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JEE Advanced Chemistry 10 Years Topicwise Questions with Solutions

INORGANIC CHEMISTRY

METALLURGY

1. The correct statement(s) related to processes involved in the extraction of metals is(are)

[JEE(Advanced) 2023]

[JEE(Advanced) 2022]

- (A) Roasting of Malachite produces Cuprite.
- (B) Calcination of Calamine produces Zincite.
- (C) Copper pyrites is heated with silica in a reverberatory furnace to remove iron.
- (D) Impure silver is treated with aqueous KCN in the presence of oxygen followed by reduction with zinc metal.
- 2. The electrochemical extraction of aluminum from bauxite ore involves. [JEE(Advanced) 2022]
 - (A) the reaction of Al_2O_3 with coke (C) at a temperature > 2500°C.
 - (B) the neutralization of aluminate solution by passing CO₂ gas to precipitate hydrated alumina (Al₂O₃.3H₂O).
 - (C) the dissolution of Al_2O_3 in hot aqueous NaOH.
 - (D) the electrolysis of Al_2O_3 mixed with Na_3AlF_6 to give Al and CO_2 .
- 3. The treatment of galena with HNO₃ produces a gas that is
 - (A) paramagnetic (B) bent in geometry
 - (C) an acidic oxide (D) colorless
- The correct option(s) related to the extraction of iron from its ore in the blast furnace operating in the temperature range 900 1500 K is(are) [JEE(Advanced) 2022]
 - (A) Limestone is used to remove silicate impurity.
 - (B) Pig iron obtained from blast furnace contains about 4% carbon.
 - (C) Coke (C) converts CO₂ to CO.
 - (D) Exhaust gases consist of NO_2 and CO.
- 5. The correct statement(s) related to the metal extraction processes is(are) [JEE(Advanced) 2021]
 - (A) A mixture of PbS and PbO undergoes self-reduction to produce Pb and SO₂.
 - (B) In the extraction process of copper from copper pyrites, silica is added to produce copper silicate.
 - (C) Partial oxidation of sulphide ore of copper by roasting, followed by self-reduction produces blister copper.
 - (D) In cyanide process, zinc powder is utilized to precipitate gold from Na[Au(CN)₂].
- 6. Which among the following statement(s) is(are) true for the extraction of aluminium from bauxite?

[JEE(Advanced) 2020]

- (A) Hydrated Al₂O₃ precipitates, when CO₂ is bubbled through a solution of sodium aluminate.
- (B) Addition of Na₃AlF₆ lowers the melting point of alumina.
- (C) CO_2 is evolved at the anode during electrolysis.
- (D) The cathode is a steel vessel with a lining of carbon.

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(A) CuFeS₂

7.

	(C) $ZnSO_4$, $Cu(OH)_2$, Fe_3O_4 , Na_3AlF_6	(D) $ZnCO_3$, $CuCO_3$, Fe_2O_3 ,	Na	
8.	The cyanide process of gold extraction involves leaching out gold from its ore with			
	Q in water to form R . Subsequently, R is treat	ated with \mathbf{T} to obtain Au and \mathbf{Z} . Cho	200	
			[
	(A) T is Zn	(B) R is $[Au(CN)_4]^-$		
	(C) Z is $[Zn(CN)_4]^{2-}$	(D) \mathbf{Q} is O ₂		
9. Galena (an ore) is partially oxidized by passing air through it at high te			tur	
	passage of air is stopped, but the heating is	continued in a closed furnance such	ı th	
	self-reduction. The weight (in kg) of Pb prod	uced per kg of O ₂ consumed is		
	(Atomic weights in g mol ^{-1} : O = 16, S = 32,	Pb = 207)	[
10.	Extraction of copper from copper pyrite (Cul	FeS_2) involves	[
	(A) crushing followed by concentration of th	e ore by froth-flotation		
	(B) removal of iron as slag			
	(C) self-reduction step to produce 'blister cop	pper' follwoing evolution of SO ₂		
	(D) refining of 'blister copper' by carbon red	action		

- 11.
- 12.

	Colu	mn - I	Colu	mn - II	
	(A)	Carbonate	(P)	Siderite	
	(B)	Sulphide	(Q)	Malachite	
	(C)	Hydroxide	(R)	Bauxite	
	(D)	Oxide	(S)	Calamine	
			(T)	Argentite	
•	Upor	heating with Cu_2S , the reagent(s) that give c	copper	metal is/are	
					 -

(C) Cu₂O

(B) CuO

[JEE(Advanced) 2014]

(D) (CuSO	4	

Calamine, malachite, magnetite and cryolite, respectively are

	(A) Z	ZnSO ₄ , CuCO ₃ , Fe ₂ O ₃ , AlF ₃	(B) 2	ZnCO ₃ , CuCO ₃ .Cu(OH) ₂ , Fe ₃ O ₄ , Na ₃ AlF ₆	
	(C) Z	ZnSO ₄ , Cu(OH) ₂ , Fe ₃ O ₄ , Na ₃ AlF ₆	(D) Z	ZnCO ₃ , CuCO ₃ , Fe ₂ O ₃ , Na ₃ AlF ₆	
	The c	cyanide process of gold extraction involves le	aching	out gold from its ore with CN ⁻ in the presence of	
	Q in	water to form R . Subsequently, R is treated v	vith T	to obtain Au and \mathbf{Z} . Choose the correct option(s).	
				[JEE(Advanced) 2019]	
	(A) T	ſ is Zn	(B) F	$a is [Au(CN)_4]^-$	
	(C) Z	$2 \text{ is } [Zn(CN)_4]^{2-}$	(D) (is O ₂	
	Galer	na (an ore) is partially oxidized by passing a	air thro	ough it at high temperature. After some time, the	
	passa	ge of air is stopped, but the heating is contin	ued in	a closed furnance such that the contents undergo	
	self-r	reduction. The weight (in kg) of Pb produced	per kg	of O ₂ consumed is	
	(Ator	mic weights in g mol^{-1} : O = 16, S = 32, Pb =	207)	[JEE(Advanced) 2018]	
•	Extra	action of copper from copper pyrite (CuFeS ₂)	involv	es [JEE(Advanced) 2016]	
	(A) crushing followed by concentration of the ore by froth-flotation				
	(B) re	emoval of iron as slag			
	(C) se	elf-reduction step to produce 'blister copper' f	ollwoi	ng evolution of SO ₂	
	(D) re	efining of 'blister copper' by carbon reduction			
•	Copp	er is purified by electrolytic refining of blist	er cop	per. The correct statement(s) about this process is	
	(are)			[JEE(Advanced) 2015]	
	(A) Impure Cu strip is used as cathode				
	(B) Acidified aqueuous CuSO ₄ is used as electrolyte				
	(C) Pure Cu deposits at cathode				
	(D) Impurities settle as anode-mud				
•	Matc	h the anionic species given in Column-I that	are pre	sent in the ore(s) given in Column-II	
				[JEE(Advanced) 2015]	
	Colu	mn - I	Colu	mn - II	
	(A)	Carbonate	(P)	Siderite	
	(B)	Sulphide	(Q)	Malachite	
	(C)	Hydroxide	(R)	Bauxite	
	(D)	Oxide	(S)	Calamine	
			(T)	Argentite	

LEN® [JEE(Advanced) 2019]

SOLUTIONS

1. Ans. (B, C, D)

Sol. \Rightarrow Under roasting condition, the malachite will be converted into

$$CuCO_3.Cu(OH)_2 \rightarrow 2CuO + CO_2 + H_2O$$

- $\Rightarrow ZnCO_3 \rightarrow ZnO + CO_2 \uparrow$ (Calamine) (Zincite)
- \Rightarrow Copper pyrites is heated in a reverberatory furnace after mixing with silica. In the furnace, iron oxide 'slag of' as iron silicate and copper is produced in the form of copper matte.

$$FeO + SiO_{2} \rightarrow FeSiO_{3}$$
(Slag)
$$\Rightarrow Ag + KCN + O_{2} + H_{2}O \longrightarrow [Ag(CN)_{2}]^{-} + KOH$$

$$\downarrow Zn$$

$$Ag \downarrow + [Zn(CN)_{4}]^{2-}$$

2. Ans. (B, C, D)

- Sol. (A) Electrochemical extraction of Aluminum from bauxite done below 2500°C
 - (B) 2Na[Al(OH)₄]_{aq.} + 2CO_{2(g)} → Al₂O<sub>3.3H₂O_(s) ↓ + 2NaHCO_{3(aq.)}
 The sodium aluminate present in solution is neutralised by passing CO₂ gas and hydrated Al₂O₃ is precipitated.
 </sub>
 - (C) Al₂O_{3(s)} + 2NaOH_(aq.) + 3H₂O_(l) → 2Na[Al(OH)₄]_{aq.}
 Concentration of bauxite is carried out by heating the powdered ore with hot concentrated solution of NaOH.
 - (D) In metallurgy of aluminum, Al_2O_3 is mixed with Na_3AlF_6

3. Ans. (A, D)

Sol. $3PbS + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 2NO + 4H_2O + S$

 $NO \Rightarrow$ Neutral oxide, Paramagnetic, Linear geometry, Colourless gas

4. Ans. (A, B, C)

- Sol. (A) $CaO + SiO_2 \rightarrow CaSiO_3$ (in the temperature range 900 1500 K)
 - (B) In fusion zone molten iron becomes heavy by absorbing elemental impurities and produces Pig iron. (in the temperature range 900 1500 K)
 - (C) C + CO₂ \rightarrow 2CO (in the temperature range 900 1500 K)
 - (D) Exhaust gases does not contain NO₂.

5. Ans. (A, C, D)

- **Sol.** (A) $PbS + 2PbO \rightarrow 3Pb + SO_2$ (self reduction)
 - (B) Silica is added to remove impurity of Fe in the form of slag FeSiO₃
 - (C) CuFeS₂ ore is partially oxidized first by roasting and then self reduction of Cu takes place to produce blister copper.

(D) 4 Na [Au (CN)₂] +2 Zn
$$\longrightarrow$$
 2 Na₂[Zn(CN)₄] + 4 Au
Reducing
Agent

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6. Ans. (A, B, C, D)

Sol. (A) $2Na[Al(OH)_4]_{(aq.)} + CO_2 \longrightarrow Na_2CO_3 + H_2O + 2Al(OH)_3(\downarrow)$

or

Al₂O₃.2H₂O (ppt)

(B) Function of Na₃AlF₆ is to lower the melting point of electrolyte.

(C) During electrolysis of Al₂O₃, the reactions at anode are :

$$\begin{bmatrix} 2Al^{3+}(\ell) + 3O^{2-}(\ell) & \xrightarrow{At \text{ anode}} & O_2(gas) + 2e^{-} \end{bmatrix}$$

C(graphite) + O₂ \longrightarrow CO(\uparrow) + CO₂(\uparrow)

(D) The steel vessel with a lining of carbon acts as cathode.

7. Ans. (B)

Ore	Formula	
Calamine	ZnCO ₃	
Malachite	CuCO ₃ .Cu(OH) ₂	
Magnetite	Fe ₃ O ₄	
Cryolite	Na ₃ AlF ₆	
	Malachite Magnetite	

So correct answer is option(2)

8. Ans. (A, C, D)

Sol.
$$4Au(s) + 8CN(aq) + 2H_2O(aq) + O_2(g) \rightarrow 4[Au(CN)_2](aq) + 4OH(aq)$$

(Q)

$$2[\operatorname{Au}(\operatorname{CN})_2]^{-}(\operatorname{aq}) + \operatorname{Zn}(\operatorname{s}) \rightarrow [\operatorname{Zn}(\operatorname{CN})_4]^{2-}(\operatorname{aq}) + 2\operatorname{Au}(\operatorname{s})$$

9. Ans. (6.47)

Sol. $PbS + O_2 \longrightarrow Pb + SO_2$

$$\frac{1000}{32}$$
 mol $\frac{1000}{32} \times 207$ gm

mol of $Pb = mol of O_2$

$$= \frac{1000}{32} \text{ mol}$$

∴ mass of Pb = $\frac{1000}{32} \times 207 \text{ g} = \frac{207}{32} \text{ kg} = 6.47 \text{ kg}$

4

10. Ans. (A, B, C) Copper pyrite [CuFeS₂] Sol. \downarrow Crushing into fine powder Concentrated by froth floatation process \downarrow Roasting take place in reverberatory furnace $\begin{cases} 2CuFeS_2 + O_2 & \Delta \\ (air) \\ FeS + O_2 & \Delta \\ (air) \\ FeS + O_2 & \Delta \\ FeO + SO_2 \\ \hline \\ Smelting \\ FeO + SiO_2(flux) & \Delta \\ FeSiO_3(\ell)(slag) \\ \end{bmatrix}$ Copper matte (Cu₂S + FeS) \downarrow Self reduction $\begin{bmatrix} Self reduction occurs in Bessemer converter \\ 2Cu_2S + 3O_2 & 2Cu_2S + 2SO_2(\uparrow) \\ Cu_2S + 2Cu_2O & 6Cu + SO_2(\uparrow) \\ \end{bmatrix}$ (Blister copper)

Refining of blister copper is done by poling followed by electrorefining but not by carbon reduction method.

11. Ans. (B, C, D)

Sol. (A) Impure Cu strip is used as cathode : INCORRECT

Impure Cu strip is used as anode

(B) Aq.solution of $(CuSO_4 + H_2SO_4)$ is used as electrolyte : **CORRECT**

(C) Pure Cu deposites at cathode : **CORRECT**

 $Cu^{+2} \xrightarrow{+2e^-} Cu$

At cathode

(D) Impurities settle as anode mud : CORRECT

In electrorefining impurities are either soluble in electrolyte solution or deposit below anode known as anode mud.

12. Ans. (A - P,Q,S ; B - T ; C - Q,R ; D - R)

Sol. (A) \rightarrow P, Q, S, (B) \rightarrow T, (C) \rightarrow Q, R, (D) \rightarrow R Siderite : FeCO₃ Malachite : CuCO₃.Cu(OH)₂ Bauxite : Al₂O₃.2H₂O consisting of part of hydroxide of aluminium also and the general formula is AlO_x(OH)_{3-2x} where 0 < x < 1 Calamine : ZnCO₃

Argentite : Ag_2S

- 13. Ans. (C)
- **Sol.** $Cu_2S + 2Cu_2O \xrightarrow{\Delta} 6Cu + SO_2$