1. It is because of their malleability and ductility that metals can be given different shapes according to our needs. (Some metals are used for making cooking vessels)

2. Metals are good conductors of heat and have high melting points. (Some metals are used for making cooking vessels)

3. The wires that carry current in your homes have a coating of polyvinylchloride (PVC) or a rubber-like material. (Poor conductors)

4. The metals that produce a sound on striking a hard surface are said to be sonorous. (School bells are made of metals)

5. Gallium and caesium have very low melting points. These two metals will melt if you keep them on your palm.

6. Diamond, an allotrope of carbon, is the hardest natural substance known and has a very high melting and boiling point. (Cutting & grinding tools)

Graphite, another allotrope of carbon, is a conductor of electricity. (Electrodes)

7. Metal oxides which react with both acids as well as bases to produce salts and water are known as amphoteric oxides. Example: Aluminium oxide, Zinc oxide.

Aluminium oxide reacts in the following manner with acids and bases –

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$$

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

8. Most metal oxides are insoluble in water but some of these dissolve in water to form alkalis.

Sodium oxide and potassium oxide dissolve in water to produce alkalis as follows –

$$Na_2O(s) + H_2O\ (l) \rightarrow 2NaOH\ (aq)$$

$$K_2O(s) + H_2O\ (l) \rightarrow 2KOH\ (aq)$$

9. Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.

10. At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide. The protective oxide layer prevents the metal from further oxidation.

11. Iron does not burn on heating but iron filings burn vigorously (sparkling) when sprinkled in the flame of the burner. (As the surface area increases the rate of reaction also increases)

12. Copper does not burn, but the hot metal is coated with a black coloured layer of copper (II) oxide.

$$2Cu + O_2 \rightarrow 2CuO$$

13. Silver and gold do not react with oxygen even at high temperatures. (***Noble metals***)

14. Metals react with water and produce a metal oxide and hydrogen gas.

Metal oxides ***that are soluble in water*** dissolve in it to further form metal hydroxide.

Metal + Water → Metal oxide + Hydrogen and, **Metal oxide + Water → Metal hydroxide**

$$2K(s) + 2H_2O\ (l) \rightarrow 2KOH\ (aq) + H_2\ (g)$$

$$2Al(s) + 3H_2O\ (g) \rightarrow Al_2O_3\ (s) + 3H_2\ (g)$$

15. The reaction of calcium with water is less violent. The heat evolved is not sufficient for the hydrogen to catch fire.

$$Ca(s) + 2H_2O\ (l) \rightarrow Ca\ (OH)_2\ (aq) + H_2\ (g)$$

Calcium ***starts floating*** because the bubbles of hydrogen gas formed stick to the surface of the metal.

NOTE: - Magnesium does not react with cold water. It reacts with hot water to form magnesium hydroxide and hydrogen. It also starts floating due to the bubbles of hydrogen gas sticking to its surface.

16. Hydrogen gas is ***not evolved*** when a metal reacts with nitric acid.

It is ***because***; HNO_3 is a strong oxidizing agent. It oxidizes the H_2 produced to water and itself gets reduced to any of the nitrogen oxides (N_2O, NO, NO_2).

NOTE: -Magnesium (Mg) and manganese (Mn) react with very dilute HNO_3 to evolve H_2 gas.

17. Sample Reactivity Series [eg, reaction with HCl (aq)]: **Mg > Al > Zn > Fe > Cu**.

When copper reacts with HCl (aq),

a. no bubbles (of H_2 gas) were seen.

b. the temperature also remained unchanged.

The rate of formation of bubbles was the fastest in the case of magnesium. The reaction was also the most exothermic in this case.

18. Noble gases, which have a ***completely filled*** valence shell, show ***little*** chemical activity. Therefore, the reactivity of elements can be as ***a tendency to attain a completely filled valence shell.***

19. Sodium and chloride ions, being oppositely charged, attract each other and are held by strong electrostatic forces of attraction to exist as sodium chloride (NaCl). It should be noted that sodium chloride does not exist as molecules but aggregates of oppositely charged ions. (***Ionic compounds have 3 D crystal lattice structure***)

20. Ionic compounds are solids and are somewhat hard because of the strong force of attraction between the positive and negative ions.

21. Ionic compounds have high melting and boiling points. This is because a considerable amount of energy is required to break the strong inter-ionic attraction. (***Ionic compounds have 3 D crystal lattice structure***)

22. Electrovalent compounds are generally soluble in water (polar in nature) and insoluble in (non-polar) solvents such as kerosene, petrol, etc. (***Like Dissolves Like***)

23. The conduction of electricity through a solution involves the movement of charged particles. A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution. Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure. But ionic compounds conduct electricity in the molten state. This is possible in the molten state since the electrostatic forces of attraction between the oppositely charged ions are overcome due to the heat. Thus, the ions move freely and conduct electricity.

24. Some metals are found in the earth's crust in the free state. Some are found in the form of their compounds. The metals at the bottom of the activity series are the least reactive. They are often found in a free state. For example, gold, silver, platinum and copper are found in the free state.

25. The metals at the top of the activity series (K, Na, Ca, Mg and Al) are so reactive that they are never found in nature as free elements.

26. The metals in the middle of the activity series (Zn, Fe, Pb, etc.) are moderately reactive. They are found in the earth's crust mainly as oxides, sulphides or carbonates.

27. The ores of many metals are oxides. This is because oxygen is a very reactive element and is very abundant on the earth.

28. Ores mined from the earth are usually contaminated with large amounts of impurities such as soil, sand, etc., called gangue. The impurities must be removed from the ore prior to the extraction of the metal. The processes used for removing the gangue from the ore are based on the differences between the physical or chemical properties of the gangue and the ore. Different separation techniques are accordingly employed.

29. Metals low in the activity series are very unreactive. The oxides of these metals can be reduced to metals by heating alone. For example, cinnabar (HgS) is an ore of mercury.

$$2HgS(s) + 3O_2\,(g) \rightarrow 2HgO(s) + 2SO_2\,(g)$$

Mercuric oxide is then reduced to mercury on further heating.

$$2HgO(s) \rightarrow 2Hg\,(l) + O_2\,(g)$$

30. It is easier to obtain a metal from its oxide, as compared to its sulphides and carbonates. Therefore, prior to reduction, the metal sulphides and carbonates must be converted into metal oxides.

The sulphide ores are converted into oxides by heating strongly in the presence of excess air. This process is known as roasting.

$$2ZnS(s) + 3O_2\,(g) \rightarrow 2ZnO(s) + 2SO_2\,(g)$$

The carbonate ores are changed into oxides by heating strongly in limited air. This process is known as calcination.

$$ZnCO_3\,(s) \rightarrow ZnO(s) + CO_2\,(g)$$

31. These displacement reactions are highly exothermic. The amount of heat evolved is so large that the metals are produced in the molten state. In fact, the reaction of iron (III) oxide (Fe_2O_3) with aluminium is used to join railway tracks or cracked machine parts. This reaction is known as the thermit reaction.

$$Fe_2O_3\,(s) + 2Al(s) \rightarrow 2Fe\,(l) + Al_2O_3\,(s) + Heat$$

32. Carbon cannot reduce the oxides of sodium, magnesium, calcium, aluminium, etc., to the respective metals.

OR

The metals high up in the reactivity series are very reactive. They cannot be obtained from their compounds by heating with carbon.

This is because these metals have more affinity for oxygen than carbon.

33. The metals high up in the reactivity series being very reactive are obtained by electrolytic reduction.

For example, sodium, magnesium and calcium are obtained by the electrolysis of their molten chlorides.

The metals are deposited at the cathode (the negatively charged electrode), whereas, chlorine is liberated at the anode (the positively charged electrode). The reactions are –

At cathode: - $Na^+ + e- \rightarrow Na$

At anode: - $2Cl^- \rightarrow Cl_2 + 2e^-$

NOTE: - Aluminium is obtained by the electrolytic reduction of aluminium oxide.

34. The metals produced by various reduction processes described above are not very pure. They contain impurities, which must be removed to obtain pure metals. The most widely used method for refining impure metals is electrolytic refining.

35. The silver articles become black due to the formation of a thin silver sulphide layer on their surface by the action of hydrogen sulphide gas present in air.

Copper reacts with moist carbon dioxide in the air and slowly loses its shiny brown surface and gains a green coat. This green substance is (basic) copper carbonate.

Iron when exposed to moist air for a long time acquires a coating of a brown flaky substance called rust.

36. Galvanization is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc. The galvanized article is protected against rusting even if the zinc coating is broken.

37. Alloying is a very good method of improving the properties of a metal. For example, iron is the most widely used metal. But it is never used in its pure state. This is because pure iron is very soft and stretches easily when hot. But, if it is mixed with a small amount of carbon (about 0.05 %), it becomes hard and strong. When iron is mixed with nickel and chromium, we get stainless steel, which is hard and does not rust.

38. The electric current is carried through aqueous solutions by ions. Therefore, aqueous solutions of acids & alkalis conduct electricity. Glucose and alcohol solutions do not conduct electricity because they do not give ions in aqueous solution. Glucose & alcohol are covalent compounds.

$$HCl\ (l) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + Cl^-\ (aq)$$

$$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$$

$$KOH(s) \xrightarrow{H_2O} K^+(aq) + OH^-(aq)$$

$$Mg(OH)_2(s) \xrightarrow{H_2O} Mg^{2+}(aq) + 2OH^-(aq)$$

NOTE: - Acidic and basic solutions in water conduct electricity because they produce hydrogen and hydroxide ions respectively.

39. Care must be taken while mixing concentrated nitric acid or sulphuric acid with water. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid,

a. the heat generated may cause the mixture to splash out and cause burns.

b. The glass container may also break due to excessive local heating.

40. Mixing an acid or base with water results in decrease in the concentration of ions (H_3O^+/OH^-) per unit volume. Such a process is called dilution & the acid or the base is said to be diluted.

41. The strength of acids and bases depends on the number of H^+ ions and OH^- ions produced, respectively.

42. Strong acids are fully ionized but weak acids do not undergo complete ionization in aqueous solution. ***At the same concentration***, strong acids have a higher concentration of hydrogen ions than weak acids.

43. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.

44. During ***indigestion*** the stomach produces ***too much*** hydrochloric acid and this causes pain and irritation. To get rid of this pain, people use *bases called antacids*. These antacids neutralize the excess acid. Magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose.

NOTE: - Sodium hydrogen carbonate is also an ingredient in antacids. Being alkaline, it neutralizes excess acid in the stomach and provides relief.

45. Tooth decay starts or tooth enamel (calcium phosphate) gets corroded when the pH of the mouth is lower than 5.5. Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating. The best way to prevent this is to clean the mouth after eating food. Using toothpastes, which are generally basic, for cleaning the teeth can neutralize the excess acid and prevent tooth decay.

46. Bee-sting leaves an acid which causes pain and irritation. Use of a mild base like baking soda on the stung area gives relief. Stinging hair of nettle leaves inject methanoic acid causing burning pain. A traditional remedy is rubbing the area with the leaf of the dock plant, which often grows beside the nettle in the wild.

47. Salts of a strong acid and a strong base are neutral with pH value of 7. On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7 and those of a strong base and weak acid are basic in nature, with pH value more than 7.

48. Baking powder is a mixture of baking soda (sodium hydrogen carbonate) and a mild edible acid such as, citric acid, tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place –

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.

49. Sodium carbonate can be obtained by heating baking soda; ***recrystallisation*** of sodium carbonate gives washing soda. It is also a basic salt.

$$Na_2CO_3 + 10\ H_2O \rightarrow Na_2CO_3.10\ H_2O$$

50. Only half a water molecule is shown in the chemical equation attached as water of crystallization. It means that two formula units of $CaSO_4$ share one molecule of water.

$$CaSO_4 .\underline{\frac{1}{2}H_2O} + 1\ \frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O$$

Plaster of Paris is a white powder and on mixing with water, it changes to gypsum once again giving a hard solid mass.

51. Covalently bonded molecules are seen to have strong bonds within the molecule, but intermolecular forces are small. This gives rise to the low melting and boiling points of these compounds. Since the electrons are shared between atoms and no charged particles are formed, such covalent compounds are generally poor conductors of electricity.

52. Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation. These compounds may have long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings. The carbon-carbon bond is very strong and hence stable. This gives us the large number of compounds with many carbon atoms linked to each other.

53. The bonds that carbon forms with most other elements like, oxygen, hydrogen, nitrogen, sulphur, chlorine, etc., are very strong making these compounds exceptionally stable. One reason for the formation of strong bonds

by carbon is its small size. This enables the nucleus to hold on to the shared pairs of electrons strongly. The bonds formed by elements having larger atoms are much weaker.

54. Saturated hydrocarbons will generally give a clean flame while unsaturated carbon compounds will give a yellow flame with lots of black smoke. This results in a sooty deposit on the metal plate.

55. However, limiting the supply of air results in incomplete combustion of even saturated hydrocarbons giving a sooty flame. The gas/kerosene stove used at home has inlets for air so that a sufficiently oxygen-rich mixture is burnt to give a clean blue flame. (The bottoms of cooking vessels getting blackened, it means that the air holes are blocked and fuel is getting wasted.)

56. Fuels such as coal and petroleum have some amount of nitrogen and sulphur in them. Their combustion results in the formation of oxides of sulphur and nitrogen which are major pollutants in the environment.

57. Vegetable oils generally have long unsaturated carbon chains while animal fats have saturated carbon chains. Hydrogenation of vegetable oils using a nickel catalyst is carried out so that hydrogen atoms get added up across some of the double bonds (reactive centres) between carbon atoms. As a result vegetable oil gets converted to vanaspati ghee (DALDA). Hydrogenation process improves the shelf life of oils.

58. Animal fats generally contain saturated fatty acids which are said to be harmful for health. Oils containing unsaturated fatty acids should be chosen for cooking.

59. Ethanol being a good solvent, it is also used in medicines such as tincture iodine, cough syrups, and many tonics.

60. Reaction to give unsaturated hydrocarbon: Heating ethanol at 443 K with excess concentrated sulphuric acid results in the dehydration of ethanol to give ethene –

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[443\,K]{\text{conc.}H_2SO_4} \underset{\text{Ethene}}{CH_2{=}CH_2} + \underset{\text{Water}}{H_2O}$$

Concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol.

61. The melting point of pure ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid.

62. The charged ends of detergents do not form insoluble precipitates with the calcium and magnesium ions in hard water. Thus, they remain effective in hard water. Detergents are usually used to make shampoos and products for cleaning clothes.

63. At a higher concentration a soap solution acts as a colloid (associated colloid) in which the soap micelles scatter light. Hence a soap solution appears cloudy.

64. Most carbon compounds also release a large amount of heat and light on burning. (They are used as fuels)