Diamond d) All the above
[Ans. (d) All the above]

4. An example of metal deficiency defect
a) NaCl b) AgCl c) CsCl d) FeS
[Ans. (d) FeS]

5. Which of the following is characteristic of ionic solids?
a) Very low value of electrical conductivity in the molten state
b) Brittle nature
c) Very strong forces of attraction
d) Anisotropic nature
[Ans. (c) Very strong forces of attraction]

6. What is the relation between diamond and graphite?
a) Polymorphous b) Isomer
c) Isotope d) Isomorphous
[Ans. (a) Polymorphous]

7. Which one of the following crystal has 8 : 8 structure?
a) MgF_2 b) CsCl c) KCl d) NaCl
[Ans. (b) CsCl]

8. Amorphous solids have
a) orderly arrangement of atoms
b) sharp melting point
c) isotropy d) both (a) and (b)
[Ans. (c) isotropy]

9. A solid with formula ABC_3 would probably have,
a) A at body centre, B at face centres and C at corners of the cube
b) A at corners of cube, B at body centre, C at face centre
c) A at corners of hexagon, B at centres of the hexagon and C inside the hexagonal unit cell
d) A at corner, B at face centre, C at body centre
[Ans. (b) A at corners of cube, B at body centre, C at face centre]

10. A binary solid A^+B^- has a structure with B^- ions constituting the lattice and A^+ ions occupying 25% tetrahedral holes. Formula of the solid is
a) A_2B b) AB c) AB_2 d) AB_4
[Ans. (c) AB_2]

11. If 'a' is the length of unit cell, then which one is correct relationship?
a) For simple cubic lattice, radius of metal atom = $\frac{a}{2}$
b) For bcc lattice, radius of metal atom = $\frac{\sqrt{3}a}{4}$
c) For fcc lattice, radius of metal atom = $\frac{a}{2\sqrt{2}}$
d) All of these
[Ans. (d) All of these]

12. The empty space between the shaded balls and hollow balls as shown in the diagram is called,

a) Hexagonal void b) Octahedral void
c) Tetrahedral void
d) Double triangular void
[Ans. (b) Octahedral void]

13. Which type of solids will have the highest melting point?
a) Ionic crystals
b) Network covalent solid
c) Molecular solids d) Metallic crystals
[Ans. (b) Network covalent solid]

14. Which of the following statement is correct?
a) On increasing temperature, the co-ordination number of solid remains unchanged.

b) On increasing pressure, the co-ordination number of solid increases.
c) On increasing pressure, the co-ordination number of solid decreases.
d) On increasing temperature, the co-ordination number of solid increases.

[*Ans.* (b) On increasing pressure, the co-ordination number of solid increases]

15. Which of the following is incorrect statement about the Bragg's equation $n\lambda = 2d \sin\theta$?

a) n, represents order of reflection
b) λ, represents wave length of uv-rays used
c) θ, represents angle of incidence
d) d, represents distance between two parallel planes [*Ans.* (b) λ, represents wave length of uv-rays used]

16. Schottky defects contains

a) Cation vacancies only
b) Cation vacancies and interstitial cations
c) Equal number of cation and anion vacancies
d) Anion vacancies and interstitial anions

[*Ans.* (c) Equal number of cation and anion vacancies]

17. Calculate the number of atoms in a cubic unit cell having one atom on each corner and one atom on each body diagonal

a) 2 b) 3 c) 4 d) 5

[*Ans.* (d) 5]

Solution
No. of atoms from 8 corners = $\frac{1}{8} \times 8 = 1$
No. of atoms from 4 body diagonals = $1 \times 4 = 4$
∴ Total no. of atoms per unit cell = 5

18. A regular three dimensional arrangement of identical points in space is called

a) Unit cell b) Space lattice
c) Primitive d) Crystallography

[*Ans.* (b) Space lattice]

19. Three atoms P, Q and R crystallize in a cubic solid lattice having P atom at corners, Q atom at body centre and R atom at the face centres. Identify formula of the compound.

a) PQR b) PQR_2
c) PQR_3 d) P_3QR

[*Ans.* (c) PQR_3]

Solution
No. of atoms of P = $8 \times \frac{1}{8} = 1$
No. of atoms of Q = $1 \times 1 = 1$
No. of atoms of R = $6 \times \frac{1}{2} = 3$
Hence, compound is PQR_3

20. An element with atomic mass 60 having fcc structure has a density of 6.23g/cm^3. what is the edge length of unit cell?

a) 200 Pm b) 300 Pm
c) 400 Pm d) 500 Pm

[*Ans.* (c) 400 Pm]

Solution
$$a_3 = \frac{Z \times M}{No \times P} = \frac{4 \times 60}{6.02 \times 10^{23} \times 6.23} = 400 \text{ Pm}$$
$a = 400$ Pm

21. In a face–centered cubic lattice, a unit cell is shared equally by how many unit cells?

a) 8 b) 4 c) 2 d) 6

[*Ans.* (d) 6]

22. Which one of the following does not belong to AB type?

a) Cu_2O b) CsCl c) FeS d) ZnS

[*Ans.* (a) Cu_2O]

23. What is wrong about a.b.c.c. unit cell?

a) In addition to an atom at the centre of the body of the unit cell, there are 8 atoms at 8 different corners
b) $\frac{1}{8}$ atom at a corner of the unit cell
c) No. of atoms in the unit cells is 2
d) The no. of atoms in the unit cells is 4

[*Ans.* (d) The no. of atoms in the unit cells is 4]

24. In a body centred cubic unit cell, a metal atom at the centre of the cell is surrounded by how many other metal atoms?

a) 12 b) 4 c) 6 d) 8

[*Ans.* (d) 8]

25. The smallest repeating unit in space lattice which when repeated over and again results in the crystal of the given substance is called

a) Space lattice b) Crystal lattice
c) Unit cell d) Isomorphism

[*Ans.* (c) Unit cell]

26. **In the Bragg's equation for diffraction of X-rays, '*n*' represents**
a) The number of moles
b) Avogadro number
c) A quantum number
d) Order of reflection
[*Ans.* (d) Order of reflection]

27. **In a simple cubic cell, each point on a corner is shared by**
a) One unit cell b) Two unit cell
c) 8 unit cell d) 4 unit cell
[*Ans.* (c) 8 unit cell]

28. **Pick out the example for covalent and molecular crystal.**
a) Ice, Diamond b) Diamond, Ice
c) NaCl, FeS d) FeS, Ice
[*Ans.* (b) Diamond, Ice]

29. **The defect arising due to an ion occupying interstitial position is called**
a) Schottky defect b) Metal excess defect
c) Frenkel defect
d) Metal deficiency defect
[*Ans.* (c) Frenkel defect]

30. **The wavelength of X-ray is in the order of**
a) 10^{-8}cm b) 10^{-10}cm
c) 10^{-8}m d) 10^{-10}nm
[*Ans.* (a) 10^{-8} cm]

31. **The number of close neighbours in a body centred cubic lattice of identifical spheres is**
a) 6 b) 4 c) 12 d) 8
[*Ans.* (d) 8]

32. **The diffraction of crystal of Ba with X-ray of wavelength 2.29Å gives a first order reflection at 27°8′. What is the distance between the diffracted patterns?**
a) 5.02 Å b) 0.398 Å
c) 2.51 Å d) 10.04 Å
[*Ans.* (b) 0.398 Å]

33. **Crystalline solids are also called as**
a) supercooled liquids b) true solids
c) pseudo solids d) all the above
[*Ans.* (b) true solids]

34. **Which one of the following statements is not true?**
a) The heat of vaporisation of ionic crystals are high
b) Ionic crystals are soluble in non-polar solvent
c) Ionic crystals are hard and brittle
d) Ionic crystals are conductors in solution state **[*Ans.* (b) Ionic crystals are soluble in non-polar solvent]**

35. **Which type of defect is found in transition metals that have variable valency?**
a) Frenkel defect b) Schottky defect
c) Line defect
d) Metal deficiency defect
[*Ans.* (d) Metal deficiency defect]

36. **Which one of the following statements is wrong about Frenkel defect?**
a) An ion occupies an interstitial position
b) Anion is much larger in size than the cation
c) The crystal remains neutral
d) Non-stoichiometric compound is formed
[*Ans.* (d) Non-stoichiometric compound is formed]

37. **Element 'A' and 'B' form a compound with cubic structure in which 'A' atoms are at the corners of the cube and 'B' atoms at the face centres. What is the formula of the compound?**
a) AB b) AB_2 c) AB_3 d) AB_6
[*Ans.* (c) AB_3]

38. **In an hexagonal crystal**
a) $a = b = c, \alpha = \beta = \gamma = 90°$
b) $a = b = c, \alpha = \beta = \gamma \neq 90°$
c) $a = b \neq c, \alpha = \beta = \gamma = 90°$
d) $a = b \neq c, \alpha = \beta = 90°, \gamma = 120°$
[*Ans.* (d) $a = b \neq c, \alpha = \beta = 90°, \gamma = 120°$]

39. **Which of the following exists as covalent crystals in solid state?**
a) phosphorus b) sulphur
c) chlorine d) silicon
[*Ans.* (d) silicon]

9. Define the term amorphous.

Ans. A solid is said to be amorphous if its constituent particles are not arranged in a regular fashion.

10. What is point defect in crystals?

Ans. The defects which are caused by missing or misplaced atoms or ions in the crystal.

11. Diamond and solid rhombic sulphur are covalent solids but the latter has very low melting point than the former. Explain why?

Ans. *(i)* Diamond has network structure, while sulphur does not.

(ii) Due to this, particles of carbon are held at their positions firmly which makes diamond hard, brittle with extremely high melting point.

12. Define the term: space lattice.

Ans. **Space Lattice :** An infinite three dimensional array of points showing how atoms (or) molecules are arranged in a crystal is known as space lattice. The points are known as lattice points.

13. What is coordination number?

Ans. Coordination number is defined as the number of nearest neighbours that an atom has in a unit cell.

Coordination no. of sc = 6

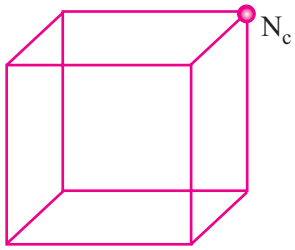
Coordination no. of fcc = 12

Coordination no. of bcc = 8

14. How many atoms can be present in a simple cubic lattice?

Ans. *(i)* In a simple cubic lattice atoms are present at the corners only, each atom at the corner is shared equally by eight other unit cells.

(ii) The total number of atoms per unit cell $= \frac{N_c}{8} = 8 \times \frac{1}{8} = 1$ (N_c is the number of atoms at the corners.)

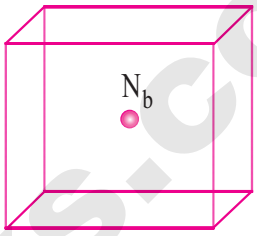


15. Write a note on the assignment of atoms per unit cell in body centred cubic lattice of CsCl.

Ans. The total number of atoms per unit cell in bcc.

$$= \frac{N_c}{8} + \frac{N_b}{1} = \frac{8}{8} + \frac{1}{1} = 1 + 1 = 2$$

N_b = Number of atoms inside the body; N_c is the number of atoms at the corners.



16. Define void.

Ans. The empty spaces present between the metal atom or the ions when they are packed within the crystal are called voids.

17. In CaF_2 crystal, Ca^{2+} ions are present in arrangement. Calculate the number of F^- ions in the unit cell.

Ans. No. of Ca^{2+} ions per unit cell

$$= \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right)$$

$$= 1 + 3 = 4$$

Hence No. of F^- ions per unit cell = $2 \times 4 = 8$.

18. What are primitive unit cells?

Ans. A unit cell that contains only one lattice point is called a primitive unit cell, which is made up from the lattice points at each of the corners.

19. A compound made up of two atoms X and Y has a face centred cubic arrangement. X is present in the coners and Y at the centre of each face. If one atom is missing from corner. What is the simplest formula of the compound.

Ans. No. of atoms of X at the corners = 8 – 1 = 7 (since 1 is missing)

Contribution of X towards unit cell

$$= 7 \times \frac{1}{8} = \frac{7}{8}$$

No. of atoms of Y at the face centres = 6

Contribution of Y towards unit cell

$$= 6 \times \frac{1}{2} = 3$$

Ratio of X : Y $= \frac{7}{8} : 3 = 7 : 24$

Formula of the compound is $X_7 Y_{24}$.

20. NaCl has a sharp melting point but glass does not - Justify.

Ans. NaCl is a crystalline solid so possess sharp melting points where as glass is amorphous in nature so does not have sharp melting point.

21. Distinguish between cubic and hexagonal unit cells.

Ans.

Cubic	Hexagonal
$a = b = c$	$a = b \neq c$
$\alpha = \beta = \gamma = 90°$	$\alpha = \beta = 90°, \gamma = 120°$

22. Why is FeS not formed in stoichometric composition?

Ans. In FeS, Fe^{2+} ions are replaced by Fe^{3+} ions. To maintain electrical neutrality, 3 Fe^{2+} ions are replaced by $2Fe^{3+}$ ions.

Short Answer 3 marks

1. Why are solids rigid?

Ans. *(i)* The intermolecular forces of attraction that are present in solids are very strong.

(ii) The constituent particles of solids cannot move from their positions. They have fixed positions.

(iii) However, they can oscillate about their mean positions.

(iv) This is the reason solids are rigid.

2. Silver crystallines in fcc lattice. If edge length of the cell is 4.07×10^{-8} cm and density is 10.5 g cm^{-3}. Calculate the atomic mass of silver.

Ans. $M = \frac{d \times a^3 \times NA}{g}$

d = Density of the material
a = Length of the edge of the cell
N_A = Avogadro number
Z = No. of atoms

$$M = \frac{10.5\ gcm^{-3} \times (4.07 \times 10^{-8} cm)^3 \times (6.023 \times 10^{23} mol^{-1})}{4}$$

Atomic mass of silver M = 106.59 g mol^{-1}.

3. If NaCl is doped with 10^{-3} mol % of $SrCl_2$. What is the concentration of cation valencies?

Ans. Doping of NaCl with 10^{-3} mol% $SrCl_2$ means that 100 moles of NaCl are doped with 10^{-3} mol of $SrCl_2$.

∴ 1 mole of NaCl is doped with $SrCl_2$

$$= \frac{10^{-3}}{100} \times 6.023 \times 10^{23} = 6.023 \times 10^{18}$$

4. Why are solids incompressible?

Ans. *(i)* Compressibility is the ability of the substance to change its shape by applying external pressure.

(ii) Solids form closed packed structure with negligible intermolecular space and possesses very strong intermolecular forces of attraction.

(iii) Thus, they do not change their shape in the presence of external pressure.

5. Classify the following solids in different categories based on the nature of intermolecular force operating in them:
Potassium sulphate, tin, benzene, urea, ammonia, water, zinc sulphide, graphite, rubidium, argon, silicon carbide.

Ans. *(i)* **Covalent Solids :** Silicon carbide, graphite.

(ii) **Molecular solids :** Urea, benzene, ammonia, water and argon.

(iii) **Ionic Solids :** Zinc sulphide, potassium sulphate

(iv) **Metallic solids :** Rubidium and tin.

6. What is the formula of a compound in which the element Y forms ccp lattice and atoms of X occupy ⅔rd of tetrahedral voids?

Ans. Number of tetrahedral voids formed = 2 × No. of atoms of element Y

No. of atoms of element Y in the ccp unit cell = 4

No. of tetrahedral voids by atoms of Y = 2×4=8

∴ No. of tetrahedral voids occupied by atoms of

$$X = \frac{2}{3} \times 8 = \frac{16}{3}$$

Ratio of the no. of atoms of X and Y is $= \frac{16}{3} : 4$

$= 16 : 12$

$= 4 : 3$

Hence, formula would be $X_4 Y_3$.

HOTS

1. A compound forms hexagonal closed packed structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?

Ans. 1 Mole of hexagonal packed structure contains 1 mole of octahedral voids and two moles of tetrahedral voids. Therefore, 0.5 moles of hexagonal packed structure contains 0.5 moles of octahedral voids and 1 mole of tetrahedral voids.

No. of tetrahedral voids $= 6.022 \times 10^{23}$

No. of octahedral voids $= \frac{1}{2} \times$ no. of tetrahedral voids

No. of octahedral voids $= \frac{1}{2} \times 6.022 \times 10^{23}$

$= 3.011 \times 10^{23}$

Total No. of voids $= (6.022+3.011) \times 10^{23}$

$= 9.033 \times 10^{23}$.

2. Sodium crystallizes in a bcc unit cell. Calculate the approximate number of unit cells in 9.2g of sodium. (Atomic mass Na 23u).

Ans. No. of atoms per unit cell for bcc (z) = 2

No. of atom is 9.2 g of Na

$= \frac{9.2\text{g}}{23\text{g mol}^{-1}} \times 6.022 \times 10^{23}$ atoms mol^{-1}

No. of Na atoms $= 2.4088 \times 10^{23}$

No. of unit cells $= \frac{2.4088 \times 10^{23} \text{ atoms}}{2 \text{ atoms unit cell}^{-1}}$

$= 1.2044 \times 10^{23}$.

3. The energy required to vapourize one mole of copper is smaller than that of energy required to vapourise 1 mole of diamond why?

Ans. Copper is a metallic solid having metal - metal bonds white diamond is a covalent solid having covalent bonds. Metallic bonds are weaker than covalent bonds and thus less amount of energy is required to break metallic bonds than covalent bonds.

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UNIT TEST

Time : 40 min Marks : 25

I. Choose the Correct Answer (5 × 1 = 5)

1. The ratio of close packed atoms to tetrahedral hole in cubic packing is

a) 1:1 b) 1:2 c) 2:1 d) 1:4

2. The yellow colour in NaCl crystal is due to

a) excitation of electrons in F centers

b) reflection of light from Cl^- ion on the surface

c) refraction of light from Na^+ ion

d) all of the above

3. Potassium has a bcc structure with nearest neighbor distance 4.52 A^0. Its atomic weight is 39. its density will be

a) 915 kg m^{-3} b) 2142 kg m^{-3}

c) 452 kg m^{-3} d) 390 kg m^{-3}

4. The vacant space in bcc lattice unit cell is

a) 48% b) 23% c) 32% d) 26%

5. Assertion : Monoclinic sulphur is an example of monoclinic crystal system

Reason : For a monoclinic system, $a \neq b \neq c$ and $\alpha = \gamma = 90°, \beta \neq 90°$

a) Both assertion and reason are true and reason is the correct explanation of assertion.

b) Both assertion and reason are true but reason is not the correct explanation of assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

II. Short Answer (2 × 2 = 4)

1. Classify the following solids

a. P_4 b. Brass

c. Diamond d. NaCl

e. Iodine

2. Explain Schottky defect.

III. Answer In Paragraph (2 × 3 = 6)

1. Distinguish between hexagonal close packing and cubic close packing.

2. Why ionic crystals are hard and brittle?

IV. Long Answer (2 × 5 = 10)

1. KF crystallizes in fcc structure like sodium chloride. calculate the distance between K^+ and F^- in KF. (Given : density of KF is 2.48 g cm^{-3})

2. Explain the following :
Similarities and differences between metallic and ionic crystals.

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Answer Key

I. **1.** b) 1:2

2. a) excitation of electrons in F centers

3. a) 915 kg m^{-3}

4. c) 32%

5. a) Both assertion and reason are true and reason is the correct explanation of assertion.

II. **1.** *Refer Sura's Guide Book Back, Q.No. 4.*

2. *Refer Sura's Guide Book Back, Q.No. 9.*

III. **1.** *Refer Sura's Guide Book Back, Q.No. 6.*

2. *Refer Sura's Guide Book Back, Q.No. 13.*

IV. **1.** *Refer Sura's Guide Book Back, Q.No. 20.*

2. *Refer Sura's Guide Additional 5 Marks, Q.No. 7.*

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UNIT 9

ELECTRO CHEMISTRY

CHAPTER SNAPSHOT

MUST KNOW DEFINITIONS

Ohm's law : i.e., $I \alpha V$ (or) $I = \frac{V}{R} \Rightarrow V = IR$

Resistivity : Resistivity or Specific resistance is defined as the resistance of an electrolyte confined between to electrodes having unit cross sectional area and are separated by a unit distance. Unit of resistivity is ohm metre (Ωm).

The ratio $\left(\frac{l}{A}\right)$ is called the cell constant.

Specific conductance : The reciprocal of the specific resistance $\left(\frac{1}{\rho}\right)$ is called the specific conductance

(or) conductivity. It is represented by the symbol κappa (κ). $\kappa = C / \left(\frac{l}{a}\right)$

The SI unit of conductance is Siemen (S).

Molar Conductance : The conductivity cell in which the electrodes are separated by 1m and having V m^3 of electrolytic solution which contains 1 mole of electrolyte. The conductance of such a system is called the molar conductance (Λ_m).

$$\Lambda_m = \frac{\kappa(Sm^{-1}) \times 10^{-3}}{M} mol^{-1}m^3$$

Equivalent conductance : Equivalent conductance is defined as the conductance of 'V' m^3 of electrolytic solution containing one gram equivalent of electrolyte in a conductivity cell in which the electrodes are one metre apart.

Debye - Huckel and Onsagar equation : $\Lambda_m = \Lambda_m^\circ - (A + B\Lambda_m^\circ)\sqrt{C}$

Kohlraush's law : At infinite dilution, the limiting molar conductivity of an electrolyte is equal to the some of the limiting molar conductivities of its constituent ions.

Galvanic Cell : It is a device in which a spontaneous chemical reaction generates an electric current i.e., it converts chemical energy into electrical energy. It is commonly known as a battery.

Electrolytic cell : It is a device in which an electric current from an external source drives a non-spontaneous reaction i.e., it converts electrical energy into chemical energy.

Nernst equation : Nernst equation is the one which relates the cell potential and the concentration of the species involved in an electrochemical reaction.

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF} \log \frac{[C]^l [D]^m}{[A]^x [B]^y}$$

EVALUATION

Choose The Correct Answer

[Please refer to the Textbook Page No. 306-308 for the explanatory answers for MCQs.]

1. The number of electrons that have a total charge of 9650 coulombs is *[PTA-2;Aug-'21]*

a) 6.22×10^{23} b) 6.022×10^{24}
c) 6.022×10^{22} d) 6.022×10^{-34}

[Ans. (c) 6.022×10^{22}]

2. Consider the following half cell reactions:

$Mn^{2+} + 2e^- \longrightarrow Mn$ $E^\circ = -1.18V$

$Mn^{2+} \longrightarrow Mn^{3+} + e^-$ $E^\circ = -1.51V$

The E° for the reaction $3Mn^{2+} \longrightarrow Mn + 2Mn^{3+}$, and the possibility of the forward reaction are respectively.

a) 2.69V and spontaneous
b) –2.69 and non spontaneous
c) 0.33V and Spontaneous
d) 4.18V and non spontaneous

[Ans. (b) –2.69 and non spontaneous]

3. The button cell used in watches function as follows

$Zn(s) + Ag_2O(s) + H_2O(l) \rightleftharpoons 2Ag(s) + Zn^{2+}(aq) + 2OH^-(aq)$

the half cell potentials are

$Ag_2O(s) + H_2O(l) + 2e^- \longrightarrow 2Ag(s) + 2OH^-(aq)$

$E^\circ = 0.34V$ and $Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$ $E^o = 0.76V$. The cell potential will be

a) 0.84V b) 1.34V c) 1.10V d) 0.42V

[Ans. (c) 1.10V]

4. The molar conductivity of a 0.5 mol dm^{-3} solution of $AgNO_3$ with electrolytic conductivity of 5.76×10^{-3} S cm^{-1} at 298 K is

a) 2.88 S cm^2 mol^{-1} b) 11.52 S $cm^2 mol^{-1}$
c) 0.086 S $cm^2 mol^{-1}$ d) 28.8 S cm^2 mol^{-1}

[Ans. (b) 11.52 S $cm^2 mol^{-1}$]

5.

Electrolyte	KCl	KNO_3	HCl	NaOAC	NaCl
Λ_m (S cm^2 mol^{-1})	149.9	145.0	426.2	91.0	126.5

Calculate Λ°_{HOAC} using appropriate molar conductances of the electrolytes listed above at infinite dilution in water at 25°C.

a) 517.2 b) 552.7 c) 390.7 d) 217.5

[Ans. (c) 390.7]

6. Faradays constant is defined as *[PTA - 4; May-'22]*

a) charge carried by 1 electron
b) charge carried by one mole of electrons
c) charge required to deposit one mole of substance
d) charge carried by 6.22×10^{10} electrons.

[Ans. (b) charge carried by one mole of electrons]

7. How many faradays of electricity are required for the following reaction to occur $MnO_4^- \longrightarrow Mn^{2+}$ *[Mar-2020; SRT&July-'22]*

a) 5F b) 3F c) 1F d) 7F

[Ans. (a) 5F]

8. A current strength of 3.86 A was passed through molten Calcium oxide for 41minutes and 40 seconds. The mass of Calcium in grams deposited at the cathode is (atomic mass of Ca is 40 g / mol and 1F = 96500C).

a) 4 b) 2 c) 8 d) 6

[Ans. (b) 2]

9. During electrolysis of molten sodium chloride, the time required to produce 0.1mol of chlorine gas using a current of 3A is *[Govt.MQP_'19]*

a) 55 minutes b) 107.2 minutes
c) 220 minutes d) 330 minutes

[Ans. (b) 107.2 minutes]

10. The number of electrons delivered at the cathode during electrolysis by a current of 1A in 60 seconds is
(charge of electron = 1.6×10^{-19}C)

a) 6.22×10^{23} b) 6.022×10^{20}
c) 3.75×10^{20} d) 7.48×10^{23}

[*Ans.* (c) 3.75×10^{20}]

11. Which of the following electrolytic solution has the least specific conductance *[SRT-'22]*

a) 2N b) 0.002N
c) 0.02N d) 0.2N

[*Ans.* (b) 0.002N]

12. While charging lead storage battery *[PTA - 1]*

a) $PbSO_4$ on cathode is reduced to Pb
b) $PbSO_4$ on anode is oxidised to PbO_2
c) $PbSO_4$ on anode is reduced to Pb
d) $PbSO_4$ on cathode is oxidised to Pb

[*Ans.* (c) $PbSO_4$ on anode is reduced to Pb]

13. Among the following cells
I) Leclanche cell
II) Nickel – Cadmium cell
III) Lead storage battery
IV) Mercury cell
Primary cells are

a) I and IV b) I and III
c) III and IV d) II and III

[*Ans.* (a) I and IV]

14. Zinc can be coated on iron to produce galvanized iron but the reverse is not possible. It is because

a) Zinc is lighter than iron
b) Zinc has lower melting point than iron
c) Zinc has lower negative electrode potential than iron
d) Zinc has higher negative electrode potential than iron

[*Ans.* (d) Zinc has higher negative electrode potential than iron]

15. Assertion : pure iron when heated in dry air is converted with a layer of rust.
Reason : Rust has the composition Fe_3O_4

a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false
d) Both assertion and reason are false.

[*Ans.* (d) both assertion and reason are false]

16. In H_2–O_2 fuel cell the reaction occur at cathode is

a) $O_2(g) + 2H_2O\ (l) + 4e^- \longrightarrow 4OH^-\ (aq)$
b) $H^+(aq) + OH^-\ (aq) \longrightarrow H_2O(l)$
c) $2H_2(g) + O_2\ (g) \longrightarrow 2H_2O\ (g)$
d) $H^+ + e^- \longrightarrow \frac{1}{2} H_2$

[*Ans.* (a) $O_2(g) + 2H_2O\ (l) + 4e^- \longrightarrow 4OH^-\ (aq)$]

17. The equivalent conductance of $\frac{M}{36}$ solution of a weak monobasic acid is 6 mho cm^2 equivalent^{-1} and at infinite dilution is 400 mho cm^2 equivalent^{-1}. The dissociation constant of this acid is *[SRT-'22]*

a) 1.25×10^{-6} b) 6.25×10^{-6}
c) 1.25×10^{-4} d) 6.25×10^{-5}

[*Ans.* (b) 6.25×10^{-6}]

18. A conductivity cell has been calibrated with a 0.01M, 1:1 electrolytic solution (specific conductance ($\kappa = 1.25 \times 10^{-3}$ S cm^{-1}) in the cell and the measured resistance was 800 Ω at 25°C . The cell constant is,

a) 10^{-1} cm^{-1} b) 10^{1} cm^{-1}
c) 1 cm^{-1} d) 5.7×10^{-12}

[*Ans.* (c) 1 cm^{-1}]

19. Conductivity of a saturated solution of a sparingly soluble salt AB (1:1 electrolyte) at 298 K is 1.85×10^{-5} S m^{-1}. Solubility product of the salt AB at 298 K $(\Lambda_m^\circ)_{AB} = 14 \times 10^{-3}$ S m^2 mol^{-1}.

a) 5.7×10^{-12} b) 1.32×10^{-12}
c) 7.5×10^{-12} d) 1.74×10^{-12}

[*Ans.* (d) 1.74×10^{-12}]

20. In the electrochemical cell: $Zn \mid ZnSO_4$ (0.01 M) $\| CuSO_4$ (1.0 M) $\mid Cu$, the emf of this Daniel cell is E_1. When the concentration of $ZnSO_4$ is changed to 1.0 M and that $CuSO_4$ changed to 0.01M, the emf changes to E_2. From the followings, which one is the relationship between E_1 and E_2?

a) $E_1 < E_2$ b) $E_1 > E_2$
c) $E_2 \geq E_1$ d) $E_1 = E_2$

[Ans. **(b) $E_1 > E_2$]**

21. Consider the change in oxidation state of Bromine corresponding to different emf values as shown in the diagram below:

$$BrO_4^- \xrightarrow{1.82V} BrO_3^- \xrightarrow{1.5V} HBrO \xrightarrow{1.595V} Br_2 \xrightarrow{1.0652V} Br^-$$

Then the species undergoing disproportionation is

a) Br_2 b) BrO_4^- c) BrO_3^- d) HBrO

[Ans. **(d) HBrO]**

22. For the cell reaction

$2Fe^{3+}(aq) + 2I^-(aq) \longrightarrow 2Fe^{2+}(aq) + I_2(aq)$

$E^\circ_{cell} = 0.24$ V at 298 K. The standard Gibbs energy (Δ, G°) of the cell reactions is :

a) -46.32 KJ mol^{-1} b) -23.16 KJ mol^{-1}
c) 46.32 KJ mol^{-1} d) 23.16 KJ mol^{-1}

[Ans. **(a) -46.32 KJ mol^{-1}]**

23. A certain current liberated 0.504 gm of hydrogen in 2 hours. How many grams of copper can be liberated by the same current flowing for the same time through copper sulphate solution

a) 31.75 b) 15.8 c) 7.5 d) 63.5

[Ans. **(b) 15.8]**

24. A gas X at 1 atm is bubble through a solution containing a mixture of $1MY^-$ and $1MZ^-$ at 25°C. If the reduction potential of Z>Y>X, then

a) Y will oxidize X and not Z
b) Y will oxidize Z and not X
d) Y will oxidize both X and Z
d) Y will reduce both X and Z

[Ans. **(a) Y will oxidize X and not Z]**

25. Cell equation : $A + 2B^- \longrightarrow A^{2+} + 2B$; $A^{2+} + 2e^- \longrightarrow A$, $E^\circ = +0.34$ V and $\log_{10} K = 15.6$ at 300 K for cell reactions find E° for $B^+ + e^- \longrightarrow B$ **(AIIMS – '18)**

a) 0.80 b) 1.26 c) -0.54 d) -10.94

[Ans. **(a) 0.80]**

Q & A SHORT ANSWER QUESTIONS

1. Define anode and cathode.

Ans. **Anode** is the electrode at which oxidation occurs. It sends electrons into the outer circuit. It has a negative charge and in shown as (–) in cell diagram.

Cathode is the electrode at which reduction occurs. It receives electrons from the outer circuit. It has a positive charge and is shown as (+) in cell diagram.

2. Why does conductivity of a solution decrease on dilution of the solution?

Ans. The conductivity of solution is directly proportional to the number of ions present in unit volume of the solution. On dilution, the ion concentration decreases per unit volume and hence conductivity decreases.

3. State Kohlrausch Law. How is it useful to determine the molar conductivity of weak electrolyte at infinite dilution?

[Govt.MQP_'19]

Ans. **Kohlraush's law :** At infinite dilution, the limiting molar conductivity of an electrolyte is equal to the some of the limiting molar conductivities of its constituent ions.

Calculation of molar conductance at infinite dilution of a weak electrolyte.

It is impossible to determine the molar conductance at infinite dilution for weak electrolytes experimentally. However, the same can be calculated using **Kohlraush's Law**.

For example, the molar conductance of CH_3COOH, can be calculated using the experimentally determined molar conductivities of strong electrolytes HCl, NaCl and CH_3COONa.

$\Lambda^{\circ}_{CH_3COONa} = \lambda^{\circ}_{Na^+} + \lambda^{\circ}_{CH_3COO^-}$ .....(1)

$\Lambda^{\circ}_{HCl} = \lambda^{\circ}_{H^+} + \lambda^{\circ}_{Cl^-}$ .....(2)

$\Lambda^{\circ}_{NaCl} = \lambda^{\circ}_{Na^+} + \lambda^{\circ}_{Cl^-}$ .....(3)

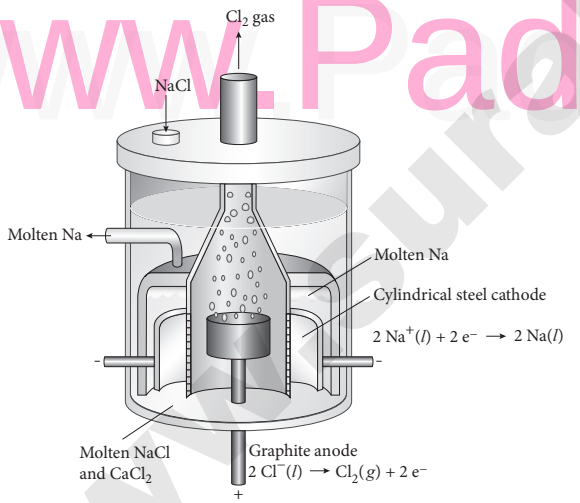
Equation (1) + Equation (2) – Equation (3) gives.

$\left(\Lambda^{\circ}_{CH_3COONa}\right) + \left(\Lambda^{\circ}_{HCl}\right) - \left(\Lambda^{\circ}_{NaCl}\right) = \lambda^{\circ}_{H^+} + \lambda^{\circ}_{CH_3COO^-}$

$= \Lambda^{\circ}_{CH_3COOH}$

4. Describe the electrolysis of molten NaCl using inert electrodes

Ans. The electrolytic cell consists of two iron electrodes one is cylindrical steel cathode and another one is graphite anode. Both are dipped in molten sodium chloride and they are connected to an external DC power supply via a key as shown in the figure. The electrode which is attached to the negative end of the power supply is called the cathode, and the one which attached to the positive end is called the anode. Once the key is closed, the external DC power supply drives the electrons to the cathode and at the same time pull the electrons from the anode.



Electrolysis of molten NaCl

Cell reactions :

Na^+ ions are attracted towards cathode, where they combines with the electrons and reduced to liquid sodium.

Cathode (reduction)

$Na^+(l) + e^- \longrightarrow Na(l)$ $\quad E^\circ = -2.71V$

Similarly, Cl^- ions are attracted towards anode where they losses their electrons and oxidised to chlorine gas.

Anode (oxidation)

$2Cl^-(l) \longrightarrow Cl_2(g) + 2e^-$ $\quad E^\circ = -1.36V$

The overall reaction is,

$2Na^+(l) + 2Cl^-(l) \longrightarrow 2Na(l) + Cl_2(g)$

$E^\circ = -4.07V$

The negative E° value shows that the above reaction is a non-spontaneous one. Hence, we have to supply a voltage greater than 4.07V to cause the electrolysis of molten NaCl.

In electrolytic cell, oxidation occurs at the anode and reduction occur at the cathode as in a galvanic cell, but the sign of the electrodes is the reverse i.e., in the electrolytic cell cathode is –ve and anode is +ve.

5. State Faraday's Laws of electrolysis. *[Govt.MQP_'19; Aug-'21]*

Ans. **First Law :** *[HY-'19]*

The mass of the substance (m) liberated at an electrode during electrolysis is directly proportional to the quantity of charge (Q) passed through the cell.

i.e m α Q

We know that the charge is related to the current by the equation $I = \frac{Q}{t} \Rightarrow Q = It$

$\therefore$ m α It

(or)

m = Z It

Where is Z is known as the electro chemical equivalent of the substance produced of the electrode.

Second Law : *[Govt.MQP_'19]*

When the same quantity of charge is passed through the solutions of different electrolytes, the amount of substances liberated at the respective electrodes are directly proportional to their electrochemical equivalents.

6. Describe the construction of Daniel cell. Write the cell reaction. *[Govt.MQP_'19]*

Ans. **Construction of Daniel cell :** The separation of half reaction is the basis for the construction of Daniel cell. It consists of two half cells.

(i) **Oxidation half cell :** A metallic zinc strip that dips into an aqueous solution of zinc sulphate taken in a beaker.

GOVERNMENT EXAM QUESTIONS AND ANSWERS

CHOOSE THE CORRECT ANSWER 1 MARK

1. Laptops have : *[Mar-2020]*

(a) Lead storage battery (b) Fuel cell

(c) Mercury button cell

(d) Lithium-ion battery

[*Ans.* (d) Lithium-ion battery]

ANSWER THE QUESTIONS 2 MARKS

1. A solution of silver nitrate is electrolysed for 20 minutes with a current of 2 amperes. Calculate the mass of silver deposited at the cathode. *[July-'22]*

Ans. **Electrochemical reaction at cathode is**

$Ag^+ + e^- \rightarrow Ag$ (reduction)

$m = ZIt$

$Z = \frac{\text{molarmass of Ag}}{(96500)} = \frac{108}{1 \times 96500}$

$I = 2A$

$t = 20m = (20 \times 60)s = 1200\ s$

$It = 2A \times 1200\ s = 2400\ C$

$m = \frac{108\ g\ mol^{-1}}{96500\ C\ mol^{-1}} \times 2400\ C$

$m = 2.68\ g.$

ANSWER THE QUESTIONS 3 MARKS

1. Write the Factors affecting electrolytic conductance. *[HY_'19; Aug-'21; SRT & May-'22]*

Ans. ***(i)*** If the interionic attraction between the oppositely charged ions of solutes increases, the conductance will decrease.

(ii) Solvent of higher dielectric constant show high conductance in solution.

(iii) Conductance is inversely proportional to the Viscosity of the medium. i.e., conductivity increases with the decrease in viscosity.

(iv) If the temperature of the electrolytic solution increases, conductance also increases. Increase in temperature increases the kinetic energy of the ions and decreases the attractive force between the oppositely charged ions and hence conductivity increases.

(v) Molar conductance of a solution increases with increase in dilution. This is because, for a strong electrolyte, interionic forces of attraction decrease with dilution. For a weak electrolyte, degree of dissociation increases with dilution.

2. A solution of silver nitrate is electrolysed for 30 minutes with a current of 2 amperes. Calculate the mass of silver deposited at the cathode. *[Sep-2020]*

Ans. Electrochemical reaction at cathode is

$Ag^+ + e^- \rightarrow Ag$ (reduction)

$m = ZIt$

$Z = \frac{\text{molarmass of Ag}}{(96500)} = \frac{108}{1 \times 96500}$

$I = 2A$

$t = 30m = (30 \times 60)s = 1800\ s$

$It = 2A \times 1800\ s = 3600\ C$

$m = \frac{108\ g\ mol^{-1}}{96500\ C\ mol^{-1}} \times 3600\ C$

$m = 4.03\ g.$

3. Define equivalent conductance. *[Aug-'21]*

Ans. Equivalent conductance is defined as the conductance of 'V' m^3 of electrolytic solution containing one gram equivalent of electrolyte in a conductivity cell in which the electrodes are one meter apart.

$$\Lambda = \frac{\kappa\left(Sm^{-1}\right) \times 10^{-3}\left(\text{gram equivalent}\right)^{-1} m^3}{N}$$

4. Mention the three Applications of Kohlraush's Law. *[SRT-'22]*

Ans. Application of Kohlrausch's Law:

(i) Calculation of molar conductance at infinite dilution of a weak electrolyte.

(ii) Calculation of degree of dissociation of weak electrolytes.

(iii) Calculation of solubility of sparingly soluble salts.

5. **Calculate the molar conductance of 0.025 M aqueous solution of $CaCl_2$ at 25°C. The Specific conductance of $CaCl_2$ is 12.04×10^{-2} Sm^{-1}.** *[SRT-'22]*

Ans. Molar conductance = $\wedge_m$

$$= \frac{K(Sm^{-1}) \times 10^{-3}}{M} mol^{-1}\ m^3 = \frac{(12.04 \times 10^{-2}\ Sm^{-1})^M \times 10^3\ (mol^{-1}\ m^3)}{0.025} = 481.6 \times 10^{-5}\ Sm^2\ mol^{-1}$$

Additional Questions and Answers

Choose the Correct Answer 1 mark

1. **Pick out the correct statement regarding resistance of an electrolytic solution**

a) It is inversely proportional to the length (l)
b) It is inversely proportional to the cross sectional area (A)
c) It is directly proportional to the cross sectional area (A)
d) Resistivity is denoted by ρ (rho)

[Ans. (b) It is inversely proportional to the cross sectional area (A)]

2. **Which among the following is the strongest reducing agent?**

a) F_2 b) Cl_2 c) Zn d) Li

[Ans. (d) Li]

3. **Which one of the following solution has highest equivalent conductance?**

a) 0.1 M NaCl b) 0.05 M NaCl
c) 0.005 M NaCl d) 0.25 M NaCl

[Ans. (c) 0.005 M NaCl]

NOTE :
Equivalent conductance increases with dilution.

4. **A device in which spontaneous chemical reaction generates electric current.**

a) Galvanic cell b) Voltaic cell
c) Daniel cell d) All the above

[Ans. (d) All the above]

5. **Recharging of lead storage battery involves**

a) anode is reduced to pb
b) cathode is reduced to pb
c) cathode is oxidised to pb
d) anode is oxidised to pbO_2

[Ans. (a) anode is reduced to pb]

6. **An example for 1 : 1 electrolyte is**

a) H_2SO_4 b) Na_2SO_4
c) NaCl d) $Al_2(SO_4)_3$

[Ans. (c) NaCl]

7. **Using the data given below find out the strongest reducing agent**

$E^\circ_{Cr_2O_7^{2-}}\ Cr^{3+} = 1.33V$, $E^\circ_{Cl_2/Cl^-} = 1.36V$

$E^\circ_{MnO_4^-}\ /\ Mn^{2+} = 1.51V$, $E^\circ_{Cr^{3+}/Cr} = -0.74V$

a) Cr b) Cr^{3+} c) Cl^- d) Mn^{2+}

[Ans. (a) Cr]

8. **$\lambda_c = \mu_c$ for,**

a) NaCl b) H_2SO_4
c) Na_2SO_4 d) $Al_2(SO_4)_3$

[Ans. (a) NaCl]

9. **Kohlraush's law is applied to calculate**

a) molar conductance at infinite dilution of a weak electrolyte
b) degree of dissociation of weak electrolyte
c) solubility of a sparingly soluble salt
d) all the above *[Ans. (d) all the above]*

10. **The limiting molar conductivities of HCl, CH_3COONa and NaCl are respectively 425, 190 and 150 mho cm^2 mol^{-1} at 25°C. The molar conductivity of 0.1 M acetic acid is 9.2 mho cm^2 mol^{-1}. The degree of dissociation of 0.1 M acetic acid is**

a) 0.10 b) 0.02 c) 0.019 d) 0.03

[Ans. (c) 0.019]

HINT :

$$\Lambda^\circ_{CH_3COOH} = \Lambda^\circ_{CH_3COONa} + \Lambda^\circ_{HCl} - \Lambda^\circ_{NaCl}$$

$$= 190 + 425 - 150 = 465$$

$$\alpha = \frac{\Lambda^C_m}{\Lambda^\circ_m} = \frac{9.2}{465} = 0.019$$

11. **The laws of electrolysis were enunciated first by**

a) Dalton b) Faraday
c) Kekule d) Avogadro

[Ans. (b) Faraday]

12. **1mho is equal to**

a) 1 siemen b) 1 second
c) 1 ohm d) none of the above

[Ans. (a) 1 siemen]

13. When one coulomb of electricity is passed through an electrolytic solution, the mass deposited on the electrode is equal to

a) equivalent weight
b) molecular weight
c) electrochemical equivalent
d) one gram

[Ans. (c) electrochemical equivalent]

14. What happens during the electrolysis of molten sodium chloride?

a) Cl_2 is released at the cathode
b) Liquid sodium is obtained at the anode
c) The emf of the overall reaction is –4.07 V
d) Both (a) and (b)

[Ans. (c) The emf of the overall reaction is –4.07 V]

15. For the given cell

$Cr_{(s)}|Cr^{3+}_{(aq)}||Cu^{2+}_{(aq)}|Cu_{(s)}$ **which is correct?**

a) Cr is the anode
b) Cu is the anode
c) Overall cell reaction is $2Cr^{3+}_{(aq)} + 3Cu_{(s)} \longrightarrow 2Cr_{(s)} + 3Cu^{2+}_{(aq)}$
d) Both (b) and (c)

[Ans. (a) Cr is the anode]

16. Faraday's laws of electrolysis are related to

a) atomic number of the cation
b) atomic number of the anion
c) equivalent weight of the electrolyte
d) speed of the cation

[Ans. (c) equivalent weight of the electrolyte]

17. The specific conductance of a 0.01 M solution of KCl is 0.0014 ohm^{-1} cm^{-1} at 25°C. Its equivalent conductance is

a) 14 ohm^{-1}cm^{2}eq^{-1} b) 140 ohm^{-1}cm^{2}eq^{-1}
c) 1.4 ohm^{-1}cm^{2}eq^{-1} d) 0.14 ohm^{-1}cm^{2}eq^{-1}

[Ans. (b) 140 ohm^{-1}cm^{2}eq^{-1}]

18. The equivalent conductivity of CH_3COOH at 25°C is 80 ohm^{-1} cm^2 eq^{-1} and at infinite dilution 400 ohm^{-1} cm^2 eq^{-1}. The degree of dissociation of CH_3COOH is

a) 1 b) 0.2 c) 0.1 d) 0.3

[Ans. (b) 0.2]

19. NH_4OH is a weak base because

a) it has low vapour pressure
b) it is only partially ionised
c) it is completely ionised
d) it has low density

[Ans. (b) it is only partially ionised]

20. When sodium acetate is added to acetic acid, the degree of ionisation of acetic acid

a) increases b) decreases
c) dose not change d) becomes zero

[Ans. (b) decreases]

21. The important use of Kohlrausch's law is deducing the

a) λ_∞ value of weak electrolyte.
b) λ_∞ value of strong electrolyte.
c) λ_C value of weak electrolyte.
d) λ_C value of weak electrolyte.

[Ans. (a) λ_∞ value of weak electrolyte]

22. According to Faraday's first law m = ZIt, where Z is

a) reaction quotient
b) effective nuclear charge
c) atomic number
d) electrochemical equivalent

[Ans. (d) electrochemical equivalent]

23. Ohm's law is mathematically expressed as

a) $I = \frac{V}{R}$ b) $I = \frac{R}{V}$ c) $V = \frac{I}{R}$ d) $R = \frac{I}{V}$

[Ans. (a) $I = \frac{V}{R}$]

24. Which among the following has same equivalent and molar conductance

a) H_2SO_4 b) CH_3COOH
c) NaCl d) Na_2SO_4

[Ans. (c) NaCl]

25. When λ_c decreases linearly with increase in $\sqrt{C}$, then it is

a) an insulator b) a semiconductor
c) a weak electrolyte d) a strong electrolyte

[Ans. (d) a strong electrolyte]

26. Debye, Huckel and Onsager equation for strong electrolytes is $\lambda_c = \lambda_\infty(A+B\lambda_\infty)\sqrt{C}$. The slope value is

a) λ_∞ b) $(A+B\lambda_\infty)$
c) A d) $\sqrt{C}$

[Ans. (b) $(A+B\lambda_\infty)$]

27. **Ionic conductance at infinite dilution of Al^{3+} and SO_4^{2-} are 1890 $ohm^{-1}cm^2gm\ equiv^{-1}$ and 1600 $ohm^{-1}cm^2gm\ equiv^{-1}$ respectively. The equivalent conductance is**

a) 143 mho cm^2 gm $equiv^{-1}$
b) 858mho cm^2 gm $equir^{-1}$
c) 153 mho cm^2 gm $equiv^{-1}$
d) 341mho cm^2 gm $equir^{-1}$

[Ans. (a) 143 mho cm^2 gm $equiv^{-1}$]

28. **If 0.2 ampere can deposit 0.1978 g of copper in 50 minutes, how much of copper will be deposited by 600 coulombs ?**

a) 19.78 g b) 1.978 g
c) 0.1978 g d) 197.8 g

[Ans. (c) 0.1978 g]

29. **The potential of a single electrode is a half cell is called the**

a) Reduction potential
b) Half-wave potential
c) Single electrode potential
d) Cell potential

[Ans. (c) Single electrode potential]

30. **The relationship between free energy change and emf of a cell is**

a) $\Delta G = -nFE$ b) $\Delta H = -nFE$
c) $\Delta E = -nFG$ d) $\Delta F = -nFG$

[Ans. (a) $\Delta G = -nFE$]

31. **The feasibility of a redox reaction can be predicted with the help of**

a) Electronegativity
b) Electrochemical series
c) Electron affinity
d) Equivalent conductance

[Ans. (b) Electrochemical series]

32. **The metals near the bottom of the electro chemical series are**

a) strong reducing agents
b) strong oxidising agents
c) weak reducing agents
d) weak oxidising agents

[Ans. (a) strong reducing agents]

33. **How many half cells are present in an electrochemical cell?**

a) 3 b) 4 c) 2 d) 6

[Ans. (c) 2]

34. **The emf of a cell with 1 M solution of reactants and products in solution at 25°C is called**

a) Half cell potential
b) Standard emf
c) Single electrode potential
d) Redox potential *[Ans. (b) Standard emf]*

35. **The relationship between equilibrium constant and standard emf of a cell is**

a) $E° = 0.0591 \log K$ b) $0.0591\ E° = \log K$
c) $nE° = 0.0951 \log K$ d) $nE° = 0.0591 \log K$

[Ans. (d) $nE° = 0.0591 \log K$]

36. **Calculate the standard emf of the cell, provided the standard reduction potentials of cathode and anode are –0.763 V and 0.80 V.**

a) – 1.563 V b) 0.037V
c) – 0.610 V d) None of these

[Ans. (a) – 1.563 V]

37. **How will you predict whether a reaction is not feasible?**

a) $E°_{cell} = -ve$ b) $E°_{cell} = +ve$
c) $E°_{cell} = 0$ d) both (a) and (c)

[Ans. (a) $E°_{cell} = -ve$]

38. **The condition to obtain standard emf is**

a) 1M solution of reactants and products
b) 25°C c) both (a) and (b)
d) neither (a) and (b)

[Ans. (c) both (a) and (b)]

39. **What is/are the factor(s) that govern the single electrode potential of a half cell?**

a) concentration of ions in solution
b) tendency to form ions
c) temperature
d) all of these *[Ans. (d) all of these]*

40. **What will be the equilibrium constant for the reaction between $AgNO_3$ and metallic Zn, where $E°_{cell} = 1.56V$?**

a) 6.19×10^{52} b) 619×10^{52}
c) 0.619×10^{25} d) 6.19×10^{25}

[Ans. (a) 6.19×10^{52}]

41. **The emf generated by an electrochemical cell is given by the symbol**

a) E b) M c) F d) S

[Ans. (a) E]

2. Define resistance. Give its mathematical expression.

Ans. The resistance of an electrolytic solution is also directly proportional to the length (l) and inversely proportional to the cross sectional area (A).

$$R \alpha \frac{l}{A}$$

$$R = \rho \frac{l}{A}$$

3. Define resistivity.

Ans. Resistivity is defined as the resistance of an electrolyte confined between two electrodes having unit cross sectional area and are separated by a unit distance.

The ratio $\left(\frac{l}{A}\right)$ is called the cell constant, Unit of resistivity is ohm metre (Ωm).

4. Two electrodes having cross sectional area of A and are separated by a distance *l*. What is the ratio of length by area called?

Ans. The ratio $\left(\frac{l}{A}\right)$ is called the cell constant.

5. Define conductance. Give its unit.

Ans. The reciprocal of the resistance $\left(\frac{1}{R}\right)$ gives the conductance of an electrolytic solution. The SI unit of conductance is Siemen (S).

6. Give a mathematical expression that relates cell constant, specific conductance and specific resistance.

Ans. $\kappa = \frac{1}{R} \cdot \frac{l}{A} = \frac{1}{\rho}$

Where κ is specific conductance

R is resistance and $\frac{l}{a}$ is cell constant.

ρ is specific resistance.

7. On dilution of 0.1 M of Na_2SO_4, what will happen to its

(a) Conductance (C)

(b) Conductivity κ

(c) Molar conductance Λ_m

(d) Equivalent conductance Λ

Ans. Conductivity, molar conductance and equivalent conductance increases with dilution whereas Conductance (C) decreases.

8. Derive the unit of specific conductance.

Ans. Unit of κ

$$\kappa = \frac{1}{\rho} \cdot \frac{l}{A} \left(\frac{1}{\text{ohm}} \cdot \frac{m}{m^2} \right)$$

$$= \text{ohm}^{-1}\ m^{-1} = \text{mho}\ m^{-1} \text{ (or) } Sm^{-1}$$

9. Give the empirical relationship between molar conductance and concentration of the electrolyte.

Ans. Kohlraush deduced the following empirical relationship between the molar conductance (Λ_m) and the concentration of the electrolyte (C).

$$\Lambda_m = \Lambda_m^\circ - k\sqrt{C}$$

10. Account for the following : For a strong electrolyte molar conductivity decreases as concentration increases.

Ans. *(i)* For a strong electrolyte, at high concentration, the number of constituent ions of the electrolyte in a given volume is high and hence the attractive force between the oppositely charged ions is also high.

(ii) Moreover the ions also experience a viscous drag due to greater solvation.

(iii) These factors attribute for the low molar conductivity at high concentration.

11. What is meant by limiting molar conductivity?

Ans. Λ_m° is called the limiting molar conductivity. i.e., the molar conductance of a solution at infinite dilution.

12. Molar conductivity increases with dilution. Is the above statement true? Justify your answer

Ans. Yes, the above given statement is true.

When the dilution increases, the ions are far apart and the attractive forces decrease. At infinite dilution the ions are so far apart, the interaction between them becomes insignificant and hence, the molar conductivity increases and reaches a maximum value at infinite dilution.

13. Express Kohlraush's law for molar conductance of a uni – univalent electrolyte NaCl.

Ans. For a uni – univalent electrolyte such as NaCl, the Kohlraush's law is expressed as

$$\left(\Lambda_m^0\right)_{NaCl} = \left(\lambda_m^0\right)_{Na^+} + \left(\lambda_m^0\right)_{Cl^-}$$

14. Give the expression that relates molar conductivity and degree of dissociation.

Ans. $\alpha = \frac{\Lambda_m}{\Lambda_m^0}$

15. Apply Kohlraush's law and determine the limiting molar conductivity of

(i) $BaCl_2$ **(ii)** $Al_2(SO_4)_3$

Ans. (i) $\Lambda_m^0\ BaCl_2 = \lambda_{Ba^{2+}}^0 + 2\lambda_{cl^-}^0$

(ii) $\Lambda_m^0\ Al_2(SO_4)_3 = 2\lambda_{Al^{3+}}^0 + 3\lambda_{SO_4^{2-}}^0$

16. What is a electro chemical cell?

Ans. Electrochemical cell is a device which converts chemical energy into electrical energy and vice versa. It consists of two separate electrodes which are in contact with an electrolyte solution.

17. What type of cell is a Daniel cell?

Ans. It is an Galvanic cell.

18. Explain the function of a salt bridge in an electrochemical cell.

Ans. The main functions of the salt bridge are

(i) To complete the electrical circuit by the allowing only ions to flow from one solution to other without mixing the two solutions.

(ii) To maintain electrical neutrality of the solution in the two half cells.

19. What are the factors on which cell potential depends?

Ans. The cell voltage depends on the nature of the electrodes, the concentration of the electrolytes and the temperature at which the cell is operated.

20. Give the uses of mercury button cell.

Ans. It has higher capacity and longer life. Used in pacemakers, electronic watches, cameras etc.

21. Why is the electrode potential of a single electrode cannot be determined?

Ans. Its is because oxidation half reaction and reduction half reaction cannot take place alone. It can be measured only by using a reference electrode.

22. What is the value of Faraday constant?

Ans. IF = 96500 C

It is defined as the quantity of electricity which deposits one gram equivalent of the substance or it is the charge carried by one mole of electrons.

23. Define electrolysis.

Ans. Electrolysis is a process in which the electrical energy is used to cause a non-spontaneous chemical reaction to occur.

24. Define electro chemical equivalent.

Ans. Electrochemical equivalent is defined as the amount of substance deposited or liberated at the electrode by a charge of 1 coulomb.

25. How much amount of a substance is deposited by 1 coulomb? What is it called?

Ans. One coulomb will deposit $\frac{\text{Eq.wt}}{96500}$ of substance.

It is called the electrochemical equivalent.

26. What are the two types of batteries?

Ans. The two types of batteries are primary batteries (non – rechargeable) and secondary batteries (rechargeable).

27. What are primary cells?

Ans. Primary cells are those in which the redox reaction occurs only once and the cell becomes dead after sometime and cannot be used again.

28. What is the anode, cathode and electrolyte of a mercury button cell?

Ans. (i) **Anode :** Zinc amalgamated with mercury

(ii) **Cathode :** HgO mixed with graphite

(iii) **Electrolyte :** Paste of KOH and ZnO

29. What are secondary cells?

Ans. Secondary cells are those which can be recharged by passing electric current through them and hence can be used over and again.

30. What is the principle used in secondary batteries to regenerate the original reactants?

Ans. Electrochemical reactions which take place in a galvanic cell may be reversed by applying a potential slightly greater than the emf generated by the cell. This principle is used in secondary batteries to regenerate the original reactants.

31. Write the anode, cathode and electrolyte of lead storage battery.

Ans. (i) **Anode :** Spongy lead

(ii) **Cathode :** Lead plate bearing PbO_2

(iii) **Electrolyte :** 38% by mass of H_2SO_4 with density 1.2 g / mL.

32. On what does the emf of a lead storage battery depend?

Ans. The emf of the cell depends on the concentration of H_2SO_4. As the cell reaction uses SO_4^{2-} ions, the concentration H_2SO_4 decreases. When the cell potential falls to about 1.8V, the cell has to be recharged.

33. Give examples of primary cells.

Ans. *(i)* Leclanche cell
(ii) Mercury button cell

34. Give an example of secondary cell.

Ans. Lead storage battery.

35. Name the anode, cathode and electrolyte used in lithium – ion Battery.

Ans. *(i)* **Anode :** Porus graphite
(ii) **Cathode :** Transition metal oxide such as CoO_2.
(iii) **Electrolyte :** Lithium salt in an organic solvent.

36. Write the oxidation, reduction and overall redox reaction taking place in the Lithium ion battery.

Ans. At the anode oxidation occurs

$$Li_{(s)} \longrightarrow Li^+_{(aq)} + e^-$$

At the cathode reduction occurs

$$Li^+ + CoO_{2(s)} + e^- \longrightarrow Li\,CoO_{2(s)}$$

Overall reactions

$$Li_{(s)} + CoO_2 \longrightarrow LiCoO_{2(s)}$$

37. What is a fuel cell?

Ans. The galvanic cell in which the energy of combustion of fuels such as H_2, CO, CH_4 etc is directly converted into electrical energy is called the **fuel cell**.

38. Write a note on galvanising.

Ans. Galvanizing - by coating with another metal such as zinc. Zinc is stronger reducing agent than iron and hence it can be more easily corroded than iron. i.e., instead of iron, the zinc is oxidised.

39. What is passivation?

Ans. The metal is treated with strong oxidising agents such as concentrated HNO_3. As a result, a protective oxide layer is formed on the surface of metal.

40. Higher the standard reduction potential lesser is corrosion. Give reason.

Ans. The greater the E° value means greater is the tendency shown by the species to accepts electrons and undergo reduction. So higher the (E°) values lesser is the tendency to undergo corrosion.

41. How are specific and equivalent conductances related?

Ans. $\lambda_c = \kappa \times V$

$$\boxed{\lambda_C = \frac{\kappa \times 10^{-3}}{C}}\ \text{mho.m}^2\ (\text{gm.equir})^{-1}$$

42. Write the cell reaction for the half cell $Cl^-_{(aq)}/AgCl_{(s)}$ Ag .

Ans. $AgCl_{(s)} + e^- \longrightarrow Ag_{(s)} + Cl^-$

Ag / Ag^+

43. The standard reduction potentials of Fe^{3+} / Fe and Fe^{2+} / Fe electrode system are –0.035 V and –0.44 V respectively. Predict which of the two oxidations is easy. Fe^{3+} / Fe and Fe^{2+} / Fe.

Ans. *(i)* The ion which has **lower reduction potential will be oxidised first at the anode**.
(ii) Among (0.035V) and (0.44V), **Fe^{2+} / Fe** oxidation is easy because it has the lower reduction potential (–0.44V).

44. What is single electrode potential?

Ans. *(i)* An electrochemical cell consists of two half cells. With an open circuit, the metal electrode in each half cell transfers its ions into solution.
(ii) Thus, an individual electrode develops a potential with respect to the solution.
(iii) The potential of a single electrode in a half cell is called single electrode potential.

45. Define standard emf of a cell.

Ans. When the emf of a cell is determined under **standard conditions**, it is called the standard emf.

It is defined as the emf of a cell with **1 M solutions of reactants and products** in solution measured at 25°C. It is represented by the symbol E°.

Problems For Practice

1. What is the electrochemical equivalent of a substance when 150 gm of it is deposited by 10 ampere of current passed for 1 sec?

Sol. Given :

Amount of the substance deposited,

m = 150 g

current strength = I = 10 ampere

Time = t = 1 sec.

By Faraday's first law,

Formula : $m = ZIt$

Solution : $\therefore Z = \frac{m}{It} = \frac{150}{10 \times 1}$

Electrochemical equivalent

= 15.0 gm coloumb^{-1}.

2. The electrochemical equivalent of an electrolyte is 2.35 gm amp^{-1} sec^{-1}. Calculate the amount of the substance deposited when 5 ampere is passed for 10 sec.

Sol. Given : Electrochemical equivalent = Z = 2.35 g amp^{-1} sec^{-1}

Time = t = 10 sec.

Current strength = I = 5 ampere.

Formula : m = ZIt

Solution : m = $2.35 \times 10 \times 5 = 117.5$ g

The amount of the substance deposited

= 117.5 g.

3. To 1 M solution of $AgNO_3$, 0.75 F quantity of current is passed. What is the concentration of the electrolyte, $AgNO_3$ remaining in the solution?

Sol. Given : Initial concentration of $AgNO_3$ = 1M = 1N

Quantity of current = 0.75 F

Formula :

1 Faraday = 1 equivalent mass

Solution :

For 1F current, 1$AgNO_3$ will be liberated.

For 0.75F current, 0.75 N $AgNO_3$ will be liberated

The concentration of $AgNo_3$ remaining

= 1.0 – 0.75 = 0.25 N

$\therefore$ The concentration of $AgNO_3$ remaining

= 0.25 M

4. 0.5 F of electric current was passed through 5 molar solution of $AgNO_3$, $CuSO_4$ and $AlCl_3$ connected in series. Find out the concentration of each of the electrolyte after the electrolysis.

Sol. Given :

Quantity of electricity, Q = 0.5 F

Concentration of solution, C = 5 M

***(i)* For $AgNO_3$**

1 mol of Ag^+ = 1F

0.5F = 0.5 mol of $AgNO_3$

Concentration of $AgNO_3$ after electrolysis

= 5 – 0.5 = 4.5 M

***(ii)* For $CuSO_4$**

1 mol of $CuSO_4$ (or) Cu^{2+} = 2F

2F = 1M $CuSO_4$

$0.5F = \frac{1}{2} \times 0.5 = 0.25$ M

Concentration of $CuSO_4$ after electrolysis

= 5 – 0.25 = 4.75 M

***(iii)* For $AlCl_3$**

1 mol of $AlCl_3$ or Al^{3+} = 3F

3F = 1M $AlCl_3$

$0.5F = \frac{1}{3} \times 0.5$

$= \frac{0.5}{3} = 0.167$ M

Concentration of $AlCl_3$ after electrolysis

= 5 – 0.167

Concentration of $AlCl_3$ after electrolysis

= 4.833 M

5. To one molar solution of a trivalent metal salt, electrolysis was carried out and 0.667 M was the concentration remaining after electrolysis. Calculate the quantity of electricity passed.

Sol. Given : Initial concentration of the solution

= 1 M

The concentration remaining after electrolysis

= 0.667 M

$\therefore$ The amount deposited = 1 – 0.667 M

= 0.333 M

1F = Faraday = 3×0.333 M

= 0.999M = 1 M

$\therefore$ 1 Faraday current is used.

13. **The emf of the half cell $Cu^{2+}_{(aq)}$ / $Cu_{(s)}$ containing 0.01 M Cu^{2+} solution is + 0.301V. Calculate the standard emf of the half cell.**

Sol. **Given :** E = 0.301 V; $[Cu^{2+}] = 0.01M$

Formula :

$$E^{\circ}_{Cu^{2+}/Cu} = E_{Cu^{2+}/Cu} + \frac{2.303RT}{nF}\log\frac{[Cu^{2+}]}{[Cu]}$$

$$= +0.301 + \frac{0.0591}{2}\log\frac{0.01}{1}$$

$$E^{\circ} = 0.301 + \frac{0.059}{2} \times 2 = 0.3591\ V$$

E° = 0.36 V

14. **Calculate the standard emf of the cell having the standard free energy change of the cell reaction is –64.84 kJ for 2 electrons transfer.**

Sol. Given : $\Delta G = -64.84 \times 10^3 J$; $n = 2$; $F = 96500\ C$

Formula : $\Delta G = -nFE^{\circ}$

Solution :

$$E^{\circ} = -\frac{\Delta G}{nF} = \frac{-(64.84\times10^3)}{2\times96500}$$

$$= \frac{64840}{2\times96500} = 0.3359V$$

E° = 0.3359 V

15. **Calculate the emf of the cell Zn / ZnO^{-}_{2}, OH^{-}_{aq}, HgO / Hg given that E° values of OH^{-}, ZnO^{-}_{2} / Zn and OH^{-}, HgO / Hg half cells are –1.216 V and 0.098 V respectively.**

Sol. **Given :**

$E^{\circ}_{R} = 0.098$ V; $E_L = -1.216$ V

Formula : $\therefore E^{\circ}_{cell} = E^{\circ}_{R} - E^{\circ}_{L}$

$E^{\circ}_{cell} = 0.098 - (-1.216)$

$= 0.098 + 1.216 = +1.314$

E° = + 1.314 V.

16. **The emf values of the cell reactions $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$ and $Ce^{2+} \rightarrow Ce^{3+} + e^{-}$ are 0.61 V and –0.85 V respectively. Construct the cell such that the free energy of the cell is negative. Calculate the emf of the cell.**

Sol. **Given :**

$Fe^{3+}/Fe^{2+} = 0.61V$

$Ce^{3+} / Ce^{2+} = 0.85$ V (after reversing)

$E^{\circ} = E_R - E_L$

$= 0.85 - 0.61 = 0.24$ V

Cell is,

$Fe^{3+} \mid Fe^{2+} \parallel Ce^{3+} \mid Ce^{2+}$

Left Right

E° Cell = 0.24 V

$\Delta G^{\circ} = -nFE^{\circ}$

$\Delta G^{\circ} = -(1\times 96500 \times 0.24)$

= –ve value

17. **A zinc rod is placed in 0.095 M zinc chloride solution at 25°C. Emf of this half cell is –0.79 V. Calculate $E^{\circ}_{Zn2+/Zn}$.**

Sol. **Given :** E = – 0.79 V

n = 2, $[Zn^{+}] = 0.095$ M

Formula : $E = E^{\circ} - \frac{0.0591}{n}\log Zn^{2+}$

$$E^{0}_{Zn^{2+}/Zn} = E + \frac{0.0591}{2}\log Zn^{2+}$$

$$E^{0}_{Zn^{2+}/Zn} = -0.79 + \frac{0.0591}{2}\log 0.095$$

$= -0.79 + 0.02889 = -0.76$ V

E° = – 0.76 V.

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UNIT TEST

Time : 40 min | Marks : 25

I. Choose the Correct Answer (5 × 1 = 5)

1. During electrolysis of molten sodium chloride, the time required to produce 0.1mol of chlorine gas using a current of 3A is

a) 55 minutes b) 107.2 minutes
c) 220 minutes d) 330 minutes

2. Assertion : pure iron when heated in dry air is converted with a layer of rust.
Reason : Rust has the composition Fe_3O_4

a) if both assertion and reason are true and reason is the correct explanation of assertion.
b) if both assertion and reason are true but reason is not the correct explanation of assertion.
c) assertion is true but reason is false
d) both assertion and reason are false.

3. $\lambda_c = \mu_c$ for,

a) NaCl b) H_2SO_4
c) Na_2SO_4 d) $Al_2(SO_4)_3$

4. Which among the following is the strongest reducing agent?

a) F_2 b) Cl_2 c) Zn d) Li

5. The emf of a cell with 1 M solution of reactants and products in solution at 25°C is called

a) Half cell potential
b) Standard emf
c) Single electrode potential
d) Redox potential

II. Very Short Answer (2 × 2 = 4)

1. Define anode and cathode.
2. State Faraday's Laws of electrolysis.

III. Short Answer (2 × 3 = 6)

1. Write a note on sacrificial protection.
2. How are elctro chemical cells classified?

IV. Long Answer (2 × 5 = 10)

1. Derive an expression of Nernst equation.
2. A current of 1.608 A is passed through 250 mL of 0.5 M solution of copper sulphate for 50 minutes. Calculate the strength of Cu^{2+} after electrolysis assuming volume to be constant and the current efficiency is 100%.

Answer Key

I. 1. b) 107.2 minutes
2. d) both assertion and reason are false
3. a) NaCl
4. d) Li
5. b) Standard emf

II. 1. *Refer Sura's Guide Book back Q.No. 1.*
2. *Refer Sura's Guide Book back Q.No. 5.*

III. 1. *Refer Sura's Guide Book back Q.No. 25.*
2. *Refer Sura's Guide Additional 3 marks Q.No. 2.*

IV. 1. *Refer Sura's Guide Book back Q.No. 24.*
2. *Refer Sura's Guide Book back Q.No. 13.*

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NEET BASED QUESTIONS

NEET BASED QUESTIONS

1. **Rutherford's alpha-particle scattering experiment eventually led to the conclusion that**

(A) Mass and energy are related
(B) Electron occupy space around the nucleus
(C) Neutrons are buried deep in the nucleus
(D) The point of impact with matter can be precisely determined

2. **The number of α- and β-particles emitted in the nuclear reaction**

$$_{90}Th^{228} \longrightarrow {}_{83}Bi^{212}$$

(A) Four alpha and one beta
(B) Three alpha and seven beta
(C) Eight alpha and one beta
(D) One alpha and four beta

3. **Principal quantum number determines**

(A) Size of the electron wave and energy of electron
(B) Orbital angular momentum
(C) Shape of the electron cloud
(D) Configuration of orbitals in space

4. **Correct electronic configuration of Cr is**

(A) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^{10}\ 3d^5\ 4s^1$
(B) $1s^2\ 2s^2\ 2p^6\ 3s^2,\ 3d^8\ 4s^0$
(C) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
(D) $1s^2\ 2p^2\ 2p^6\ 3p^0\ 3d^5\ 4s^1$

5. **The bond order of individual carbon-carbon bond in benzene is–**

(A) 1 (B) 2
(C) Between 1 and 2 (D) 1 and 2, alternatively

6. **Hybridisation of sulphur in SO_2 is**

(A) *sp* (B) sp^3 (C) sp^2 (D) dsp^2

7. **Hybridisation states of carbon in diamond, graphite and acetylene respectively, are**

(A) sp^2, sp, sp^3 (B) sp, sp^2, sp^3
(C) sp^3, sp^2, sp (D) sp, sp^3, sp

8. **$NaHCO_3$ decompose as**

$$2NaHCO_{3(s)} \rightleftharpoons Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$$

The equilibrium pressure is 1.04 atm the K_p for the reaction is–

(A) 0.2704 (B) 2.704
(C) 27.04 (D) 270.4

9. For the reaction

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

K_c = 66.9 at 350°C and 50.0 at 448°C. The reaction has–

(A) ΔH +ve (B) ΔH = –ve
(C) ΔH = zero (D) None of these

10. A mixture of SO_3, SO_2 and O_2 gases in a 10.0 litre flask is maintained at a temperature at which the equilibrium constant K_c of the reaction :

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

is 100. If the number of moles of SO_2 and SO_3 in the flask are equal, the number of moles of O_2 prersent is–

(A) 0.01 (B) 0.1 (C) 1.0 (D) 10.0

11. For the reaction

$$C_{(s)} + CO_{2(g)} \rightleftharpoons 2CO_{(g)}$$

the partial pressures of CO_2 and CO are 2.0 and 4.0 atm respectively at equilibrium, K_p for the reaction is–

(A) 0.5 (B) 8.0 (C) 4.0 (D) 32

12. For a reversible reaction

$$2H_2S_{(g)} \rightleftharpoons 2H_{2(g)} + S_{2(g)}$$

The equilibrium concentrations are,
$[H_2S]$ = 0.5 mole/litre
$[H_2]$ = 0.1 mole/litre
$[S_2]$ = 0.4 mole/litre
The value of 'K' would be–

(A) 0.004 mole/litre (B) 0.08 mole/litre
(C) 0.016 mole/litre (D) 0.16 mole/litre

13. "The molecularity of a reaction can be 0, 1, 3 etc." The statement is

(A) True (B) False
(C) Both the above (D) None of these

14. For a first order reaction the ratio of $t_{0.75}$ to $t_{0.50}$ would be

(A) 4 : 3 (B) 3 : 2
(C) 2 : 1 (D) 1 : 2

15. Which is the first order reaction ?

(A) $NH_4NO_2 \longrightarrow N_2 + 2H_2O$
(B) $2HI \longrightarrow H_2 + I_2$
(C) $2NO_2 \longrightarrow 2NO + O_2$
(D) $2NO + O_2 \longrightarrow 2NO_2$

16. Which of the following aqueous solutions of sodium acetate will show a minimum pH ?

(A) 0.01 *m* (B) 0.001 *m*
(C) 0.0001 *m* (D) 0.1 *m*

17. Pure water dissociates to a small extent as per equilibrium

$$2H_2O_{(i)} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}.$$

The pH of pure water at 298 K is 7, what will be the pH of pure water at 310 K ?

(A) 0 (B) < 7 (C) >7 (D) 7

18. A solution has pH = 3. If its hydrogen ion concentration is decreased 1000 times, the pH of the solution will be

(A) 6 (B) 0
(C) 3 (D) None of these

19. The brown ring compound is formulated as $[Fe(H_2O)_5.NO]SO_4$. The oxidation number of iron is

(A) +1 (B) 2 (C) 3 (D) 0

20. In the reaction

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + 2Na\,I$$

the equivalent weight of oxidant is
[M = Molecular weight of oxidant]–

(A) $\frac{M}{2}$ (B) M (C) $-\frac{M}{2}$ (D) 2 M

21. Active mass is–

(A) gm moles per unit volume
(B) gm atoms per unit volume
(C) gm atomic number per unit volume
(D) gm equivalent per unit volume

22. An acid solution may have the pOH–

(A) 1 (B) 3
(C) 0 (D) 12

NEET

98. In electroplating copper with silver the bath solution used is of $K[Ag(CN)_2]$ instead of $AgNO_3$ because on account of complex formation

(A) A thinner coating of silver is obtained

(B) Availability of Ag+ ions in solution is so reduced that they are not replaced by copper ions

(C) Ag+ ions are completely removed from the solution

(D) Expenses on electricity are reduced

99. The atomic numbers of chromium and iron are 24 and 26 respectively. Which one of the following complexes exhibits paramagnetic character due to electronic spin ?

(A) $[Fe(CO)_5]$

(B) $[Cr(NH_3)_6]^{3+}$

(C) $[Fe(CN)_6]^{4-}$

(D) $[Cr(CO)_6]$

100. Enzymes are basically

(A) Edible proteins

(B) Carbohydrates

(C) Carbohydrates containing nitrogen

(D) Specially structured proteins

NEET

ANSWERS

1. (D)	2. (A)	3. (A)	4. (C)	5. (C)	6. (C)	7. (C)	8. (A)	9. (B)	10. (B)
11. (B)	12. (C)	13. (B)	14. (C)	15. (A)	16. (C)	17. (B)	18. (A)	19. (A)	20. (A)
21. (A)	22. (D)	23. (A)	24. (A)	25. (D)	26. (B)	27. (A)	28. (D)	29. (B)	30. (A)
31. (D)	32. (C)	33. (C)	34. (B)	35. (C)	36. (A)	37. (B)	38. (A)	39. (D)	40. (B)
41. (C)	42. (C)	43. (C)	44. (C)	45. (B)	46. (A)	47. (D)	48. (D)	49. (C)	50. (C)
51. (C)	52. (D)	53. (C)	54. (A)	55. (C)	56. (B)	57. (D)	58. (D)	59. (D)	60. (C)
61. (C)	62. (A)	63. (D)	64. (B)	65. (D)	66. (D)	67. (B)	68. (D)	69. (D)	70. (C)
71. (A)	72. (C)	73. (B)	74. (D)	75. (B)	76. (D)	77. (B)	78. (D)	79. (C)	80. (A)
81. (A)	82. (C)	83. (C)	84. (D)	85. (D)	86. (A)	87. (A)	88. (C)	89. (C)	90. (C)
91. (D)	92. (A)	93. (C)	94. (C)	95. (D)	96. (C)	97. (C)	98. (B)	99. (B)	100. (D)

EXPLANATORY NOTES

8. $Kp = p_{CO_2(g)} \cdot p_{H_2O(g)}$

$p_{CO_2(g)} + p_{H_2O(g)} = 1.04$

$p_{CO_2(g)} = p_{H_2O(g)}$

$p_{CO_2(g)} = \frac{1.04}{2} = 0.52$

Kp = 0.52 × 0.52 = 0.2704.

9. The reaction is exothermic because, with the increase in temperature Kc decreases
ΔH = –ve.

10. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$
has the expression for Kc

$$Kc = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$

$[SO_3] = [SO_2]$

$$Kc = \frac{1}{[O_2]}$$

$[O_2] = \frac{1}{K_c} = \frac{1}{100} = 0.01$ mole/litre

Moles of O_2 in 10 litre

= 0.01 × 10 = 0.1

11. $Kp = \frac{P^2_{CO}}{P_{CO_2}}$

$= \frac{4 \times 4}{2} = 8$

12. $K = \frac{[H_2]^2[S_2]}{[H_2S]^2}$

$= \frac{0.1 \times 0.1 \times 0.4}{0.5 \times 0.5}$

= 0.016 mole/litre.

13. The molecularity can never be zero.

14. $t_{0.5} = \frac{0.693}{K_2}$

$t_{0.75} = \frac{2 \times 0.693}{K_1}$

Hence **$t_{0.75} : t_{0.5} = 2 : 1.$**

16. $[H^+] \propto \frac{1}{\sqrt{C}}$

$pH \propto \frac{1}{[H^+]} \propto \sqrt{C}$

where C = conc. of the salt. Hence, minimum the concentration, minimum is the pH.

17. The pH of pure water decreases with the rise in-temperature.
Hence $t_{0.75} : t_{0.5} = 2 : 1$

18. pH = 3, $[H^+] = 10^{-3}$

$[H^+] = \frac{10^{-3}}{1000} = 10^{-6}$

pH = 6.

20. I_2 is an oxidant

$2e + I_2 \rightarrow 2I^-$

Equivalent weight

$= \frac{\text{Molecular wt. of the oxidant}}{\text{Number of electrons gained}}$

$= \frac{M}{2}$

23. Calculation

$Al_2O_3 . 2H_2O \xrightarrow{\Delta} Al_2O_3 + 2H_2O$

NEET BASED QUESTIONS

24. In the extraction of copper auto-reduction process takes place.

$$Cu_2S + 2Cu_2O \longrightarrow 6Cu + SO_2$$

26. Gun metal contains Cu, Sn and Zn.

27. Due to high standard oxidation potential they act as a best reductants.

29. Mn^{++} has the configuration [Ar] $3d^5$. It contains maximum number of unpaired electrons. Hence it shows maximum magnetic moment.

31. $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

33. Ordinary glass is

$$Na_2O \,.\, CaO \,.\, 6SiO_2$$

35. $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$

46. $K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

Hence $x = 1$
$y = 3$
$z = 1$

47. Molecular mass of hydrogen = 2

Hence 2.0 gm of H_2 has = 6.02×10^{23} molecule

$\therefore$ 1.0 gm of H_2 will have

$$= \frac{6.02 \times 10^{23}}{2}$$

$$= 3.01 \times 10^{23} \text{ molecule}$$

48. When l = 3, the sub-shell is f, and f-sub-shell has 7 orbitals and maximum of 14 electrons.

49. $E = \frac{hc}{\lambda}$ or, $\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$

$$= \frac{4000}{2000} = 2$$

50. $_{17}Cl = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^5$ in 3*p*-orbital one unpaired electron is there. Hence for unpaired electron–

$n = 3$
$l = 1$
$m = 1$

56. Phenols are more acidic than alcohols. Now the choice is between phenol and p-chlorophenol. When electron attracting group is attached to phenol at m-position then H+ loss becomes more easier. Hence m-chlorophenol is most acidic.

☆ ☆ ☆

NEET

12th STD

INSTANT SUPPLEMENTARY EXAM JULY - 2022

CHEMISTRY

PART III (with Answers)

Reg. No.

Time Allowed : 3.00 Hours] [Maximum Marks : 70

Instructions :

(1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

Note : Draw diagrams and write equations wherever necessary.

PART - I

Note : (i) Answer **all** the questions. **[15 × 1 = 15]**

(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

1. Zinc is obtained from ZnO by:
   (a) Carbon reduction
   (b) Reduction using silver
   (c) Electrochemical process
   (d) Acid leaching
2. The element that shows lowest Catenation among the following p-block elements is :
   (a) Carbon (b) Silicon
   (c) Lead (d) Germanium
3. XeF_6 on complete hydrolysis produces :
   (a) $XeOF_4$ (b) XeO_2F_2
   (c) XeO_3 (d) XeO_2
4. The actinoid elements which show the highest oxidation state of +7 are:
   (a) Np, Pu, Am (b) U, Fm, Th
   (c) U, Th, Md (d) Es, No, Lr
5. An example for double salt:
   (a) $FeSO_4$
   (b) $FeSO_4(NH_4)_2SO_4.6H_2O$
   (c) $K_4[Fe(CN)_6]$
   (d) $K_2SO_4 2H_2O$
6. Graphite and Diamond are
   (a) covalent and molecular crystals
   (b) ionic and covalent crystals
   (c) both are covalent crystals
   (d) both are molecular crystals
7. Half -life period for first order reaction:
   (a) $t_{1/2}=\frac{0.6932}{K}$ (b) $t_{1/2}=\frac{K}{0.6932}$
   (c) $t_{1/2}=\frac{2.303}{K}$ (d) $t_{1/2}=\frac{K}{2.303}$
8. Which of these is not likely to act as Lewis base?
   (a) BF_3 (b) PF_3 (c) CO (d) F^-
9. How many Faradays of electricity are required for the following reaction to occur $MnO^-_4 \rightarrow Mn^{2+}$
   (a) 5F (b) 3F (c) 1F (d) 7F
10. The phenomenon observed when a beam of light is passed through a colloidal solution is:
    (a) Cataphoresis
    (b) Electrophoresis
    (c) Coagulation
    (d) Tyndall effect
11. Which of the following compounds can be used as antifreeze in automobile radiators?
    (a) Methanol (b) ethanol
    (c) Neo-pentyl alcohol
    (d) ethan -1, 2-diol
12. Which of the following represents the correct order of acidity in the given compounds?
    (a) $FCH_2COOH > CH_3COOH > BrCH_2COOH > ClCH_2COOH$

(b) $FCH_2COOH > ClCH_2COOH > BrCH_2COOH > CH_3COOH$

(c) $CH_3COOH > ClCH_2COOH > FCH_2COOH > Br.CH_2COOH$

(d) $ClCH_2COOH > CH_3COOH > BrCH_2COOH > ICH_2COOH$

13. Aniline + benzoylchloride $\xrightarrow{NaOH}$ $C_6H_5 - NH - COC_6H_5$ This reaction is known as :
(a) Friedel – Crafts reaction
(b) HVZ reaction
(c) Schotten – Baumann reaction
(d) Kolbe's reaction

14. Which of the following are epimers?
(a) D(+)– Glucose and D(+)– Galactose
(b) D(+)– Glucose and D(+)– Mannose
(c) Neither (a) nor (b)
(d) Both (a) and (b)

15. Which of the following reduces Tollen's reagent?
(a) formic acid (b) acetic acid
(c) benzophenone (d) none of these

PART - II

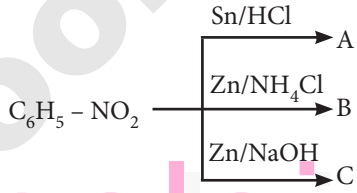
Note : Answer **any six** questions. Question No. **24** is **compulsory.** **6 × 2 = 12**

16. Give the uses of argon
17. Write a note on Zeigler-Natta catalyst. Give its use.
18. What are the limitations of VB Theory?
19. Define unit cell.
20. What are Lewis acids and bases? Given an example for each.
21. Write the uses of glycerol.
22. Write a note on Rosenmund reduction.
23. Draw the structure of D(+) Fructose.
24. A solution of silver nitrate is electrolysed for 20 minutes with a current of 2 amperes. Calculate the mass of silver deposited at the cathode.

PART - III

Note : Answer **any six** questions. Question No. **33** is **Compulsory.** **6 × 3 = 18**

25. Explain Acid leaching with an example.
26. What are the uses of boric acid?
27. Write the IUPAC ligand for the following :
(a) $C_2O_4^{2-}$ (b) H_2O (c) Cl^-
28. Define order and molecularity of a reaction.
29. What is Buffer Solution? Give an example.
30. What is Heterogeneous Catalysis? Give example.
31. Write the bromination reaction of anisole.
32. What is called zwitter ion? Give an example.
33. Identify compounds A, B and C for the following.



PART - IV

Note : Answer **all** the questions: **5 × 5 = 25**

34. (a) Explain the principle of electrolytic refining with an example.

(OR)

(b) What is catenation? Write the conditions for catenation property

35. (a) Write the properties of inter halogen compounds.

(OR)

(b) Compare lanthanides and actinides.

36. (a) (i) What is packing efficiency?
(ii) Write a note on Frenkel defect.

(OR)

(b) Derive Integrated rate Law for a zero order reaction A → product.

37. (a) Derive an expression for Nernst equation.

(OR)

(b) Describe adsorption theory of Catalysis.