

(iron and carbon), brass (copper and zinc), bronze (copper and tin), and duralumin (aluminium and copper).

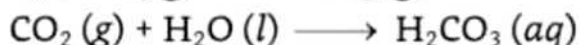
NON-METALS

Physical Properties of Non-Metals

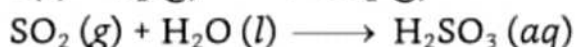
- (i) They are dull, however diamond, graphite and iodine are lustrous.
- (ii) They are poor conductors of heat and electricity. Graphite is a good conductor.
- (iii) They are weak and brittle (they easily break or shatter).
- (iv) They have a low density (they feel light for their size).
- (v) They do not make a ringing sound when they are hit.
- (vi) Melting points and boiling points are usually low.
- (vii) Non-metals are usually soft. (Diamond is an exception, it is quite hard. It is a crystalline solid).
- (viii) They exist in allotropic forms.

Chemical Properties of Non-Metals

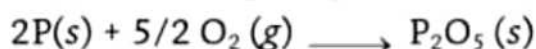
- (i) Non-metals react with oxygen to form either acidic or neutral oxides.
- (ii) Carbon reacts with oxygen to form carbon dioxide, which dissolves in water to form carbonic acid. Carbon reacts with insufficient amount of oxygen to form carbon monoxide, which is a neutral oxide and does not dissolve in water.

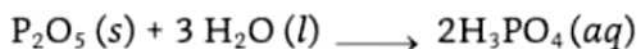


- (iii) Sulphur reacts with oxygen to form sulphur dioxide, an acidic oxide, which dissolves in water to form sulphurous acid.



- (iv) Phosphorus reacts with oxygen to form phosphorus pentoxide, an acidic oxide, which dissolves in water to form phosphoric acid.





- (v) Hydrogen reacts with oxygen to form water, which is a neutral oxide.
- (vi) Non-metals do not react with water.
- (vii) Non-metals do not replace hydrogen from acids.

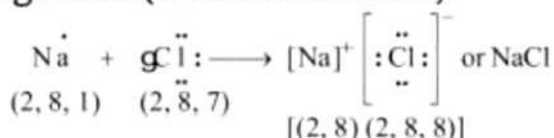
Uses of Non-Metals

- (i) Oxygen is essential for survival of life.
- (ii) Hydrogen is used to convert vegetable oil into vegetable ghee by hydrogenation.
- (iii) Nitrogen is used to preserve food and for manufacturing proteins by plants.
- (iv) Carbon in the form of diamond is used for cutting rocks and in the form of graphite as electrode and in manufacturing of lead pencils.
- (v) Sulphur is used in vulcanization of rubber, as fungicide and in manufacture of dyes, gun powder etc.
- (vi) Chlorine is used as water disinfectant and in the manufacture of pesticides like gammaxene.

Formation and Properties of Ionic Compounds

In a metal and non-metal bond, the metal loses electrons to achieve a more stable electronic configuration, while the non-metal gains electrons. Thus an **ionic bond** is formed with transfer of electrons from metal to non-metal.

The compounds which contain ionic bonds are called **ionic compounds** or **electrovalent compounds** : e.g. NaCl (sodium chloride).



Characteristics of Ionic Compounds

- (i) They conduct electricity in aqueous solution as well as in molten state.
- (ii) They have high melting points and boiling points.
- (iii) They are highly soluble in water and are insoluble in solvents such as benzene, ether, petrol, kerosene oil etc.
- (iv) They are crystalline solids and *hard* because of strong force of attraction between positive ions (cations) and negative ions (anions).

(v) These compounds are generally *brittle* and break into pieces when pressure is applied.

Occurrence of Metals

Major source of metals is earth's crust but metals also exist in sea water as their soluble salts. Metals exist both in free state or native state (Au, Ag) and also in combined state (e.g., Na as NaCl, Fe as Fe_2O_3 , Cu as Cu_2S etc.)

Minerals

The inorganic elements or compound which occur naturally in earth's crust are called minerals.

Ores

Those minerals from which the metal can be extracted profitably and conveniently are called ores.

Gangue or Matrix

The unwanted impurities of sand and rocky materials present in the ore is known as gangue or matrix.

METALLURGY

It is the branch of science which deals with the extraction of metals from their ores, and then refining them for use.

Various Steps Involved in Metallurgy are

- (i) Enrichment or concentration of ore
- (ii) Reduction
- (iii) Refining.

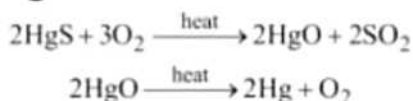
Extraction of a Metal

Because of a difference in reactivities different techniques are used for extracting these three different categories of metals.

- (i) Metals with low reactivity
- (ii) Metals with medium reactivity
- (iii) Metals with high reactivity.

Extracting Metals Low in the Activity Series

Metals that are low in the activity series are very un-reactive. The oxides of these metals can be reduced to metals by heating alone. For example, mercury is obtained from its ore, cinnabar (HgS), by the process of heating.

Reduction using heat :**Extracting Metals in the Middle of the Activity Series**

Metals such as iron, zinc, lead, copper, etc., are in the middle of the reactivity series. These are moderately reactive metals and are usually present as sulphides or carbonates. A metal is obtained from its ore by the processes of reduction or by electrolysis. In the reduction process, it is the oxide ore that is reduced.

Roasting

Sulphide ores are converted into oxides by heating strongly in the presence of excess air, so that oxygen gets added to form the corresponding oxides. Sulphur impurities escape as gas.

Calcination

In Calcination process the ore is heated to a high temperature in the absence of air, or where air does not take part in the reaction. Usually, carbonate ores or ores containing water are calcined to drive out carbonate and moisture impurities.

Thermite Reaction

A thermite reaction is basically iron oxide (rust) reacting with aluminium to produce molten iron. Here, iron oxide (Fe_2O_3 = rust) and aluminum metal powder undergo a redox (reduction-oxidation) reaction to form iron metal and aluminum oxide (Al_2O_3 = alumina):

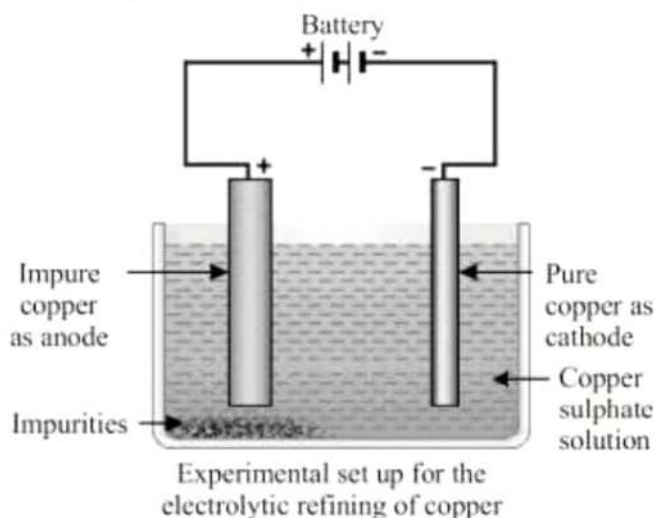


This reaction is so exothermic that the iron is actually molten.

Extracting metals towards the top of the activity series: Metals such as sodium, magnesium, calcium, aluminium high up in the reactivity series are very reactive and cannot be obtained from their compounds by heating with carbon. This is because these metals have more affinity for oxygen than carbon. These metals are obtained by electrolytic reduction.

REFINING OF THE METALS

- (i) By liquation :** This method is used for the easily fusible metals like tin etc. Impure metal is placed on the inclined bed of a furnace and heated. The metal melts and flows out leaving behind the impurities. E.g. purification of Sn containing impurities of high m.p. like Fe, Cu, W.
- (ii) By distillation :** Volatile metals like zinc and Hg etc. can be purified by this method. When these metals are heated their vapours are formed leaving behind the impurities. The vapours are condensed to get pure metals.
- (iii) Electrolytic refining :** The impure metal is taken as anode and the cathode consists of a pure metal. Cathodes and anodes are placed in a soluble salt of the metal taken as an electrolyte. Pure metal gradually passes on to the cathode and impurities either settles down or dissolved in the solution called anode mud. Large number of metals like copper, silver, gold and zinc are purified by this method. The metal of highest purity are obtained by this method.



Metalloids

Metalloids are those chemical elements that exhibit properties of both metals and non-metals. They behave as non-metals physically and chemically and show electrical conductivity like metals. However, they are not good conductors of electricity like metals and are known as semiconductors. There are seven metalloids in the periodic table that are placed in Group 13, 14, 15, 16 and 17. They form a zig zag step line in the periodic table.

Corrosion of Metals

Corrosion is an oxidation reaction with atmospheric oxygen in the presence of water on the surface of a metal. Corrosion or rusting of iron is accelerated in the presence of CO_2 and also in the presence of salt solution. Rusting is

$2\text{Fe(s)} + \frac{3}{2}\text{O}_2\text{(g)} + x\text{H}_2\text{O(l)} \longrightarrow \text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O(s)}$ i.e., rust is hydrated iron (III) oxide.

The major problem of corrosion occurs with iron (or steel) as it is used as a structural material in industries like construction, infrastructure, bridges, rail transport, power transmission, ship building, automobiles, heavy industries etc. Lead corrodes to a white lead oxide or carbonate and copper corrodes to form a basic green carbonate (combination of the hydroxide Cu(OH)_2 and carbonate CuCO_3).

Prevention of Rusting (Corrosion)

- (i) Painting or applying a coat of grease on iron articles.
- (ii) Galvanising iron articles. It is a process in which a layer of metals like chromium or zinc is deposited electrolytically on iron articles.
- (iii) Electroplating the surface of iron articles with metals not attacked by atmospheric moisture.
- (iv) **Alloying** : Iron or steel along with other metals can also be protected by 'alloying' or mixing with other metals (e.g., chromium) to make non-rusting alloys. Stainless steel is an example of a non-rusting alloy of iron and carbon.

Purity of Gold : 24-Carat gold

The carat (abbreviation ct or Kt) is a measure of the purity of gold alloys. Carat is used to refer to the measure of mass for gemstones. As a measure of purity, one carat is purity by mass.

Alloy: An alloy is a mixture of two or more elements in solid solution in which the major component is a metal. Combining different ratios of metals as alloys modify the properties of pure metals to produce desirable characteristics.

S. No.	Alloy	Composition	Uses
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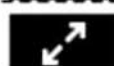



1.	Brass	Cu = 80%, Zn = 20%	For making utensils and cartridges.
2.	Bronze	Cu = 90%, Sn = 10%	For making statues, medals, ships, coins and machines
3.	Solder	Sn = 50%, Pb = 50%	For joining metals, soldering wire and electronic components etc.
4.	Duralumin	Al = 95.5%, Cu = 3%, Mn = 1.0%, Mg = 0.5%	Used in bodies of aircrafts, kitchen ware and automobile parts etc.
5.	German Silver	Cu = 60%, Zn = 20%, Ni = 20%	For making utensils and ornaments
6.	Gun metal	Cu = 90%, Sn = 10%	For making gears and castings etc.
7.	Bell metal	Cu = 80%, Sn = 20%	For making bells, gangs etc.
8.	Magnalium	Al = 90%, Mg = 10%	For making balance beams, light instruments.
9.	Type metal	Pb = 82%, Sb = 15%, Sn = 3%	For making casting type
10.	Stainless steel	Fe, Ni, Cr, C	For making utensils, cutlery etc.



Some important ores and the metals obtained from these ores are listed in the following table:

S. no.	Name of the ore	Formula of the ore	Types of ore	Metal obtained from the ore
1	Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$	Oxide	Aluminium (Al)
2.	Haematite	Fe_2O_3	Oxide	Iron (Fe)
3.	Magnetite	Fe_3O_4	Oxide	Iron (Fe)
4.	Zincite	ZnO	Oxide	Zinc (Zn)
5.	Cuprite	Cu_2O	Oxide	Copper (Cu)
6.	Litharge	PbO	Oxide	Lead (Pb)
7.	Malachite	$\text{CuCO}_3 \cdot \text{Cu(OH)}_2$	Carbonate	Copper (Cu)
8.	Magnesite	MgCO_3	Carbonate	Magnesium (Mg)
9.	Lime stone	CaCO_3	Carbonate	Calcium (Ca)
10.	Cinnabar	HgS	Sulphide	Mercury (Hg)
11.	Chalcopyrite	CuFeS_2	Sulphide	Copper (Cu)
12.	Zinc blende	ZnS	Sulphide	Zinc (Zn)
13.	Galena	PbS	Sulphide	Lead (Pb)
14.	Common salt	NaCl	Chloride (Halide)	Sodium (Na)
15.	Fluorspar	CaF_2	Fluoride (Halide)	Calcium (Ca)
16.	Horn silver	AgCl	Chloride (Halide)	Silver (Ag)



17.	Chalcocite	Cu_2S	Sulphide	Copper (Cu)
				

Exercise	
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DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) out of which only one is correct.

1. Which of the following is liquid at ordinary temperature?
 - (a) Germanium
 - (b) Gallium
 - (c) Gold
 - (d) Galena
2. The correct order of increasing chemical reactivity of following metals is -
 - (a) $\text{Zn} < \text{Fe} < \text{Mg} < \text{K}$
 - (b) $\text{Fe} < \text{Mg} < \text{Zn} < \text{K}$
 - (c) $\text{Fe} < \text{Mg} < \text{K} < \text{Zn}$
 - (d) $\text{Fe} < \text{Zn} < \text{Mg} < \text{K}$
3. Metals generally are
 - (a) reducing agents
 - (b) oxidising agent
 - (c) both oxidising and reducing agents
 - (d) None of these
4. The most abundant metal in the earth's crust is -
 - (a) iron
 - (b) copper
 - (c) aluminium
 - (d) mercury
5. The metal that reacts with cold water is -
 - (a) mercury
 - (b) sodium
 - (c) zinc
 - (d) tungsten
6. The only metal that is liquid at room temperature is -
 - (a) mercury
 - (b) sodium
 - (c) zinc
 - (d) tungsten
7. Chemically rust is
 - (a) hydrated ferric oxide only
 - (b) hydrated ferrous oxide only
 - (c) ferric oxide only
 - (d) ferrous oxide only
8. Alumina is chief ore of which of the following metal?

- (a) Na
 - (b) K
 - (c) Ca
 - (d) Al
9. Horn silver is
- (a) an oxide ore of silver
 - (b) a sulphite ore of silver
 - (c) a carbonate ore of silver
 - (d) a chloride ore of silver
10. Naturally occurring substances from which a metal can be profitably (or economically) extracted are called?
- (a) Minerals
 - (b) Ores
 - (c) Gangue
 - (d) Salts
11. Cinnabar is an ore of
- (a) Hg
 - (b) Cu
 - (c) Pb
 - (d) Zn
12. Which of the following is not an ore ?
- (a) Bauxite
 - (b) Malachite
 - (c) Zinc blende
 - (d) Pig iron
13. Which of the following mineral does not contain Al ?
- (a) Cryolite
 - (b) Mica
 - (c) Feldspar
 - (d) Fluorspar
14. Formula of magnetite is
- (a) Fe_2O_3
 - (b) FeS_2
 - (c) FeCO_3
 - (d) Fe_3O_4
15. Copper can be extracted from -
- (a) kupfernickel
 - (b) dolomite
 - (c) galena
 - (d) malachite
16. Among the following statements, the incorrect one is -
- (a) Calamite and siderite are carbonates
 - (b) Argentite and cuprite are oxides

- (c) Zinc blende and pyrites are sulphides
(d) Malachite and azurite are ores of copper
17. Which ore contains both iron and copper?
(a) Cuprite
(b) Chalcocite
(c) Chalcopyrite
(d) Malachite
18. Calcination is the process of heating the ore
(a) in a blast furnace
(b) in absence of air
(c) in presence of air
(d) None of these
19. Of the following, which cannot be obtained by electrolysis of the aqueous solution of their salts.
(a) Ag
(b) Mg and Al
(c) Cu
(d) Cr
20. A student added zinc granules to copper sulphate solution taken in a test tube. Out of the following, the correct observation (s) made by of the student will be –
I. Zinc granules have no regular shape.
II. Zinc granules have silvery grey colour.
III. The colour of zinc granules changed to brownish black
(a) I only
(b) II only
(c) III only
(d) I, II and III
21. When sodium is exposed in air, what products will be formed
(a) Na_2O
(b) NaOH
(c) Na_2CO_3
(d) All of these
22. When a metal is added to dilute HCl solution, there is no evolution of gas. Metal is
(a) K
(b) Na
(c) Ag
(d) Zn
23. $\text{Zn} + \text{H}_2\text{O (Steam)} \longrightarrow \text{A} + \text{B}$,
In the equation A and B are -
(a) Zn, H only
(b) ZnH_2 and O_2

- (c) ZnO_2 & O_2
 - (d) ZnO & H_2
24. Which of the following is an oxide ore?
- (a) Bauxite
 - (b) Cuprite
 - (c) Haematite
 - (d) All of these
25. Removal of impurities from ore is known as -
- (a) crushing and grinding
 - (b) concentration of ore
 - (c) calcination
 - (d) roasting
26. Which reducing agent is used in chemical reduction?
- (a) C
 - (b) CO
 - (c) Al
 - (d) All of these
27. Aluminium is used in thermite welding because -
- (a) aluminium is a light metal
 - (b) aluminium has more affinity for oxygen
 - (c) aluminium is a strong oxidising agent
 - (d) aluminium is a reactive metal
28. The process of extraction of metal from its ores, is known as
- (a) concentration
 - (b) calcination
 - (c) purification
 - (d) metallurgy
29. 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
30. Brass is a mixture of
- (a) copper and zinc
 - (b) copper and tin
 - (c) copper, nickel and zinc
 - (d) aluminium, copper and traces of Mg and Mn
31. The white phosphorus is stored
- (a) in air
 - (b) under water
 - (c) under kerosene
 - (d) under CS_2
32. Aluminium is obtained from purified bauxite by

- (a) electrolysis process
 - (b) strongly heating with coke
 - (c) strongly heating in a current of CO
 - (d) strongly heating in a current of H₂
33. Sodium is obtained by the electrolysis of
- (a) an aqueous solution of sodium chloride
 - (b) an aqueous solution of sodium hydroxide
 - (c) fused sodium chloride
 - (d) fused sodium sulphate
34. The chief ore of aluminium is
- (a) bauxite
 - (b) cryolite
 - (c) alunite
 - (d) feldspar
35. One of the constituents of amalgam is
- (a) aluminium
 - (b) copper
 - (c) iron
 - (d) mercury
36. Which of the following metals reacts with water/steam to produce oxide instead of hydroxide?
- (a) Sodium
 - (b) Potassium
 - (c) Calcium
 - (d) Magnesium
37. Which of the following elements produces basic oxide on reacting with oxygen?
- (a) Chlorine
 - (b) Sulphur
 - (c) Phosphorus
 - (d) Magnesium
38. Copper sulphate solution can be safely kept in a container made of
- (a) aluminium
 - (b) lead
 - (c) silver
 - (d) zinc
39. Metal reacts with oxygen to form
- (a) neutral oxides
 - (b) basic oxides
 - (c) acidic oxides
 - (d) None of these
40. The metal used to built bridges is
- (a) gold
 - (b) silver

- (c) platinum
- (d) iron
- 41. Non-metallic oxide are
 - (a) acidic
 - (b) basic
 - (c) neutral
 - (d) (a) and (3)
- 42. Which of the following metals can displace hydrogen from acids?
 - (a) Silver
 - (b) Mercury
 - (c) Magnesium
 - (d) Copper
- 43. Which of the following is a good conductors of heat and electricity?
 - (a) Graphite
 - (b) Oxygen
 - (c) Chlorine
 - (d) Nitrogen
- 44. Metals are
 - (a) malleable
 - (b) ductile
 - (c) Both (a) and (b)
 - (d) Neither (a) nor (b)
- 45. Which of the following have low melting and boiling points?
 - (a) Phosphorus
 - (b) Sodium
 - (c) Iron
 - (d) (a) and (b)
- 46. Which of the following metal(s) catch fire on reaction with water?
 - (a) Sodium
 - (b) Potassium
 - (c) Magnesium
 - (d) (a) and (b)
- 47. A metal, which forms a protective layer of its oxide on reaction with atmospheric oxygen, on its surface is
 - (a) sodium
 - (b) aluminium
 - (c) potassium
 - (d) magnesium
- 48. Which of the following non-metals has shining lustrous surfaces?
 - (a) Graphite and phosphorus

- (b) Graphite and iodine
 - (c) Iodine and phosphorus
 - (d) Phosphorus and chlorine
49. Metals like Gold, Platinum which do not easily react are called
- (a) active metals
 - (b) dull metals
 - (c) noble metals
 - (d) bright metals
50. The metalloids include the elements
- (a) Boron, Silicon
 - (b) Arsenic, Antimony
 - (c) Germanium, Tellurium
 - (d) All the above
51. Select the one that could displace copper from a solution of copper sulphate.
- (a) Silver
 - (b) Mercury
 - (c) Tin
 - (d) Gold
52. Select the property that is associated with non-metals.
- (a) Low density
 - (b) Low melting point
 - (c) Poor conductor of electricity
 - (d) All of the above
53. Which of the following methods is suitable for preventing an iron frying pan from rusting?
- (a) Applying grease
 - (b) Applying paint
 - (c) Applying a coating of zinc
 - (d) All of the above
54. Food cans are coated with tin and not with zinc because
- (a) zinc is costlier than tin
 - (b) zinc has a higher melting point than tin
 - (c) zinc is more reactive than tin
 - (d) zinc is less reactive than tin
55. Which of the following non-metals sublimes on heating?
- (a) Fluorine
 - (b) Chlorine
 - (c) Bromine
 - (d) Iodine

56. Which of the following statement regarding metals is true?
 - (a) All metals are solid in nature.
 - (b) Metals can be used to make handle of cooking utensils
 - (c) Generally most of metals have high melting and boiling points.
 - (d) Gold is used generally to make electrical wires.
57. Which of the following statement regarding metals is false?
 - (a) Chief ore of aluminium is Bauxite.
 - (b) Chief ore of lead is Galena.
 - (c) Chief ore of mercury is Cassiterite.
 - (d) Chief ore of iron is Haematite.
58. Which of the following statement is false?
 - (a) Metals are good conductors of heat and electricity.
 - (b) Gold, Silver and Zinc are most malleable metals.
 - (c) Mercury is the only liquid metal.
 - (d) Bromine is the only liquid non-metal.
59. Which of the following statement is true?
 - (a) Silver can displace platinum from its salt solution.
 - (b) Aluminium can displace sodium from its salt solution.
 - (c) Mercury can displace copper from its salt solution.
 - (d) Silver can displace gold from its salt solution.
60. Which of the following statement regarding non-metals is true?
 - (a) Non-metals are of two types only solids and gases.
 - (b) Non-metals reacts with oxygen to form basic oxides generally.
 - (c) Non-metals are non-lustrous with dull appearance. Graphite, an allotrope of carbon and iodine have shining lustrous surfaces.
 - (d) Non-metals replace hydrogen from acids.
61. Which of the following statements regarding non-metals is false?
 - (a) 11 non-metals are in gaseous state.
 - (b) Gas carbon is a good conductor of heat and electricity.

- (c) The black material inside a pencil is metal lead.
- (d) All non-metals are non-sonorous in nature.
62. Consider the following elements:
- (i) Copper
 - (ii) Gold
 - (iii) Platinum
 - (iv) Silver
- Which of the above elements exist free in nature?
- (a) (i) and (ii)
 - (b) (ii) and (iii)
 - (c) (i), (ii) and (iv)
 - (d) (iii) and (iv)
63. Consider the following statements:
- Nitrogen is an essential constituent of
- (i) soils
 - (ii) animals
 - (iii) plants
- Which of the statements given above is/are correct ?
- (a) (iii) only
 - (b) (i) and (iii) only
 - (c) (i) and (ii) only
 - (d) (i), (ii) and (iii)
64. When iron is left exposed in open air, it gets rusted.
- Which constituent(s) of air is /are responsible for rusting iron?
- (i) Oxygen gas present in air
 - (ii) Moisture present in air
 - (iii) Carbon dioxide gas present in air
- Select the correct answer using the code given below :
- (a) (i) only
 - (b) (ii) only
 - (c) (i) and (ii)
 - (d) (ii) and (iii)
65. Aluminium is used for making cooking utensils.
- Which of the following properties of aluminium are responsible for the same ?
- (i) Good thermal conductivity
 - (ii) Good electrical conductivity
 - (iii) Ductility
 - (iv) High melting point
- (a) (i) and (ii)
 - (b) (i) and (iii)
 - (c) (ii) and (iii)
 - (d) (i) and (iv)

66. What happens when calcium is treated with water ?
- (i) It does not react with water
 - (ii) It reacts violently with water
 - (iii) It reacts less violently with water
 - (iv) Bubbles of hydrogen gas formed stick to the surface of calcium
- (a) (i) and (iv)
 - (b) (ii) and (iii)
 - (c) (i) and (ii)
 - (d) (iii) and (iv)
67. Generally metals react with acids to give salt and hydrogen gas. Which of the following acids does not give hydrogen gas on reacting with metals (except Mn and Mg) ?
- (a) H_2SO_4
 - (b) HCl
 - (c) HNO_3
 - (d) All of these
68. Which of the following are not ionic compounds ?
- (i) KCl
 - (ii) HCl
 - (iii) CCl_4
 - (iv) NaCl
- (a) (i) and (ii)
 - (b) (ii) and (iii)
 - (c) (iii) and (iv)
 - (d) (i) and (iii)
69. Metals are refined by using different methods. Which of the following metals are refined by electrolytic refining?
- (i) Au
 - (ii) Cu
 - (iii) Na
 - (iv) K
- (a) (i) and (ii)
 - (b) (i) and (iii)
 - (c) (ii) and (iii)
 - (d) (iii) and (iv)
70. Silver articles become black on prolonged exposure to air. This is due to the formation of
- (a) Ag_3N
 - (b) Ag_2O
 - (c) Ag_2S
 - (d) Ag_2S and Ag_3N

71. Which of the following metals are obtained by electrolysis of their chlorides in molten state ?
- (i) Na
 - (ii) Ca
 - (iii) Fe
 - (iv) Cu
 - (a) (i) and (iv)
 - (b) (iii) and (iv)
 - (c) (i) and (iii)
 - (d) (i) and (ii)
72. 2 mL each of concentrated HCl, HNO_3 and a mixture concentrated HCl and concentrated HNO_3 in the ratio of 3 : 1 were taken in test tubes labelled as A, B and C. A small piece of metal was put in each test tube. No change occurred in test tubes A and B but the metal got dissolved in test tube C respectively. The metal could be
- (a) Al
 - (b) Au
 - (c) Cu
 - (d) Pt
73. An electrolytic cell consists of
- (i) positively charged cathode
 - (ii) negatively charged anode
 - (iii) positively charged anode
 - (iv) negatively charged cathode
 - (a) (i) and (ii)
 - (b) (iii) and (iv)
 - (c) (i) and (iii)
 - (d) (ii) and (iv)
74. Reaction between X and Y, forms compound Z. X loses electron and Y gains electron. Which of the following properties is not shown by Z ?
- (a) Has high melting point
 - (b) Has low melting point
 - (c) Conducts electricity in molten state
 - (d) Occurs as solid
75. Brass is an alloy of Copper with which of the following metal?
- (a) Tin
 - (b) Zinc
 - (c) Nickel
 - (d) Iron
76. Copper is present in which of the following alloy?

- (a) Gun Metal
 - (b) Solder
 - (c) Magnalium
 - (d) Type Metal
77. Litharge is ore of?
- (a) Zn
 - (b) Fe
 - (c) Pb
 - (d) P
78. Formula of Cinnabar is
- (a) HgO
 - (b) HgCl_2
 - (c) HgS
 - (d) Hg_2Cl_2
79. Iron is obtained from?
- (a) Bauxite
 - (b) Magnetite
 - (c) Malachite
 - (d) Chalcopyrite

Hints & SOLUTIONS —

1. (b)
2. (d) It is the correct order on the basis of reactivity series.
3. (a) As metals are electropositive in nature and have tendency to lose electrons.
4. (c)
5. (b) It is because of extremely high reactivity of sodium.
6. (a) Mercury is the only element even being metal is liquid at room temperature.
7. (a) As the chemical formula of rust is $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
8. (d)
9. (d) Chemical formula of horn silver is AgCl .
10. (b)
11. (a) Cinnabar (HgS) is a sulphide ore of mercury
12. (d) Pig iron \rightarrow It is the most impure form of iron and contains highest proportion of carbon (2.5-4%). Rest all are ore.
 Malachite $\rightarrow \text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$,
 Zinc blende $\rightarrow \text{ZnS}$,
 Bauxite $\rightarrow \text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
13. (d) Fluorspar (CaF_2), Cryolite (Na_3AlF_6), Feldspar (KAlSi_3O_8) and Mica ($\text{K}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 2\text{H}_2\text{O}$)
14. (d)
15. (d) It is $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$
16. (b) Cuprite (Cu_2O) and Argentite (Ag_2S)
17. (c) Among cuprite [Cu_2O], Chalcocite [Cu_2S], Chalcopyrite [CuFeS_2] and Malachite [$\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$], only Chalcopyrite is an ore which contains both Fe and Cu.
18. (b)
19. (b) Mg and Al cannot be obtained by the electrolysis of aqueous solution of their salts because instead of metal H_2 gas is liberated at cathode.
20. (c) The displacement reaction that occurs is

$$\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$$

(Brownish black)
21. (d)
22. (c) As silver is less reactive in nature it will not displace hydrogen from dilute acids.
23. (d)
24. (d)
25. (b)
26. (d)

27. (b) $\text{Fe}_2\text{O}_3(\text{s}) + 2\text{Al}(\text{s}) \longrightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{l})$
28. (d)
29. (a)
30. (a)
31. (b)
32. (a)
33. (c)
34. (a) Bauxite is $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.
35. (d)
36. (d)
37. (d) As magnesium is metal.
38. (c)
39. (b) Metals form basic oxides. For example oxide of calcium being basic is used to neutralise the acidity of soil.
40. (d) Steel an alloy of iron and carbon is used for manufacturing bridges.
41. (d) Non-metallic oxide could be acidic and neutral also. For example carbon dioxide (CO_2) is acidic in nature whereas carbon monoxide (CO) is neutral in nature.
42. (c) Magnesium can displace hydrogen easily as it lie above hydrogen in activity series where as rest all three lie below hydrogen in reactivity series. Thus rest three elements will not able to displace hydrogen from acids.
43. (a) Graphite is the only non-metal, which is a good conductor of heat and electricity.
44. (c) Metals are both malleable and ductile. Metals can be drawn into thin sheets and wires.
45. (d) Phosphorus is a non-metal and non-metals have low melting and boiling points. Although, sodium is a metal, it has low melting and boiling point.
46. (d) Sodium and potassium both are extremely reactive and react with water so vigorously. This reaction is highly exothermic so that hydrogen evolved will catch fire.
47. (b) Aluminium on reaction with atmospheric oxygen form a passive layer of Al_2O_3 on its surface. This layer prevent metal from further oxidation.
48. (b) Graphite which is crystalline form of carbon and iodine are the only two non-metals which has shining lustrous surfaces.
49. (c) Noble metals are those metals which do not react easily and lie at the bottom of the activity series.
50. (a) Both boron and silicon are metalloids.
51. (c) Tin (Sn); [It lies above copper in Activity series]
52. (d)
53. (c)

54. (c)
55. (d)
56. (c) Mercury being a metal is liquid at room temperature. Metals are good conductor of heat therefore cannot be used to make handle it will result into burns. Gold cannot be used to make electrical wires it is very expensive therefore metals like copper is used for it.
57. (c) Chief ore of mercury is cinnabar.
58. (b) Gold and Silver are most malleable metals whereas zinc metal is non-malleable and brittle.
59. (d) As silver is above gold in reactivity series
60. (c)
61. (c) The black material inside a pencil is not metal lead. Actually it is graphite, a non-metal.
62. (c) Cu, Au, Ag are known as coinage metals and occur free in nature. Because of nobility they are frequently found in their native state.
63. (c) Nitrogen is an essential constituent of all vegetables and animal proteins. Soil contains nitrogen as ammonium salts.
64. (c) Both oxygen and moisture present in air cause rusting of iron.
65. (d)
66. (d)
67. (c)
68. (b) HCl and CCl_4 are covalent compounds.
69. (a)
70. (c)
71. (d)
72. (b) Gold dissolves in Conc. HCl and Conc. HNO_3 3 : 1 mixture (aqua regia)
73. (b)
74. (b) Z is ionic compound which has high melting point.
75. (b) Brass is composed of (Cu – 80% + Zn – 20%).
76. (a) Copper is present in Gun Metal (Cu – 90% + Sn – 10%).
77. (c) Lead (Pb) is obtained from Litharge (PbO).
78. (c) Cinnabar is HgS .
79. (b) Iron is obtained from its ore magnetite and haematite.

Chapter 6

Carbon and its Compounds

CARBON

Carbon has a unique place in our life. Each living cell, food, wood, paper, petrochemicals, cooking gas, perfumes etc. are all made of carbon. Carbon is an essential component of all living matters as proteins, carbohydrates and fats.

Bonding in Carbon

A carbon atom has a total of six electrons carbon atom has four valence electrons. It could gain four electrons to form C^{4-} anion or lose four electrons to form C^{4+} cation. Both these conditions require large amount of energy. Thus it has a very little tendency to form ionic compounds. To overcome this problem carbon undergoes bonding by sharing its valence electron with other carbon atoms or with atoms of other elements. This allows it to be covalently bonded to one, two, three or four carbon atoms or atoms of other elements or groups of atoms (molecule).

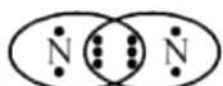
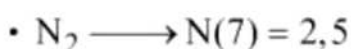
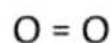
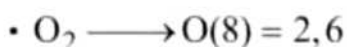
Formation of Covalent Bond

Covalent bond formation involves **sharing of electrons** between bonding atoms which may be either same or different. The bonding atoms contribute equal number of electrons (e.g. one electron each or 2 electrons each etc).

Covalency

The number of electrons contributed by an atom for sharing is known as its covalency. Depending upon the number of electrons shared by each atom in bond formation, covalent bond may be single, double or triple. A **single bond** is represented by a single line ($-$), a **double bond** by double line ($=$) and a **triple bond** by a triple line (\equiv).

Example



Characteristics of Covalent Compounds

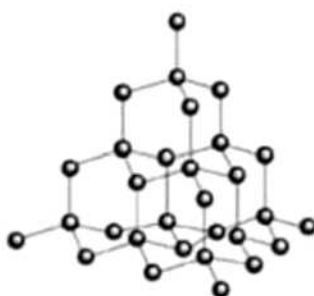
- (i) These compounds are molecular in nature (i.e. they exist as single molecules) e.g. H_2 , Cl_2 , NH_3 , CH_4 , SO_2 etc.
- (ii) These are insoluble in water and soluble in benzene, kerosene and petrol etc.
- (iii) These compounds are poor conductor of electricity.
- (iv) It is a weak bond due to weak intermolecular forces. Covalent compounds have low melting and boiling points.

Allotropy in Carbon

The property due to which an element exists in two or more forms, which differ in their physical and some of the chemical properties is known as "**Allotropy**" and the various forms are called "**Allotropes**".

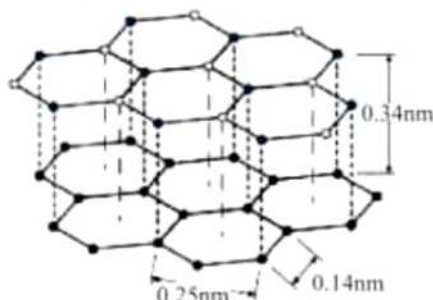
- (i) Allotropes are formed due to the difference either in the number of atoms in the molecules or arrangement of atoms in the molecules.
- (ii) Carbon exists in two allotropic form (1) crystalline (2) amorphous. The crystalline forms are diamond and graphite whereas the amorphous forms are coal, charcoal, lamp black etc.
- (iii) Both diamond and graphite are formed by carbon atom, the difference lies in the manner in which the carbon atom are bonded to one another.

- (iv) In diamond each carbon atom is bonded to four other carbon atoms tetrahedrally by covalent bond. Thus it has a three dimensional network structure.



The structure of diamond

- (v) Graphite has a two dimensional sheet structure in which each carbon atom is linked to three carbon atoms in a hexagonal planar structure, one of these bonds is a double bond and thus the valency of carbon is satisfied.



The structure of graphite

- (vi) Diamonds is the hardest substance known while graphite is smooth and slippery.
- (vii) Graphite is a very good conductor of electricity whereas diamond is a bad conductor of electricity.
- (viii) **Fullerenes** form another class of carbon allotropes. The first one to be identified was C-60, which has carbon atoms arranged in the shape of a football. Since this looked like the geodesic dome designed by the US architect Buckminster Fuller, the molecule was names fullerenes.
- Carbon atom is unique amongst all the elements that are found in nature. It can form long

chain molecules. The ability of carbon to form a long chain is called catenation. Carbon forms strong bond because of its small size which enables the nucleus to held on to the shared pairs of electrons strongly. The chains are formed because carbon atoms form tetravalent bonds with other carbon atoms. This structure can be repeated endlessly without disturbing the stability of the bonds and the compounds formed. The chains can form branches, and sub-branches. The carbon atoms also form rings.

- Catenation is also present in silicon (Si) with atomic number (Z) equal to 14. Its valence shell electronic configuration (2, 8, 4) is similar to carbon. However, only seven to eight atoms of the element can be linked by covalent bonds. It is because of smaller bond dissociation energy of Si—Si bond (200 kJ mol^{-1}) as compared to that of C—C bond. Therefore, the bonds in the silicon atoms are not as strong as in carbon atoms.
- In saturated compounds the valencies of all the carbon atoms are satisfied by single bonds between them. These compounds are very less reactive. e.g. C_2H_6 , C_3H_8 etc.
- While in the unsaturated compounds, the valencies of all the carbon atoms are not satisfied by single bonds, thus in order to satisfy their valencies, they form double or triple bond between the carbon atoms. They are more reactive than the saturated carbon compounds. e.g. C_2H_2 , C_2H_4 , C_3H_6 etc.

Straight Chain Compounds



The compounds which contain straight chain of carbon atoms are called straight chain compounds. e.g. normal butane (C_4H_{10}), normal pentane (C_5H_{12}) etc.

Branched Chain Compounds

Those compounds which are branched are called branched chain compounds. E.g. iso-butane (C_4H_{10}), isopentane (C_5H_{12}), neopentane (C_5H_{12}) etc.

Closed Chain Compounds or Ring Compounds

Cyclic compounds are called closed chain or ring compounds. E.g. cyclohexane (C_6H_{12}), cyclopentane (C_5H_{10}), cyclobutane (C_4H_8), cyclopropane (C_3H_6) etc.

Molecular Formula	Condensed formula, Structural formula	Bond line notation, Representation	Common Name
C_3H_6	$\begin{array}{c} CH_2 \\ \diagup \quad \diagdown \\ H_2C - CH_2 \end{array}$		Cyclopropane
C_5H_{10}	$\begin{array}{c} CH_2 \\ \diagup \quad \diagdown \\ H_2C \quad CH_2 \\ \diagdown \quad \diagup \\ H_2C - CH_2 \end{array}$		Cyclopentane

- All those compounds which contain just carbon and hydrogen are called hydrocarbons. Among these the saturated hydrocarbons are called alkanes and the unsaturated hydrocarbons containing double bonds are called alkenes, while the unsaturated hydrocarbons containing triple bonds are called alkynes.
- The atom or group of atoms which determine the properties of a compound is known as functional group. e.g. $-OH$ (alcohol), $-CHO$ (aldehyde), $>C=C<$ (alkene), $-C \equiv C-$ (alkyne) etc.
- A series of compounds in which the same functional group substitutes hydrogen in a carbon chain is called a homologous series. e.g. CH_3Cl and C_2H_5Cl differ by a $-CH_2$ unit, similarly C_2H_5OH and C_3H_7OH also differ by a $-CH_2$ unit.

HYDROCARBON ENERGY

Energy Resources

Natural Resources

These resources are given by nature like air, water, mineral, sunlight, etc.

Fuels

These are the substance which produce heat and light on combustion.

Coal

- It is believed to have been formed by the slow carbonisation of vegetable matter buried underneath the Earth from centuries ago, in limited supply of air under high temperature and pressure prevailing there.
- It is available in different varieties: Peat (60% C), lignite or brown coal (70% C) bituminous coal (80% C) and anthracite coal (90% C).
- Bituminous is the most common variety of coal. Coal is used for the synthesis of water gas and producer gas.

Petroleum

It is a dark coloured oily liquid with offensive odour. It is also called rock oil, mineral oil, crude oil or black gold.

When subjected to fractional distillation, it gives different products at different temperatures.

Liquefied Petroleum Gas (LPG)

It is a mixture of *n*-butane, *iso*-butane and some propane.

It is easily compressed under pressure as liquid and stored in iron cylinders.

A strong foul smelling substance called ethyl mercaptan, is added to LPG which detect the gas leakage.

Compressed Natural Gas (CNG)

It consists mainly of methane (95%) which is a relatively unreactive hydrocarbon and makes its nearly complete combustion.

It has octane rating 130.

Different Fuels, their Composition and Source

Fuel	Composition	Source
Water gas	Carbon monoxide (CO) + Hydrogen (H ₂)	By passing steam over red hot coke
Producer gas	Carbon monoxide (CO) + Nitrogen (N ₂)	by passing insufficient air over red hot coke
Oil gas	Methane (CH ₄) + Ethylene (C ₂ H ₄) + Acetylene (C ₂ H ₂)	By destructive distillation of kerosene
Coal gas	Hydrogen (H ₂) + Methane (CH ₄) + Ethylene + Acetylene + CO	by fractional distillation of wood
Natural gas	Methane (83%) + Ethane	From petroleum
LPG	Butane (C ₄ H ₁₀) + Propane (C ₃ H ₈)	From oil wells
Biogas or Gobar gas	Methane (CH ₄) + Carbon dioxide (CO ₂) + Hydrogen (H ₂) + Nitrogen (N ₂)	From organic wastes

