DPP - Daily Practice Problems

Date : | **Start Time :** | **End Time :**

CHEMISTRY CC17

SYLLABUS : General Principles and Processes of Isolation of Elements

Max. Marks : 74 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 20 Questions divided into 5 sections.
  Section I has **5** MCQs with ONLY 1 Correct Option, **3** marks for each correct answer and **–1** for each incorrect answer.
  Section II has **4** MCQs with ONE or MORE THAN ONE Correct options.
  For each question, marks will be awarded in one of the following categories:
  Full marks: **+4** If only the bubble(s) corresponding to all the correct option(s) is (are) darkened.
  Partial marks: **+1** For darkening a bubble corresponding to each correct option provided NO INCORRECT option is darkened.
  Zero marks: If none of the bubbles is darkened.
  Negative marks: **–2** In all other cases.
  Section III has **5** Single Digit Integer Answer Type Questions, **3** marks for each Correct Answer and 0 marks in all other cases.
  Section IV has Comprehension/Matching Cum-Comprehension Type Questions having **5** MCQs with ONLY ONE correct option, **3** marks for each Correct Answer and 0 marks in all other cases.
  Section V has **1** Matching Type Questions, **2** mark for the correct matching of each row and 0 marks in all other cases.
- You have to evaluate your Response Grids yourself with the help of Solutions.

Section I - Straight Objective Type

This section contains 5 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

1. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?

(a) Metal sulphides are thermodynamically more stable than CS_2

(b) CO_2 is thermodynamically more stable than CS_2

(c) Metal sulphides are less stable than the corresponding oxides

(d) CO_2 is more volatile than CS_2

2. In the electrolysis of alumina to obtain aluminium metal, cryolite is added mainly to

(a) lower the melting point of alumina

(b) dissolve alumina in molten cryolite

(c) remove the impurities of alumina

(d) increase the electrical conductivity

RESPONSE GRID	1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ

Space for Rough Work

3. Calcination is the process in which
   (a) ore is heated above its melting point to expel H_2O or CO_2 or SO_2
   (b) ore is heated below its melting point to expel volatile impurities
   (c) ore is heated above its melting point to remove S, As and Sb as SO_2 ,As_2O_3 and Sb_2O_3 respectively
   (d) ore is heated below its melting point to expel H_2O or CO_2

4. Identity *x, y, z* for the following metallurgical process.

   Metal sulphide $\xrightarrow{x}$ Metal oxide $\xrightarrow{y}$ Impure metal $\xrightarrow{z}$ Pure metal.

   x, y and *z* are respectively
   (a) roasting, smelting, electrolysis
   (b) roasting, calcination, smelting
   (c) calcination, auto-reduction, bassemerisation
   (d) None of the above is correct

5. Consider the following statements –
   (A) In the Aluminothermite process, aluminium acts as reducing agent.
   (B) 'Slag' formed during smelting in the extraction of copper is $FeSiO_3$.
   (C) In the extractive metallurgy of zinc, partial fusion of ZnO with coke is called sintering and reduction of ore to the molten metal is called smelting.
   (D) Extractive metallurgy of silver from its ore argentine involves complex formation and displacement by more electropositive metal.

   Choose the correct options –
   (a) A and B (b) B and C
   (c) A, B and C (d) A, B, C and D

Section II - Multiple Correct Answer Type

This section contains 4 multiple correct answer(s) type questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONE OR MORE** is/are correct.

6. In the process of extraction of gold

   Roasted gold ore + $CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$

   $[X] + Zn \longrightarrow [Y] + Au$

   Identify the complexes [X] and [Y].
   (a) $X = [Au(CN)_2]^-$ (b) $Y = [Zn(CN)_4]^{2-}$
   (c) $Y = [Zn(CN)_6]^{4-}$ (d) $X = [Au(CN)_4]^{3-}$

7. Which of the following is/are false ?
   (a) All minerals are ores
   (b) Mercury is transported in containers made of iron
   (c) Calcination is the process of heating the ore strongly in the presence of air
   (d) Cassiterite is an ore of iron

8. Magnesium and aluminium can be extracted
   (a) by electrolysis of their fused salts
   (b) Mg from fused $MgCl_2$ and aluminium from alumina
   (c) by electrolysis of aqueous solution of their salts
   (d) by reduction of their oxides with carbon

9. Select the statement(s) that are true about reduction during smelting
   (a) It may be carried out using carbon
   (b) It may be carried out using aluminium
   (c) It may be carried out using hydrogen
   (d) It may be carried out using silver

Section III - Integer Type

This section contains 5 questions. The answer to each of the questions is a single digit integer ranging from 0 to 9.

10. How many cyanide ions are involved in the following chemical equation?

$$Au + CN^{\ominus} + H_2O + O_2 \rightarrow [Au(CN)_2]^{\ominus} + \overset{\ominus}{O}H$$

11. Amongst the following, how many ores can be concentrated by froth flotation process:

    Galena, sphalerite, cassiterite, calamine, chalcocite, haematite, argentite

12. How many of the following are oxide ores:

    Calamine, cuprite, zincite, chalcocite, haematite, bauxite, magnetite, cassiterite

RESPONSE GRID	
	3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 5. ⓐⓑⓒⓓ 6. ⓐⓑⓒⓓ 7. ⓐⓑⓒⓓ
	8. ⓐⓑⓒⓓ 9. ⓐⓑⓒⓓ 10. ⓪①②③④⑤⑥⑦⑧⑨
	11. ⓪①②③④⑤⑥⑦⑧⑨ 12. ⓪①②③④⑤⑥⑦⑧⑨

Space for Rough Work

13. Find the number of following reactions which are involved in roasting process:

i. $S_8 + 8O_2 \xrightarrow{\Delta} 8SO_2 \uparrow$

ii. $P_4 + 5O_2 \xrightarrow{\Delta} P_4O_{10} \uparrow$

iii. $4As + 3O_2 \xrightarrow{\Delta} 2As_2O_3 \uparrow$

iv. $2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2 \uparrow$

v. $ZnCO_3 \xrightarrow{\Delta} 4ZnO + CO_2 \uparrow$

14. How many metallic ores are concentrated by magnetic separation method from the given ores?
Cassiterite, pyrolusite, rutile, magnetite, galena, cinnabar.

Section IV - Comprehension Type

Directions (Qs. 15-19) : Based upon the given paragraphs, 5 multiple choice questions have to be answered. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

PARAGRAPH-1

Column I contains compound and Column II & III contains their formula and uses respectively.

Column I	Column II	Column III
(I) Glauber's salt	(i) $FeSO_4.(NH_4)_2SO_4.6H_2O$	(P) Efflorescent
(II) Washing soda	(ii) $NaHCO_3$	(Q) Iron plating
(III) Baking soda	(iii) $Na_2CO_3.10H_2O$	(R) Deliquescent
(IV) Mohr's salt	(iv) $Na_2SO_4.10H_2O$	(S) Gives CO_2 on heating

15. Which combination represents such materials which are used as a laxative in medical field

(a) (III)(ii)(Q) (b) (IV)(ii)(P)
(c) (I)(iv)(R) (d) (I)(iii)(R)

16. Find the combination which loses water spontaneously

(a) (I)(iv)(S) (b) (II)(ii)(Q)
(c) (IV)(iii)(R) (d) (II)(iii)(P)

17. Correct combination is

(a) (I)(iv)(S) (b) IV(i)(Q)
(c) (III)(iii)(S) (d) (II)(ii)(Q)

PARAGRAPH-2

Standard Electrode Potentials and Metallurgy : The method employed for extracting a metal from its ore depends on the nature of the metal, that of the ore and may be related to the position of the metal in the electrochemical series. In general, metals with reduction potential less than – 0.5 volt yield compounds which are very difficult to reduce. Such metals are isolated by electrolysis. On the other hand noble metals with reduction potential + 0.5 volt form easily reducible compounds.

The standard electrode potential of a metal is a measure of its tendency to go into solution as hydrated ion. On the other hand, in metallurgical extractions we generally come across ores which are to be reduced to the metallic state. Thus, it may be said that a metal higher up in the electrochemical series should be more difficult to reduce to metallic form. As we move down, the reduction becomes more and more easy. However, it must be borne in mind that this is a very general statement and cannot be strictly applied because metals are seldom extracted from aqueous solutions.

Energy Factors and Electrode Potentials – The heat of sublimation (S) of solid metal, the ionization energy (I) of gaseous metal atom and the heat of hydration (H) of gaseous ion are the contributory factors towards electrode potential (E). These factors may be consolidated in a Born-Haber type of cycle.

$$\begin{array}{ccc} M_{(solid)} & \xrightarrow{E} & M^+_{(aq)} + e^- \\ S \downarrow & & \uparrow H \\ M_{(gaseous)} & \xrightarrow{I} & M^+_{(gaseous)} + e^- \end{array}$$

Thus, $E = +S + I - H$

RESPONSE GRID	13. ⓪①②③④⑤⑥⑦⑧⑨ 14. ⓪①②③④⑤⑥⑦⑧⑨ 15. ⓐⓑⓒⓓ 16. ⓐⓑⓒⓓ 17. ⓐⓑⓒⓓ

Space for Rough Work

S and *I* are positive because energy is supplied while *H* is negative as the process of hydration is an exothermic one liberating heat. As expected, ionization energies of alkali metals follow the trend : Li > Na > K > Rb > Cs

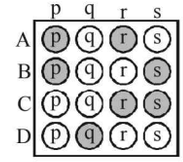
It means Li has the least tendency to lose electron among alkali metals. However, from electrochemical series we find that lithium is the most reducing in character (E° for $\frac{Li^+}{Li} = -3.05$ volt). The anomalous behaviour of Li is understandable from the fact that heat of hydration of its ion is highest because of small size. The contribution of this hydration factor towards electrode potential makes Li even more reducing than Na or K.

18. The incorrect statement among the following is
- (a) the first ionisation potential of Al is less than the first ionisation potential of Mg
- (b) the second ionisation potential of Mg is greater than the second ionisation potential of Na
- (c) the first ionisation potential of Na is less than the first ionisation potential of Mg
- (d) the third ionisation of Mg is greater than third ionisation potential of Al.

19. How can alkali metals be extracted?
- (a) Reduction of their oxides
- (b) Displacement from their salt solution by any other element
- (c) Electrolysis of their fused salts
- (d) Electrolysis of their aqueous salt solutions

Section V - Matrix-Match Type

This section contains 1 question. It contains statements given in two columns, which have to be matched. Statements in column I are labelled as A, B, C and D whereas statements in column II are labelled as p, q, r and s. The answers to these questions have to be appropriately bubbled as illustrated in the following example. If the correct matches are A-p, A-r, B-p, B-s, C-r, C-s and D-q, then the correctly bubbled matrix will look like the following:



20. Match the following :

	Column I		Column II
(A)	Carbon monoxide	p.	Cu
(B)	Liquation	q.	Ag
(C)	Cupellation	r.	Ni
(D)	Hydrometallurgy	s.	Pb

RESPONSE GRID	18. ⓐⓑⓒⓓ 19. ⓐⓑⓒⓓ 20. A - ⓟⓠⓡⓢ; B - ⓟⓠⓡⓢ; C - ⓟⓠⓡⓢ; D - ⓟⓠⓡⓢ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE 17 - CHEMISTRY			
Total Questions	20	Total Marks	74
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	38
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

1. (c) The reduction of metal sulphides by carbon reduction process is not spontaneous because ΔG for such a process is positive. The reduction of metal oxide by carbon reduction process is spontaneous as ΔG for such a process is negative.

On thermodynamic considerations, CO_2 is more stable than CS_2 and the metal sulphides are more stable than corresponding oxides.

In view of above the factor listed in choice (c) is incorrect and so is of no significance.

2. (a) Fused alumina (Al_2O_3) is a bad conductor of electricity. Therefore, cryolite (Na_3AlF_6) and fluorspar (CaF_2) are added to purified alumina which not only make alumina a good conductor of electricity but also reduce the melting point of the mixture to around 1140 K.

3. (d) Calcination is a process of heating a substance to a high temperature but below the melting or fusion point, causing loss of moisture, reduction or oxidation and dissociation into simpler substances.

4. (a) The conversion of metal sulphide to metal oxide involves the process of **roasting** (i.e., *x* is roasting).

The metal oxides can then be converted to impure metal by reduction. Of the given choices in (a) and (b) the reduction process is that of **smelting**. (i.e., '*y*' is smelting)

The conversion of impure metal to pure metal involves a process of purification. Thus it is electrolysis (z).

5. (d) (A) $Cr_2O_3 + 2Al \longrightarrow \overset{+3}{Al_2O_3} + 2Cr$

(B) $2FeS + 3O_2 \rightarrow 2FeO + 2SO_2 \uparrow$

$FeO + SiO_2 \rightarrow \underset{(Slag)}{FeSiO_3}$

(C) Statement is true

(D) $Ag_2S + 4NaCN \xrightarrow{O_2} 2Na[Ag(CN)_2] + Na_2S$

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

6. (a, b) $2Au + 4CN^- + H_2O + \frac{1}{2}O_2 \longrightarrow 2[Au(CN)_2]^- + 2OH^-$

$2[Au(CN)_2]^- + Zn \longrightarrow [Zn(CN)_4]^{2-} + 2Au$

7. (a, c, d) Mercury does not form amalgam with iron and therefore, it is transported in iron containers.

Free state occurence of metals is called native ore. All minerals are not ores. Combined state occurence of metals is called mineral.

Calcination is done in absence of air. Cassiterite is SnO_2.

8. (a,b) Mg and aluminium can be extracted by electrolysis of their fused salts (both are reactive metals). Mg is obtained from fused $MgCl_2$ and aluminium from alumina (Al_2O_3).

9. (a,b,c) Reduction during smelting may be carried out by using carbon, aluminium or hydrogen.

10. (8) $4Au + 8CN^{\ominus} + 2H_2O + O_2 \rightarrow 4[Au(CN)_2]^- + 4OH^-$

11. (3) Galena (PbS), sphalerite (Zn, Fe)S, chalcocite (Cu_2S). Although argentite (Ag_2S) is a sulphide ore, it is not concentrated by froth flotation process since its silver content is low. It is better concentrated by leaching with NaCN.

12. (6) Cuprite (Cu_2O), zincite (ZnO_2), haematite (Fe_2O_3), bauxite ($Al_2O_3.2H_2O$), magnetite (Fe_3O_4) and cassiterite (SnO_2).

13. (4) Roasting is heating the ore in presence of O_2. Reactions (i), (ii), (iii) and (iv) can be termed roasting.

14. (4) Cassiterite (SnO_2), rutile (TiO_2), magnetite (Fe_3O_4), cinnabar (PbS)

15. (c) Glauber's salt - $Na_2SO_4.10H_2O$ - Deliquescent. The Glauber's salt was historically used as laxative. It is effective for the removal of certain drugs such as paracetamol from the body.

16. (d) Washing soda - $Na_2CO_3.10H_2O$, efflorescent. Efflorescent is the property of material which means spontaneous loss of water by a hydrated salt.

17. (b) Mohr's salt ($FeSO_4.(NH_4)_2SO_4.6H_2O$ is commonly used in iron plating

18. (b) Ionisation potential or energy (IE) increases across a period but with certain breaks. IE_1 of Al ($3s^2p^1$) is less than IE_1 of Mg ($3s^2$) as electron is to be removed from 3p which is easy as compared to 3*s*. Further IE_3 shows the reverse trend because now for Al^{2+} ($3s^1$) electron is to be removed from 3*s* as compared to the completely filled 2p orbitals in Mg^{2+}. The same becomes true for IE_2 of Na, hence option (b) is correct. i.e. incorrect statement.

19. (c) Being strong reducing agent, they can not be extracted by reduction of their oxides. Being highly electropositive in nature they can not be displaced from their salt solutions.

Further, on electrolysis of aqueous solution of alkali metal salts (containing metal cation, H^+, OH^- and other anion) the alkali metal cations having higher discharge potential than H^+ and thus do not discharge at cathode. On the contrary it is the H^+ ion which is discharged at cathode to give H_2.

However, electrolysis of fused metal salt, liberates metal at cathode due to discharge of metal cation at cathode.

20. A-p,r,s; B-s, ; C-q ; D-p,q

Liquation process : This process is used when the impurity is less fusible than the metal itself (e.g. Pb, Sn etc.)

Cupellation is the oxidation process used for Ag.

Hydrometallurgy : This method is based on the fact that more electropositive metals displace less electropositive metals from their salt solution.

$$4Ag + 8NaCN + O_2(air) + 2H_2O \longrightarrow 4Na[Ag(CN)_2] + 4NaOH$$

$$AgCl + 2NaCN \longrightarrow Na[Ag(CN)_2] + NaCl\ ;$$

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

Similarly, copper is precipitated from copper sulphate solution by adding iron.

$CuSO_4 + Fe \longrightarrow FeSO_4 + Cu \downarrow$ This method is also called **wet process**.

Ni is purified using CO gas (***Mond's process***). Further, Carbon monoxide reduces the metallic oxides of Pb and Cu to free metals.

$$PbO + CO \longrightarrow Pb + CO_2\ ;$$

$$CuO + CO \longrightarrow Cu + CO_2$$