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METALS AND NON-METALS
CHEMISTRY

Exam Drill

FOR BOARD EXAM

(i) The question paper comprises four sections A, B, C and D. There are 36 questions in the question paper. All questions are compulsory.
(ii) Section-A – question no. 1 to 20 - all questions and parts thereof are of one mark each. These questions contain objective and very short answer type questions. Answers to these should be given in one word or one sentence.
(iii) Section-B – question no. 21 to 26 are short answer type questions, carrying 2 marks each. Answers to these questions should in the range of 30 to 50 words.
(iv) Section-C – question no. 27 to 33 are short answer type questions, carrying 3 marks each. Answers to these questions should in the range of 50 to 80 words.
(v) Section-D – question no. 34 to 36 are long answer type questions carrying 5 marks each. Answer to these questions should be in the range of 80 to 120 words.
(vi) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
(vii) Wherever necessary, neat and properly labeled diagrams should be drawn.

Time: 3 hrs. Max. Marks: 80

SECTION - A

1. Name a reducing agent that may be used to obtain manganese from manganese dioxide.

OR

The electronic configurations of two elements *A* and *B* are 2, 8, 1 and 2, 8, 7, respectively. Which one of them is a metal and which is a non-metal?

2. What is aqua regia?

3. Name a metal that forms amphoteric oxide.

4. An element *A* is soft and can be cut with a knife. This is very reactive to air and cannot be kept open in air. It reacts vigorously with water. Identify the element from the following.

(a) Mg (b) Na
(c) P (d) Ca

5. Aluminium is used for making cooking utensils. Which properties of aluminium are responsible for the same?

6. Which of the following elements is not a metal?

(a) Calcium (b) Copper
(c) Potassium (d) Sulphur

OR

The process to heat the ore in the presence of excess supply of air below its melting point is called

(a) roasting
(b) calcination
(c) smelting
(d) liquation.

7. There are four elements *A*, *B*, *C* and *D* and shows the following properties :

(i) *A* forms acidic oxide.
(ii) *B* forms neutral oxide.
(iii) Oxide of *C* dissolves in water to form alkali.
(iv) *D* does not react with cold or hot water.

Identify the elements *A*, *B*, *C* and *D*.

(a) $A \rightarrow S, B \rightarrow Al, C \rightarrow Mg, D \rightarrow Fe$
(b) $A \rightarrow Fe, B \rightarrow Na, C \rightarrow K, D \rightarrow Zn$
(c) $A \rightarrow K, B \rightarrow Cu, C \rightarrow Pb, D \rightarrow Na$
(d) $A \rightarrow S, B \rightarrow C, C \rightarrow Na, D \rightarrow Al$

OR

Which of the following steps is not involved in metallurgy of iron?

(a) Calcination
(b) Smelting
(c) Concentration of ore
(d) Conversion of ore into oxide

8. Metal *X* forms an oxide which dissolves in water to form alkali and metal *Y* does not react with cold or hot water. Identify metals *X* and *Y*.

9. Chlorine reacts with metals and non-metals. When metal *X* reacts with chlorine, the compound, XCl_2 is formed. Which of the following occurs when *X* and chlorine react to form XCl_2?

(i) An atom of *X* gives away two electrons.

(ii) Each atom of chlorine receives one electron.
(iii) X and Cl share a pair of electrons.
(iv) X and Cl form a double bond.
(a) (i) and (ii)
(b) (ii) and (iii)
(c) (iii) and (iv)
(d) (i), (ii) and (iv)

OR

A cleaned aluminium foil was placed in an aqueous solution of zinc sulphate. When the aluminium foil was taken out of the zinc sulphate solution after 15 minutes, its surface was found to be coated with a silvery grey deposit. From the above observation it can be concluded that
(a) aluminium is more reactive than zinc
(b) zinc is more reactive than aluminium
(c) zinc and aluminium both are equally reactive
(d) zinc and aluminium both are non-reactive.

10. Why are non-metals brittle?

11. Name one metal and one non-metal which exist in liquid state at room temperature.

OR

Why is it that non-metals do not displace hydrogen from dilute acids?

12. Why is sodium kept in kerosene oil?

OR

Which metal does not react with water even in the form of steam?

13. What are the constituents of stainless steel?

For question numbers 14-16, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

(a) Both A and R are true, and R is correct explanation of the assertion.
(b) Both A and R are true, but R is not the correct explanation of the assertion.
(c) A is true, but R is false.
(d) A is false, but R is true.

14. **Assertion :** For acidic impurities like SiO_2 present in an ore, basic fluxes are used.
Reason : Silica is a basic flux.

15. **Assertion :** Iron is the most widely used metal. But it is never used in its pure state.
Reason : Pure iron is very soft and stretches easily when hot.

16. **Assertion :** Silver, gold and platinum exist in native state in nature.
Reason : Silver, gold and platinum are not attacked by common chemical reagents.

Case Based Questions [4 × 1 Mark]

17. Read the following and answer any four questions from 17(i) to 17(v).
Non-metals are highly electronegative in nature. They have a tendency to gain electrons in their valence shell to achieve nearest noble gas configuration. Thus, they form anions and act as good oxidising agents.

$$\underset{\text{(non-metal atom)}}{X} + ne^- \longrightarrow \underset{\text{(anion)}}{X^{n-}}$$

They react with air or oxygen on heating to form oxides which react with water to form acids. Thus, non-metal oxides are acidic in nature. Non-metals do not react with dilute acids at all. This is because they are electronegative and therefore, cannot displace hydrogen from acids but they form covalent hydrides when heated with hydrogen.

(i) The acid formed when sulphur trioxide reacts with water is
(a) sulphurous acid
(b) sulphuric acid
(c) both (a) and (b)
(d) none of these.

(ii) An element 'X' forms an oxide XO_2, which is a very useful gas used in the process of photosynthesis. The element 'X' is
(a) sulphur (b) nitrogen
(c) carbon (d) phosphorus.

(iii) Non-metals generally act as
(a) oxidising agents (b) reducing agents
(c) both (a) and (b) (d) none of these.

(iv) Which of the following elements produces basic oxide on reacting with oxygen?
(a) Chlorine (b) Sulphur
(c) Phosphorus (d) Magnesium

(v) Which of the following is a covalent hydride?
(a) CH_4 (b) NH_3
(c) H_2S (d) All of these

18. Read the following and answer any four questions from 18(i) to 18(v).

Study this table related to activity series and answer the questions that follow.

Metal	Symbol
Potassium	K
Sodium	Na
Calcium	Ca
Magnesium	Mg
Aluminium	Al
Zinc	Zn
Chromium	Cr
Iron	Fe
Cadmium	Cd
Cobalt	Co
Nickel	Ni
Tin	Sn
Lead	Pb
Hydrogen	H
Copper	Cu
Mercury	Hg
Silver	Ag
Gold	Au
Platinum	Pt

Reactivity decreases

The basis of reactivity is the tendency of metals to lose electrons. If a metal can lose electrons easily to form positive ions, it will react readily with other substances. Therefore, it will be a reactive metal. On the other hand, if a meal loses electrons less rapidly to form a positive ion, it will react slowly with other substances. Therefore, such a metal will be less reactive.

(i) Which of the following metals is less reactive than hydrogen?
(a) Copper (b) Zinc
(c) Magnesium (d) Lead

(ii) Which of the following metals is more reactive than hydrogen?
(a) Mercury (b) Platinum
(c) Iron (d) Gold

(iii) Which of the following metals reacts vigorously with oxygen?
(a) Zinc (b) Magnesium
(c) Sodium (d) Copper

(iv) Which of the following represents the correct order of reactivity for the given metals?
(a) Na > Mg > Al > Cu (b) Mg > Na > Al > Cu
(c) Na > Mg > Cu > Al (d) Mg > Al > Na > Cu

(v) Hydrogen gas is not evolved when a metal reacts with nitric acid. It is because HNO_3 is a strong oxidising agent. It oxidises the H_2 produced to water and itself gets reduced to any of the nitrogen oxides (N_2O, NO, NO_2). But _____ and _____ react with very dilute HNO_3 to evolve H_2 gas.
(a) Pb, Cu (b) Na, K
(c) Mg, Mn (d) Al, Zn

19. Read the following and answer any four questions from 19(i) to 19(v).

Metals as we know, are very useful in all fields, industries in particular. Non-metals are no less in any way. Oxygen present in air is essential for breathing as well as for combustion. Non-metals form a large number of compounds which are extremely useful, *e.g.,* ammonia, nitric acid, sulphuric acid, etc.

Non-metals are found to exist in three states of matter. Only solid non-metals are expected to be hard however, they have low density and are brittle. They usually have low melting and boiling points and are poor conductors of electricity.

(i) _____ is a non-metal but is lustrous.
(a) Phosphorus (b) Sulphur
(c) Bromine (d) Iodine

(ii) Which of the following is known as 'King of chemicals'?
(a) Urea (b) Ammonia
(c) Sulphuric acid (d) Nitric acid

(iii) Which of the following non-metals is a liquid?
(a) Carbon (b) Bromine
(c) Iodine (d) Sulphur

(iv) Hydrogen is used
(a) for the synthesis of ammonia
(b) for the synthesis of methyl alcohol
(c) in welding torches
(d) all of these.

(v) Generally, non-metals are bad conductors of electricity but '*X*' which is a form of carbon is a good conductor of electricity and is an exceptional non-metal. '*X*' is '
(a) diamond (b) graphite
(c) coal (d) coke.

20. Read the following and answer any four questions from 20(i) to 20(v).

The chemical reactivity of an element depends upon its electronic configuration. All elements having less than eight electrons in the outermost shell show chemical reactivity. During chemical reactions, atoms of all elements tend to achieve a completely filled valence shell. Metals are electropositive in nature. They have tendency to lose one or more electrons present in the valence shell of their atoms to form cations and achieve nearest noble gas configuration. The compounds formed by the transfer of electrons from one element to other are known as ionic or electrovalent compounds.

(i) The electronic configurations of three elements X, Y and Z are :

$X : 2$ $Y : 2, 8, 8$ $Z : 2, 8, 8, 2$

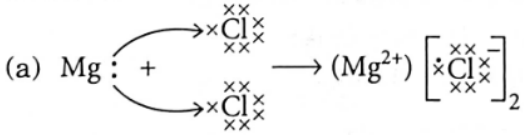
Which of the following is correct regarding these elements?

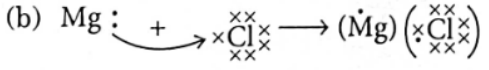
(a) X is a metal.
(b) Y is a metal.
(c) Z is a non-metal.
(d) Y is a non-metal and Z is a metal.

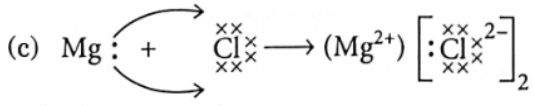
(ii) Element X reacts with element Y to form a compound Z. During the formation of compound Z, atoms of X lose one electron each whereas atoms of Y gain one electron each. Which of the following properties is not shown by compound Z?

(a) High melting point
(b) Low melting point
(c) Occurrence as solid
(d) Conduction of electricity in molten state

(iii) Which of the following is correct representation of formation of magnesium chloride?

(a) 

(b) 

(c) 

(d) None of these

(iv) The electronic configuration of sodium ion is

(a) 2, 8, 8 (b) 2, 8, 2
(c) 2, 6 (d) 2, 8.

(v) Which of the following represents an electropositive element?

(a) 2, 8, 6 (b) 2, 8, 8
(c) 2, 8, 8, 1 (d) 2, 7

SECTION - B

21. What happens when Mg and Al reacts with dil. HCl? Give reactions involved.

OR

Write the chemical equations showing roasting and calcination of zinc ores.

22. Explain how the following metals are obtained from their compounds by the reduction process :

(a) Metal X which is low in the reactivity series.
(b) Metal Z which is high up in the reactivity series.

Give one example of each type.

23. An ore on treatment with dilute hydrochloric acid gives brisk effervescence to produce a colourless, odourless gas. What type of ore is this? What methods will be required to obtain metal from it?

OR

(a) Why are ionic compounds usually hard?
(b) How is it that ionic compounds in the solid state do not conduct electricity and they do so when in molten state?

24. Write chemical equations for the reactions taking place when

(a) magnesium ribbon is burnt in a jar containing oxygen.
(b) steam is passed over hot aluminium.

25. (a) Place the metals calcium, potassium and zinc in order of chemical reactivity towards water, stating the most reactive metal first.
(b) Name the non-metal which is used in the vulcanisation of rubber.

26. Give examples of few metal oxides which are reduced by aluminium. Why they cannot be reduced by carbon?

SECTION - C

27. Which two metals do not corrode easily? Give an example in each case to support that
(i) corrosion of some metals is an advantage.
(ii) corrosion of a metal is a serious problem.

OR

What is meant by 'rusting'? With labelled diagrams describe an activity to find out the conditions under which iron rusts.

28. A metal '*M*' has the electronic configuration 2, 8, 3 and occurs in nature as M_2O_3. It is more reactive than zinc. Answer the following question :
(a) Name the metal '*M*'.
(b) Name the ore from which this metal is extracted.
(c) How is the metal oxide converted to metal?

29. Enlist three points of differences between electrolytic reduction and reduction with carbon.

30. Distinguish between the following :
(a) Electrolytic reduction and electrolytic refining.
(b) Minerals and ores.
(c) Alloys and amalgams.

31. (a) What are amphoteric oxides? Choose the amphoteric oxides from amongst the following oxides :
Na_2O, ZnO, Al_2O_3, CO_2, H_2O
(b) Show the formation of Na_2O by the transfer of electrons between the combining atoms.

32. (a) Which gas is produced when a reactive metal reacts with water?
(b) How can we extinguish fire involving electrical equipments?
(c) How can we prevent iron from rusting?

33. Give reasons for the following :
(a) Shining surface of metals is tarnished after some time.
(b) Metals conduct electricity.
(c) Tungsten is used for making filament of incandescent bulbs.

SECTION - D

34. (a) State one main ore of zinc metal. Write its formula. How is this metal ore changed into its oxide compound?
(b) Explain in brief about electrolytic refining method.

OR

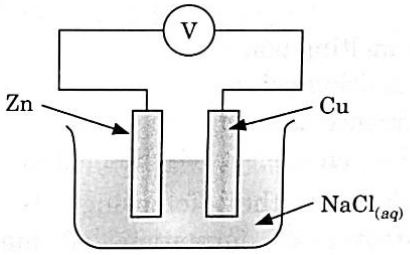
(a) Write the chief ore of iron. Write its formula.
(b) What do you mean by "concentration of ore"? and "gangue"?
(c) Draw labelled diagram for electrolytic refining of copper metal.

35. (a) State one use of the following :
(i) Iron (ii) Zinc (iii) Carbon
(b) Name the reducing agent in the following reaction :
$3MnO_2 + 4Al \longrightarrow 2Al_2O_3 + 3Mn$
Which is more reactive Mn or Al and why?

36. Sodium reacts with phosphorus under high temperature and pressure to form sodium phosphide, Na_3P. Describe the steps involved in the formation of sodium phosphide.

OR

(a) Define electrolytic refining of metal.
(b) The diagram shows an apparatus set-up for a simple experiment.



Describe the reactions occurring at
(i) the zinc electrode and
(ii) the copper electrode.

SOLUTIONS

1. Aluminium reduces manganese dioxide (MnO_2) to manganese (Mn). The reaction is highly exothermic.

$$3MnO_{2(s)} + 4Al_{(s)} \xrightarrow{Heat} 3Mn_{(l)} + 2Al_2O_{3(s)} + Heat$$

OR

The element *A* has only one electron in its outermost shell (all inner shells being complete). Therefore, the element *A* is a metal.

The element *B* has seven electrons in its outermost shell (all inner shells being complete). Therefore, the element *B* is a non-metal.

2. Aqua regia is a freshly prepared mixture of concentrated HCl and HNO_3 in the ratio of 3:1.

3. Zinc forms amphoteric oxide.

4. **(b) :** Na metal is soft and can be cut with a knife. It reacts vigorously with air and water and hence, it is kept in kerosene.

5. Aluminium is good conductor of heat and has a high melting point, hence it is used for making cooking utensils.

6. **(d) :** Sulphur is a non-metal.

OR

(a) : In roasting, ore is heated in excess of air to remove volatile impurities.

7. **(d) :** SO_2 is acidic in nature, CO_2 is neutral gas.

Oxide of Na dissolves in water to form alkali.

$$Na_2O + H_2O \longrightarrow 2NaOH$$

Aluminium does not react with cold or hot water.

Thus *A*, *B*, *C* and *D* are S, C, Na and Al respectively.

OR

(d) : Iron is extracted from its ore haematite which is an oxide.

8. Metal *X* can be potassium and metal *Y* can be lead.

9. **(a) :** *X* is a metal and Cl is a non-metal. They react by forming ionic bonds. *X* exists as X^{2+} ion and Cl exists as Cl^- in XCl_2. Hence, *X* gives two electrons and each Cl receives one electron. XCl_2 is an ionic compound. Hence, *X* and Cl do not share a pair of electrons or form a double covalent bond.

OR

(a) : As aluminium is more reactive than zinc so aluminium will displace zinc from its sulphate solution.

$$\underset{\text{Colourless}}{3ZnSO_4} + 2Al \longrightarrow \underset{\text{Colourless}}{Al_2(SO_4)_3} + 3Zn$$

10. It is due to weak forces of attraction.

11. Metal : Mercury, Non-metal : Bromine

OR

Non-metals do not displace hydrogen from dilute acids because non-metals do not provide electrons to change H^+ ions into hydrogen gas.

12. Sodium kept in kerosene oil because sodium reacts violently with water and air.

OR

Lead, copper and gold do not react with water even in steam.

13. Iron metal alloyed with other metals such as chromium and nickel are the constituents of stainless steel.

14. **(c) :** The reaction involved in removal of acidic impurities with basic flux is

$$\underset{\text{Acidic impurities}}{SiO_2} + \underset{\text{Basic flux}}{MgCO_3} \longrightarrow \underset{\text{Fusible slag}}{MgSiO_3} + CO_2\uparrow$$

15. **(a)**

16. **(a)**

17. **(i)** **(b)** : $SO_3 + H_2O \longrightarrow H_2SO_4 + heat$

(ii) **(c) :** Carbon forms CO_2 on reaction with oxygen. During photosynthesis plants take in CO_2.

(iii) **(a) :** Non-metals act as oxidising agents since they can accept electrons.

(iv) **(d) :** Magnesium, being a metal, produces basic oxide on reaction with oxygen.

$$2Mg + O_2 \longrightarrow 2MgO$$

(v) **(d) :** Carbon, nitrogen and sulphur are non-metals hence, they form covalent hydrides.

18. **(i)** **(a)** : Copper is placed below hydrogen in activity series therefore, it is less reactive than hydrogen.

(ii) **(c) :** Iron is placed above hydrogen in activity series therefore, it is more reactive than hydrogen.

(iii) **(c)**

(iv) **(a)**

(v) **(c)**

19. (i) (d) : Iodine is a lustrous non-metal.

(ii) (c) : H_2SO_4 is known as 'King of Chemicals'.

(iii) (b) : Bromine exists as a liquid.

(iv) (d)

(v) (b) : Graphite conducts electricity because of the delocalised electrons in its structure.

20. (i) (d)

(ii) (b) : '*Z*' is an ionic compound.

(iii) (a) : $\underset{2,8,2}{Mg} \longrightarrow \underset{2,8}{Mg^{2+}} + 2e^-$

$\underset{2,8,7}{Cl} + e^- \longrightarrow \underset{2,8,8}{Cl^-}$

$Mg^{2+} + 2Cl^- \longrightarrow MgCl_2$

(iv) (d) : $\underset{2,8,1}{Na} \longrightarrow \overset{+}{\underset{2,8}{Na}} + e^-$

(v) (c) : (a) and (d) represent electronegative elements and (b) represents a noble gas.

21. Magnesium chloride and aluminium chloride are formed respectively and H_2 gas is evolved.

$Mg + 2HCl \longrightarrow \underset{\text{Magnesium chloride}}{MgCl_2} + H_2$

$2Al + 6HCl \longrightarrow \underset{\text{Aluminium chloride}}{2AlCl_3} + 3H_2$

OR

Roasting of sulphide ore :

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

Calcination of carbonate ore :

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

22. (a) Metal *X* is least reactive. Hence, its oxide is reduced by the action of heat alone. As the most common ores of these metals are sulphide ores, therefore, the method used to obtain the metals from these ores is roasting, *i.e.*, heating the ore strongly in presence or excess of air. For example,

$\underset{\substack{\text{Mercuric sulphide}\\\text{(Cinnabar)}}}{HgS_{(s)}} + \underset{\text{(From air)}}{3O_{2(g)}} \xrightarrow{\text{Heat}} \underset{\text{Mercuric oxide}}{2HgO_{(s)}} + \underset{\text{Sulphur dioxide}}{2SO_{2(g)}}$

$\underset{\text{Mercuric oxide}}{2HgO_{(s)}} \xrightarrow{\text{Heat}} \underset{\text{Mercury}}{2Hg_{(l)}} + \underset{\text{Oxygen}}{O_{2(g)}}\uparrow$

(b) Metal *Z* is highly reactive. Hence, its compounds are reduced to the metal by electrolytic reduction. On passing current through their molten state, metals are deposited on the cathode. *e.g.*,

$\underset{\text{Bauxite ore}}{2Al_2O_3} \xrightarrow[\text{current}]{\text{Electric}} 4Al^{3+} + 6O^{2-}$

At cathode : $4Al^{3+} + 12e^- \xrightarrow{\text{Reduction}} 4Al_{(s)}$

At anode : $6O^{2-} \xrightarrow{\text{Oxidation}} 3O_{2(g)} + 12e^-$

23. The gas produced is carbon dioxide. Hence, the ore is a carbonate ore. Two methods required to obtain metal from it will be

(i) **Calcination :** This converts the metal carbonate into metal oxide.

Metal carbonate $\xrightarrow{\text{Calcination}}$ Metal oxide + CO_2

(ii) **Reduction with carbon :** This converts the metal oxide to free metal.

Metal oxide + Carbon → Metal + Carbon monoxide

OR

(a) Ionic compounds are usually hard due to strong electrostatic forces of attraction between oppositely charged ions.

(b) Ionic compounds in the solid state do not conduct electricity because movement of ions in solid state is not possible due to the rigid structure. But they conduct electricity in the molten state as the electrostatic forces of attraction between oppositely charged ions are overcome by heat and ions become free to move.

24. (a) $\underset{\text{Magnesium}}{2Mg} + O_2 \xrightarrow{\text{Burn}} \underset{\text{Magnesium oxide}}{2MgO}$

(b) $\underset{\text{Aluminium}}{2Al} + \underset{\text{Steam}}{3H_2O} \longrightarrow \underset{\text{Aluminium oxide}}{Al_2O_3} + \underset{\text{Hydrogen}}{3H_2}$

25. (a) Order of reactivity of given metals with water :

Potassium > Calcium > Zinc.

(b) Sulphur is used in the valcanisation of rubber.

26. Certain metals react with carbon to form compounds. As a result such metals cannot be obtained by carbon reduction method. Oxides of such metals are reduced by aluminium powder, *e.g.*,

$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3 + Heat$

$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3 + Heat$

$Cr_2O_3 + 2Al \rightarrow 2Cr + Al_2O_3 + Heat$

27. Gold and platinum.

(i) A thin impervious layer of aluminium oxide forms a protective layer which protects the aluminium metal underneath from further damage. Here, corrosion is an advantage.

(ii) Corrosion of iron is a serious problem. Every year enormous amount of money is spent to replace damaged iron and its products. Here, corrosion is a serious problem.

OR

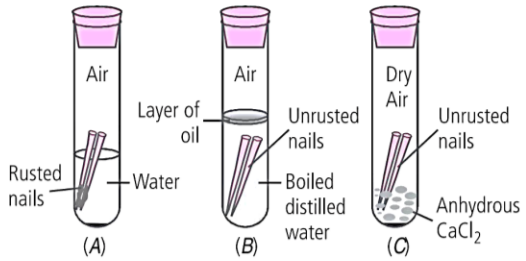
Iron when exposed to moist air for a long time acquires a coating of a brown flaky substance known as rust and this process is called rusting. Following activity can be performed to find out the conditions under which iron rusts :

Materials required : Iron nails, distilled water, turpentine oil, anhydrous calcium chloride.

Procedure :

1. Take three test tubes and put one clean nail in each of them. Label them as *A*, *B* and *C*.

2. Pour some water in test tube *A*. In test tube *B*, pour some boiled distilled water along with some turpentine oil. In test tube *C*, add some anhydrous calcium chloride.
3. Leave these test tubes undisturbed for a few days.



Observations : Only in test tube *A*, iron nails get rusted since the nails in this test tube are exposed to both air and water.

Conclusion : Both air and water are required for rusting of iron.

28. (a) Metal '*M*' is aluminium.

(b) Ore from which Al is extracted is Bauxite ($Al_2O_3 \cdot 2H_2O$).

(c) Bauxite is converted to Al by electrolytic reduction.

29.

	Reduction with carbon	Electrolytic reduction
1.	Carbon is used as a reducing agent.	Electrolysis process is used for reduction.
2.	Oxides of moderately reactive metals (*e.g.*, Zn, Fe, Cu, Ni) are reduced by carbon.	Oxides and chlorides of highly reactive metals (*e.g.*, Al, Na, K, Mg, Ca) are reduced by this process.
3.	In this process, the metal oxide is mixed with carbon (coke) and heated in a furnace. $\underset{\text{Zinc oxide}}{ZnO} + \underset{\text{Carbon}}{C} \longrightarrow \underset{\text{Zinc}}{Zn} + \underset{\text{Carbon monoxide}}{CO}$	In this process, molten metal oxide is electrolysed in an electrolytic cell where the cathode acts as a powerful reducing agent by supplying electrons to reduce metal ions into metal. $\underset{\substack{\text{Aluminium ion (from molten } Al_2O_3)}}{Al^{3+}} + \underset{\text{Electrons (from cathode)}}{3e^-} \xrightarrow[\text{Reduction}]{\text{Electrolytic}} \underset{\text{Aluminium metal}}{Al}$

30. (a)

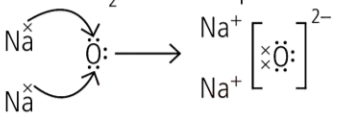
	Electrolytic reduction	Electrolytic refining
(i)	It is a process of obtaining metals from their molten chlorides or molten oxides by electrolysis.	It is a process of refining of impure metals obtained by any of the reduction processes.
(ii)	The metals are deposited at the cathode whereas chlorine or oxygen is liberated at anode.	The impure metal is taken as anode, pure metal as cathode and metal salt solution as electrolyte.

(b) Minerals are the elements or compounds which occur naturally in the earth's crust. Ores are the minerals from which metals can be extracted profitably.

(c) Alloy is a homogeneous mixture of two or more metals or a metal and a non-metal. Amalgam is an alloy in which one of the metals is mercury.

31. (a) Those oxides which react with both acids as well as bases to produce salts and water are called amphoteric oxides. Among the given oxides, Al_2O_3 and ZnO are amphoteric in nature.

(b) The formation of Na_2O can be represented as :



32. (a) Hydrogen gas

(b) By carbon dioxide gas

(c) By painting or galvanising iron articles

33. (a) The surface of some metals is attacked when exposed to atmosphere. They react with air or water (oxygen, CO_2, moisture, etc.) to form undesirable compounds on their surfaces. This process is called corrosion.

(b) Metals are good conductors of electricity due to availability of free electrons in the metallic lattice which can act as carrier of charge.

(c) Tungsten has high resistance and high melting point therefore, it is used for making filaments of incandescent bulbs.

34. (a) Ore of zinc is zinc blende (ZnS). The ore is changed into oxide by roasting it in excess of air

$$\underset{\text{Zinc blende}}{2ZnS_{(s)}} + \underset{\text{(from air)}}{3O_{2(g)}} \xrightarrow{\text{Heat}} \underset{\text{Zinc oxide}}{2ZnO_{(s)}} + \underset{\text{Sulphur dioxide}}{2SO_{2(g)}}$$

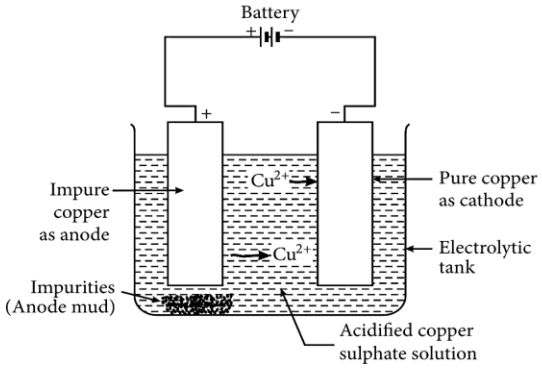
(b) The process of purifying the impure (crude) metal is called refining of metals. The most widely used method of refining impure metals produced by various reduction processes is electrolytic refining. In electrolytic refining, a thick block of impure metal acts as anode. It is connected to the positive terminal of the battery. A thin sheet of pure metal acts as cathode. It is connected to the negative terminal of the battery. An aqueous solution of a suitable salt of the metal is used as the electrolyte. On passing current through the electrolyte, pure metal gets deposited on the cathode and the impure metal of the anode dissolves into the electrolyte. The impurities either dissolve in the solution or settle down at the bottom of the anode as anode mud.

OR

(a) Chief ore of iron is haematite. Its formula is Fe_2O_3.

(b) Concentration of ore means removal of unwanted impurities from the ore. The earthy, sandy and rocky impurities associated with mineral are called gangue.

(c) Experimental set up for the electrolytic refining of copper :



35. (a) (i) Iron is used as a catalyst in the preparation of ammonia gas by Haber's process.

(ii) Zinc is used for galvanizing iron to protect it from rusting.

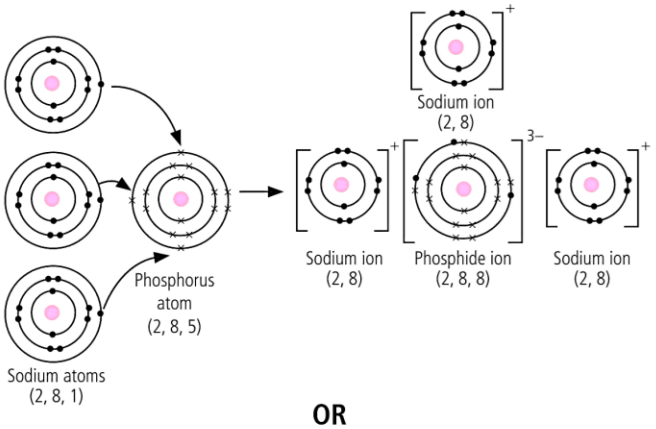
(iii) Carbon (in the form of graphite) is used for making the electrodes of electrolytic cells and dry cells.

(b) Al is a reducing agent for the given reaction. Al is more reactive than Mn, because Al placed higher in the reactivity series as compared to Mn, and metals at the top of the series are very reactive.

36. When sodium (Na) reacts with phosphorus (P), each sodium atom loses one outer shell electron to the phosphorus atom to form sodium ion, Na^+, with the stable octet electronic configuration 2, 8.

The phosphorus atom gains three electrons from three sodium atoms to form phosphide ion, P^{3-}, with the stable octet electronic configuration 2, 8, 8.

Sodium phosphide is formed when the electrostatic attraction holds the sodium and phosphide ions together.



OR

(a) The process of purifying the impure (crude) metals by electrolysis is called electrolytic refining of metals. Many metals like Cu, Sn, Ni, Ag, Au, Cr, Zn, Al, Pb etc. are purified by this method.

(b) (i) Zinc dissolves to form zinc ions.

$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$

Electrons flow from the zinc along the wire to the copper.

(ii) The aqueous solution of sodium chloride contains the following ions :

From $NaCl_{(aq)}$: $Na^+_{(aq)}$ and $Cl^-_{(aq)}$

From $H_2O_{(l)}$: $H^+_{(aq)}$ and $OH^-_{(aq)}$

Sodium is above the hydrogen in the reactivity series. Sodium ions remain in the solution and H^+ ions accept electrons to form hydrogen gas.

$2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

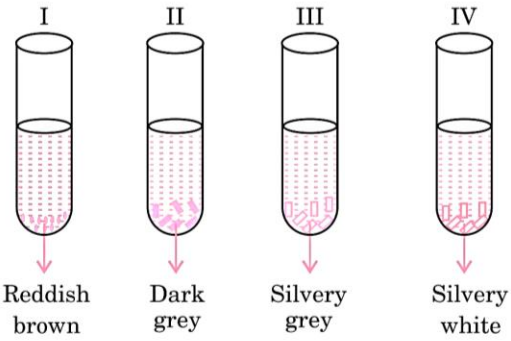
Hydrogen gas is produced at copper electrode.

☺☺☺

PRACTICAL QUESTIONS

Multiple Choice Questions

1. A student took Cu, Al, Fe and Zn strips separately in four test tubes labelled I, II, III and IV. He added 10 mL of freshly prepared ferrous sulphate solution to each test tube as shown in the figure :



Black residue would be obtained in test tubes
(a) I and II (b) I and III
(c) II and III (d) III and IV

Ans. (d) : Reddish brown = Cu (I)
Dark grey = Fe (II); Silvery grey = Zn (III)
Silvery white = Al (IV)
Al and Zn will displace iron from $FeSO_4$ to form black residue as these are more reactive than iron.

$$2Al_{(s)} + 3FeSO_{4(aq)} \longrightarrow Al_2(SO_4)_{3(aq)} + 3Fe_{(s)}$$

$$Zn_{(s)} + FeSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Fe_{(s)}$$

2. An iron nail was immersed in aluminium sulphate solution for about an hour, then it was observed that
(a) the solution becomes warm
(b) grey metal is deposited on the iron nail
(c) the colourless solution change to light green
(d) the solution remains colourless and no deposition is observed on iron nail.

Ans. (d) : The solution remains colourless and no deposition is observed on iron nail.

3. A student prepared an aqueous solution of $CuSO_4$ in beaker *X* and an aqueous solution of $FeSO_4$ in beaker *Y*. He then dropped some iron pieces in beaker *X* and some zinc pieces in beaker *Y*. After about 10 hours he observed that the solutions in *X* and *Y* respectively appear
(a) blue and green
(b) colourless and pale green
(c) colourless and light blue
(d) greenish and colourless.

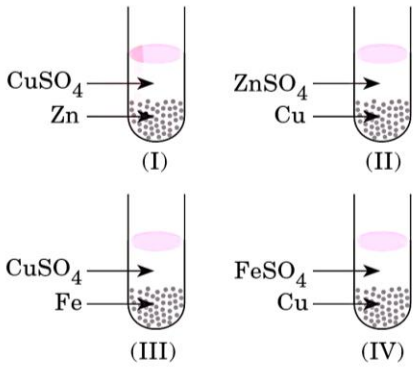
Ans. (d) : In beaker *X*, iron (Fe) is more reactive than copper (Cu), so iron will displace copper to form iron sulphate solution and thus the blue coloured solution turns into greenish solution.

$$\underset{\text{(Blue)}}{CuSO_4} + Fe \longrightarrow \underset{\text{(Greenish)}}{FeSO_4} + Cu$$

In beaker *Y*, zinc (Zn) is more reactive than iron (Fe). So, zinc will displace iron from its sulphate solution and thus pale green solution turns to colourless.

$$\underset{\text{(Pale green)}}{FeSO_4} + Zn \longrightarrow \underset{\text{(Colourless)}}{ZnSO_4} + Fe$$

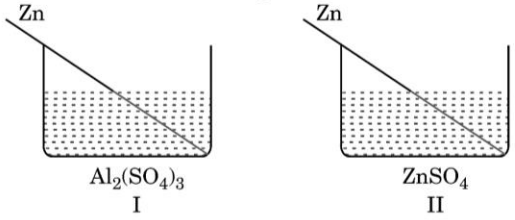
4.

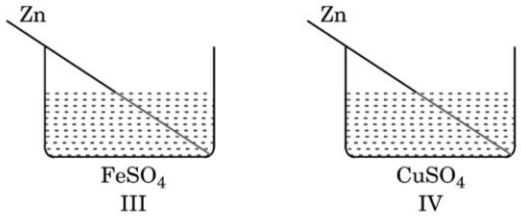


In which of the above test tubes reaction will take place ?
(a) I and II (b) II and III
(c) II and IV (d) I and III

Ans. (d) : I : $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
III : $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$
It is because Zn and Fe are more reactive than Cu.
In II and IV reaction will not take place because Cu is less reactive than Zn and Fe.

5. Four students *A*, *B*, *C* and *D* noted the initial colour of the solutions in beaker I, II, III and IV. After inserting zinc rods in each solution and leaving it undisturbed for two hours, noted the colour of each solution again.





They recorded their observations in the form of table given below :

Student	Colour of the solution	I	II	III	IV
A	Initial	Colour-less	Colour-less	Light green	Blue
	Final	Colour-less	Colour-less	Colour-less	Colour-less
B	Initial	Colour-less	Light yellow	Light green	Blue
	Final	Colour-less	Colour-less	Light green	Colour-less
C	Initial	Colour-less	Colour-less	Light green	Blue
	Final	Light blue	Colour-less	Colour-less	Light blue
D	Initial	Light green	Colour-less	Light green	Blue
	Final	Colour-less	Colour-less	Dark green	Colour-less

Which student noted the colour change in all the four beakers correctly?

(a) *A* (b) *B*
(c) *C* (d) *D*

Ans. (a) : Student *A* has recorded the correct observation. In I and II, no reaction takes place.

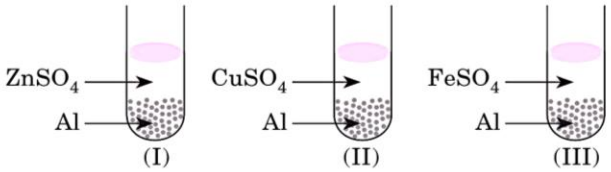
In III, green solution of $FeSO_4$ will change to colourless $ZnSO_4$

$Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$
(Green) (Colourless)

In IV, blue colour of $CuSO_4$ will change to colourless solution.

$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
(Blue) (Colourless)

6. A student perform the following experiment and his observations are given in table.



Observation	I	II	III
Solution	Colourless	Colourless	Colourless
Metal deposited	Zn	Cu	Fe

Which of the following is correct conclusion?

(a) Al is more reactive than Zn, Cu and Fe.
(b) Al is more reactive than Zn and Cu but less reactive than Fe.
(c) Al is more reactive than Cu but less reactive than Zn and Fe.
(d) Al is more reactive than Cu and Fe but less reactive than Zn.

Ans. (a) : $2Al + 3ZnSO_4 \longrightarrow Al_2(SO_4)_3 + 3Zn$
$2Al + 3CuSO_4 \longrightarrow Al_2(SO_4)_3 + 3Cu$
$2Al + 3FeSO_4 \longrightarrow Al_2(SO_4)_3 + 3Fe$

Al is most reactive among Al, Zn, Cu and Fe because it displaces them from their salt solutions.

7. Consider the following displacement reactions :

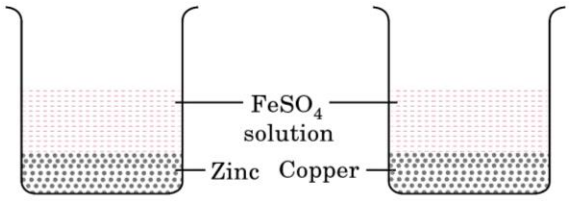
(i) $A + BSO_4 \longrightarrow ASO_4 + B$
(ii) $C + ASO_4 \longrightarrow CSO_4 + A$

Which of the following statement is correct?

(a) *B* is more reactive than *A* but less reactive than *C*.
(b) *A* is most reactive among *A*, *B* and *C*.
(c) *B* is more reactive than both *A* and *C*.
(d) *C* is more reactive than among *A*, *B* and *C*.

Ans. (d)

8. Two beakers *A* and *B* contain an aqueous solution of $FeSO_4$. In beaker *A* zinc granules and in beaker *B* copper turnings have been placed. A grey coating was observed on zinc but not on copper. From the above observations we can conclude



(a) zinc is more reactive than iron and copper.
(b) iron is more reactive than zinc and copper.
(c) iron is more reactive than zinc but less than copper.
(d) copper is more reactive than iron but less than zinc.

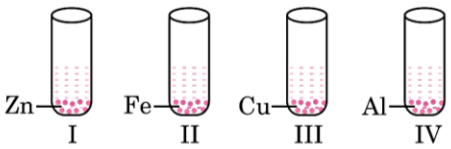
Ans. (a)

9. When zinc metal is dipped in copper sulphate solution
(a) the solution becomes colourless and reddish brown copper metal gets deposited.
(b) no reaction takes place
(c) the solution becomes green and copper metal gets deposited
(d) the solution remains blue and copper metal gets deposited.

Ans. (a) : $Zn + \underset{\text{(Blue)}}{CuSO_4} \longrightarrow \underset{\text{(Colourless)}}{ZnSO_4} + \underset{\text{(Reddish brown)}}{Cu}$

The solution becomes colourless due to formation of $ZnSO_4$ and copper metal gets deposited.

10. An aqueous solution of zinc sulphate was taken in four test tubes. Zinc, iron, copper and aluminium pieces were dropped into separate test tubes as given below :



A reaction will be observed in test tube(s)
(a) only I and II (b) only I and III
(c) only II and III (d) only IV.

Ans. (d) : As aluminium is more reactive than zinc, so aluminium displaces zinc from zinc sulphate solution. Therefore, reaction will be observed only in test tube IV.

Subjective Questions

11. State which of the following chemical reaction will take place or not, giving suitable reason for each.

(i) $Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$

(ii) $Fe_{(s)} + ZnSO_{4(aq)} \longrightarrow FeSO_{4(aq)} + Zn_{(s)}$

(iii) $Zn_{(s)} + FeSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Fe_{(s)}$

Ans. Reaction (i) will take place because zinc is more reactive than copper (higher in activity series) and can displace copper from copper sulphate solution.

The reaction (ii) will not take place because Fe is less reactive than Zn (low in activity series) and hence cannot displace more reactive Zn from $ZnSO_4$ solution.

The reaction (iii) will take place because zinc is more reactive than iron and hence can displace iron from iron sulphate solution.

12. A student added few pieces of aluminium metal to two test tubes *A* and *B* containing aqueous solutions of iron sulphate and copper sulphate. In the second part of her experiment, she added iron metal to another test tubes *C* and *D* containing aqueous solutions of aluminium sulphate and copper sulphate.
In which test tube or test tubes will she observe colour change? On the basis of this experiment, state which one is the most reactive metal and why?

Ans. As aluminium is more reactive than iron and copper, so it will displace iron from iron sulphate solution and copper from copper sulphate solution.

$\underset{\text{(White)}}{2Al_{(s)}} + \underset{\text{(Pale green)}}{3FeSO_{4(aq)}} \longrightarrow \underset{\text{(Colourless)}}{Al_2(SO_4)_{3(aq)}} + \underset{\text{(Dark grey)}}{3Fe_{(s)}}$

$\underset{\text{(White)}}{2Al_{(s)}} + \underset{\text{(Blue)}}{3CuSO_{4(aq)}} \longrightarrow \underset{\text{(Colourless)}}{Al_2(SO_4)_{3(aq)}} + \underset{\text{(Reddish brown)}}{3Cu_{(s)}}$

Hence, in both test tubes *A* and *B*, colour change is observed. Iron is less reactive than aluminium, hence, iron cannot displace aluminium from aluminium sulphate solution and therefore, no colour change is observed in test tube *C*. As iron is more reactive than copper it displaces copper from copper sulphate solution.

$\underset{\text{(Dark grey)}}{Fe_{(s)}} + \underset{\text{(Blue)}}{CuSO_{4(aq)}} \longrightarrow \underset{\text{(Pale green)}}{FeSO_{4(aq)}} + \underset{\text{(Reddish brown)}}{Cu_{(s)}}$

Hence, colour change is observed in test tube *D*.
As aluminium can displace both copper and iron from the salt solutions, thus, it is most reactive. The order of reactivity is Al > Fe > Cu.

13. What is your observation when copper is added in iron sulphate solution?

Ans. When copper is added in iron sulphate solution, no reaction occurs as Cu is less reactive than iron and it cannot displace Fe from $FeSO_4$ Solution.

14. Why can we safely preserve iron sulphate in a copper vessel whereas the same can't be safely preserved in zinc vessel?

Ans. Because copper is less reactive than iron so there is no reaction occur between iron sulphate and Cu but zinc is more reactive than Fe. So, it will displace iron from its sulphate solution.

15. What would you observe on adding zinc granules to freshly prepared ferrous sulphate solution? Give reason for your answer.

Ans. When zinc granules are added to freshly prepared ferrous sulphate solution, the colour of solution changes from pale green to colourless. This is because zinc being more reactive than iron, displaces iron from its sulphate solution.

$\underset{\text{(Pale green)}}{FeSO_4} + Zn \longrightarrow \underset{\text{(Colourless)}}{ZnSO_4} + Fe$