Chemistry Worksheets Class 12 on Chapter 6 General Principles and Processes of Isolation of Elements with Answers - Set 2

Q1. Nitriding is the process of surface hardening of steel by treating it in atmosphere of-

a.) NH_3
b.) O_3
c.) N_2
d.) H_2S

Correct Answer– (a.) NH_3

Q2. Purification of aluminium, by electrolytic refining is known as-

a.) Hoope's process
b.) Baeyer's process
c.) Hall's process
d.) Serpeck's process

Correct Answer– (a.) Hoope's process

Q3. Extraction of gold and silver involves leaching with CN^- ion. Silver is later recovered by-

a.) distillation
b.) zone refining
c.) displacement with Zn
d.) liquation

Correct Answer– (c.) displacement with Zn.

Q4. $2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2$
Which process of metallurgy of copper is represented by above equation?

a.) Concentration
b.) Roasting
c.) Reduction
d.) Purification

Correct Answer– (b.) Roasting

Q5. Identify the correct statement from the following:

a.) Wrought iron is impure with 4% carbon.
b.) Blister copper has blistered appearance due to evolution of CO_2.
c.) Vapour phase refining is carried out for nickel by Van Arkel method.
d.) Pig iron can be moulded into a variety of shapes.

Correct Answer– (d.) Pig iron can be moulded into a variety of shapes.

Q6. What is the role of flux in metallurgical processes?

Answer. Role of flux in metallurgical process-
(i) Flux is used to remove the gangue by combining with it. Thus, slag formation takes place.
(ii) It makes the molten mass more conducting.

Q7. Out of C and CO which is a better reducing agent for ZnO?

Answer. The free energy of formation of CO from C becomes lower at temperature above 1120 K whereas that of CO_2 from C becomes lower above 1323 K than free energy of formation of ZnO. The free energy of formation of from CO is always higher than that of ZnO. Therefore, C can reduce ZnO to Zn better than CO. CO_2 from CO is always higher than that of ZnO. Therefore, C can reduce ZnO to Zn better than CO.

Q8. Mention the role of the following:
a.) SiO_2 in the metallurgy of Cu.
b.) $CaCO_3$ in the metallurgy of Fe.
c.) CO in the metallurgy of iron.
d.) I_2 in the purification of zirconium.

Answer.
a.) Flux
b.) $CaCO_3$ decomposed to CaO, which acts as a flux.
c.) Reducing agent
d.) To form a volatile complex with Zr.

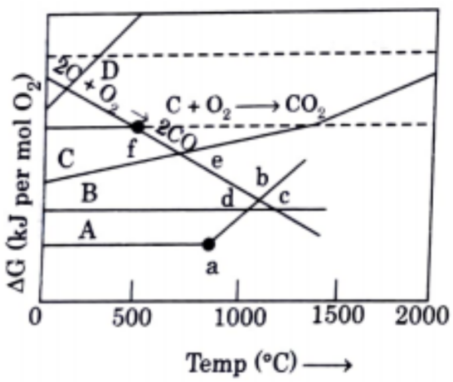
Q9. In general, which metals do you expect to occur in native state in nature? Give examples.

Answer. In general, the metals which lie below hydrogen in the electrochemical series occur in native state in nature, because these are not attacked by oxygen, moisture and CO_2 present in the atmosphere. Common examples are Cu, Ag, Au, Pt, etc.

Q10. Define Calcination.

Answer. Calcination is a process of heating the ore strongly below its melting point either in a limited supply of air or in the absence of air. During calcination, following changes take place:
i.) Moisture is removed
ii.) The volatile impurities are removed.
iii.) The ore becomes porous and hence becomes easily workable in the subsequent steps.
iv.) Water from hydrated oxides is removed.
v.) Carbonates decompose to oxides.

Q11. A part of Ellingham diagram for some metal oxides (based upon 1 mole of O_2) and carbon is shown.



In figure A,B,C and D represent curves for metal oxides and a,b,c,d,e and f are temperatures. Answer the following :
(i) Will B oxide reduce metal oxide of A or C or both?
(ii) Which metal can be reduced thermally?
(iii) Will oxide of B be reduced by coke above temperature c or below temperature c?
(iv) Will the formation of CO or CO_2 be preferred above temperature f?
(v) What does temperature 'a' represent?

Answer.
(i) Metal oxides of C
(ii)Metal oxides of B
(iii) Above temperature c
(iv) CO
(v) The change in state (at fusion or vaporisation)

Q12. Free energies of formation ($\Delta_f G$) of MgO and CO at 1273 K and 2273 K are given below-
$\Delta_f G$ (MgO(s)) = –941kJ/mol at 1273K
$\Delta_f G$ (MeO(s)) = −314kJ/mol at 2273K
$\Delta_f G$ (CO(g)) = −439kJ/mol at 1273K
$\Delta_f G$ (CO(g)) = −628kJ/mol at 2273K
On the basis of above data, predict the temperature at which carbon can be used as a reducing for agent MgO(s).

Answer.
(a) At 1273 K,

$$Mg + \frac{1}{2}O_2 \rightarrow MgO; \Delta_f G = -941 kJ/mol$$ (eq. i)

$$C + \frac{1}{2}O_2 \rightarrow CO; \Delta_f G = -439 kJ/mol$$ (eq. ii)

Subtracting eq. (i) from eq. (ii), we get
$MgO + C \rightarrow Mg + CO$: $\Delta_f G = 502$ kJ/mol.
As $\Delta_f G$ for the above reaction is +ve, therefore, reduction of MgO by C is not feasible at 1273 K.

(b) At 2273 K

$$Mg + \frac{1}{2}O_2 \rightarrow MgO; \Delta_f G = -314 k/mol$$ (eq. iii)

$$C + \frac{1}{2}O_2 \rightarrow CO; \Delta_f G = -628 kJ/mol$$ (eq. iv)

Subtracting eq. (iii) from eq. (iv), we get
$MgO + C \rightarrow Mg + CO$: $\Delta_f G = -314$ kJ/mol.
As $\Delta_f G$ for the above reaction is –ve, therefore, reduction of MgO by C is feasible at 2273 K. Hence, carbon can be used as a reducing agent.

Q13. Explain the process of smelting.

Answer. Smelting is a metallurgy technique to extract base metals from their ores with the help of heat and a chemical reducing agent.
The process of obtaining a metal either as an element or as a simple compound from its ore by heating beyond the melting point in the presence of oxidising agents such as air and coke is known as smelting. Copper is the first metal to be smelted followed by tin, lead and silver. To achieve high temperatures required for smelting, furnaces with forced air drafts are used. In modern copper smelting, a reverberatory furnace is used.

Q14. Describe how the following changes are brought about?
(i) Pig iron into steel
(ii) Zinc oxide into metallic zinc
(iii) Impure titanium into pure titanium

Answer.
(i) Heating in a converter converts pig iron to steel. The converter is blown with a blast of oxygen diluted with carbon dioxide. The reaction of oxygen with impurities raises the temperature to 2173 K. Carbon is oxidised to CO, which burns off at the converter's mouth. Slag is made up of silicon and magnesium oxides. When the flame is extinguished, the slag is tapped off, and other metals such as Mn, Cr, Ni, and W may be added at the end.

(ii) Metallic Zinc is obtained from zinc oxide by reduction with coke.
$ZnO+C \rightarrow Zn+CO$

(iii)Impure titanium is heated with Iodine to form a volatile complex TiI_4 which on further heating to higher temperature decomposes to give pure titanium.

$$Ti\,(impure) + I_2 \rightarrow TiI_4 \xrightarrow{\Delta} Ti\,(pure) + I_2$$

Q15. Why is it advantageous to roast a sulphide ore to the oxide before reduction?

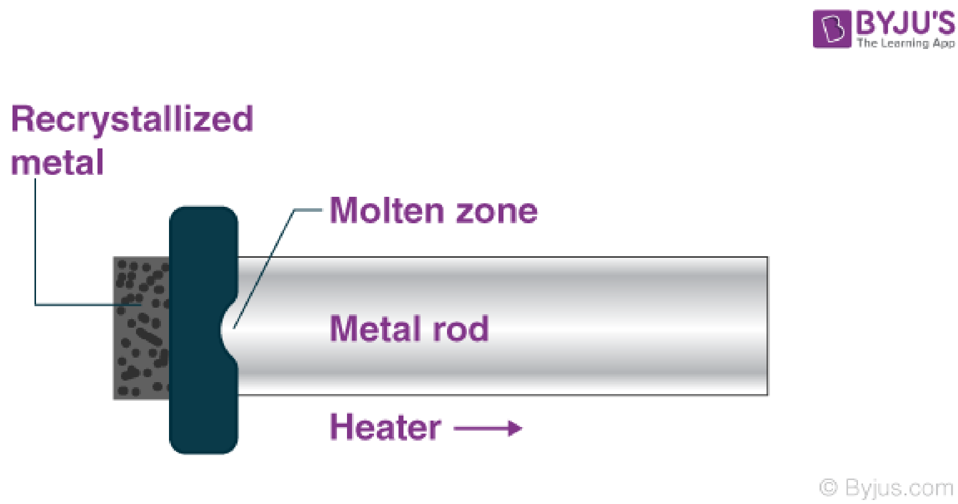
Answer. The standard free energy of formation ($\Delta_f G°$) of most of the sulphides are larger than those of CS_2 and H_2S. Therefore, these sulphides are more stable than those with carbon or hydrogen. Hence, neither carbon nor hydrogen can reduce metal sulphides to metal. In contrast, the standard free energies of formation of oxides are much lower than those of SO_2 and therefore oxidation of metal sulphides to metal oxides is thermodynamically favourable. Therefore, it is a common practice to roast sulphide ore to oxide ore before reduction.

Q16. The choice of a reducing agent in a particular case depends on thermodynamic factor. How far do you agree with this statement? Support your opinion with two examples.

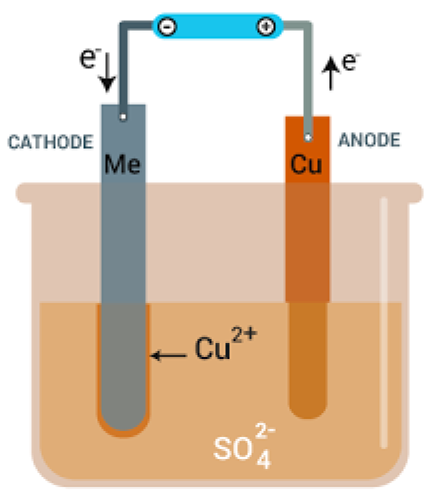
Answer. Consideration of thermodynamic factors aids in the selection of a suitable reducing agent for the reduction of a given metal oxide to metal. Ellingham diagrams (plots of $\Delta_f G$ vs T) can predict thermal reduction feasibility. Metals with a higher negative standard free energy of oxide formation can reduce metal oxides with a lower negative standard free energy of oxide formation. As the standard free energy change for combined redox reaction is negative by an amount equal to the difference in $\Delta_f G$ of two metal oxides, metal will reduce the oxides of other metals that lie above it in the Ellingham diagram. As a result, while both Al and Zn can reduce FeO to Fe, Fe cannot reduce Al_2O_3 to Al or ZnO to Zn. Also, C can reduce ZnO to Zn but not CO.

Q17. Outline the principles of refining of metals by the following methods:
(i) Zone refining
(ii) Electrolytic refining
(iii) Vapour phase refining

Answer.
(i) Zone refining:The principle of zone refining is that the impurities in an ingot or ore of metal are more soluble in the melt state when compared to the corresponding solid state of the impurities.



(ii) Electrolytic refining: The process of refining impure metals using electricity is known as electrolytic refining. The anode in this process is impure metal, and the cathode is a strip of pure metal. The electrolyte is a solution of a soluble salt of the same metal. When an electric field is passed, metal ions from the electrolyte deposit as pure metal at the cathode, while impure metal from the anode dissolves as ions in the electrolyte. The impurities in the impure metal are collected beneath the anode. This is referred to as anode mud.



(iii) Vapour phase refining: In this method crude metal is made free from impurities by first converting it into a suitable volatile compound by treating it with a specific reagent at a lower temperature and then decomposing the volatile compound at some higher temperature to give the pure metal.

Q18. (a) How does iron occur? Discuss in detail the extraction of iron from haematite ore.
(b) What are steel alloys? Give examples.

Answer. (a) Iron is present in low concentrations throughout the soil and is dissolved to a lesser extent in ground water and the oceans. It is always found in its combined form.
In a blast furnace, iron is extracted from its ore, haematite. The ore, along with coke and limestone, is fed into the top of the furnace. In the hot furnace, the limestone decomposes and produces calcium oxide. This combines with the sandy impurities (silicon dioxide) to produce slag.
(b) Alloy steels are steels to which various elements such as Cr, Ni, Cu, Mn, Mo, V, and tungsten have been added to achieve desired properties. These are high-quality steels that are typically produced in electric furnaces.
Tungsten, Steel, Stainless Steel, Chrome Steel, Vanadium Steel, and other materials are examples.

Q19. (a) Write the chemical reaction taking place in the extraction of zinc from zinc blende.
(b) State the role of silica in the metallurgy of copper.
(c) How is copper extracted from low grade copper ores?
(d) How is "pig iron" different from "cast iron"?

Answer. (a) The chemical reaction taking place in the extraction of zinc from zinc blende are as follows-
(i) Roating: $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$
(ii) Reduction: $ZnO + C \xrightarrow{coke, 673K} ZnO + CO$

(iii) Electrolytic Refining:
Anode: $Zn \rightarrow Zn^{2+} + 2e^-$
Cathode: $Zn^{2+} + 2e^- \rightarrow Zn$

(b) Silica acts as an acidic flux during the metallurgy of copper It reacts with the impurities of iron and form slag. FeS is present is the form of impurity with copper sulphide ore.
$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$
$FeO + SiO_2 \rightarrow FeSiO_3$
The role of silica in the metallurgy of copper is to remove the iron oxide obtained during the process of roasting as 'slag'. If the sulphide ore of copper contains iron, then silica SiO_2 is added as flux before roasting. Then, FeO combines with silica to form iron silicate, $FeSiO_3$ (slag).

(c) The process of extracting pure copper from low grade ore is known as leaching. Leaching is the process of extracting substances from a solid by dissolving them in a liquid; in this process, the ore but not the impurities are dissolved in liquid. The copper solution is then reacted with iron to produce pure copper (reduction process).

(d) The iron obtained from blast furnace is called pig iron. It contains about 4% carbon and many other impurities like S, P, Si, Mn etc. Cast, iron, on the other hand, is made by melting pig iron with scrap iron and coke using hot air blast.

Q20. Describe the principle behind each of the following processes-

(i) Vapour phase refining of a metal.
(ii) Electrolyytic refining of a metal.
(iii) Recovery of silver after its ore was leached with NaCN.

Answer.
(i) Vapour phase refining of a metal: The metal is converted into its volatile compound and collected elsewhere in this method. After that, it is decomposed to yield pure metal. Consider the Mond process for nickel refining.

$$Ni + 4CO \xrightarrow{330-350K} Ni\left(CO\right)_4$$

$$Ni\left(CO\right)_4 \xrightarrow{450-470K} Ni + 4CO$$

(ii) Electrolyytic refining of a metal: In this method, the impure metal is made to act as an anode. As the cathode, a pure strip of the same metal is used. They are immersed in an electrolytic bath containing a soluble salt of the same metal. When an electric current is passed through the anode, metal ions from the anode oxidise and deposit pure metal at the cathode due to metal ion reduction. Impurities of more electropositive metals remain in solution as ions, whereas impurities of less electropositive metals settle down under the anode as anode mud.
At anode: $M \rightarrow M^{n+} + ne^-$
At cathode: $M^{n+} + ne^- \rightarrow M$

(iii) Recovery of silver after its ore was leached with NaCN: During leaching, Ag is oxidised to Ag^+, which then combines with CN^- ions to form a soluble complex, $[Ag(CN)_2]^-$. The silver is then extracted from the complex using a displacement method with more electropositive zinc metal.

$$2\left[Ag\left(CN\right)_2\right]^-(aq) + Zn\left(s\right) \rightarrow 2Ag\left(s\right) + \left[Zn\left(CN\right)_4\right]^{2-}(aq)$$