

CHEMICAL REACTIVITY

8

MULTIPLE CHOICE QUESTIONS

METALS

1. Na is the member of period
(a) 1st (b) 2nd
(c) 3rd (d) 4th
2. Alkali and alkaline earth metals include
(a) KJ/mole (b) Mole
(c) JK/mole (d) None of these
3. Magnesium react with
(a) Steam (b) Cold water
(c) Hot water (d) Both a and b

ELECTRONEGATIVITY

4. The electronegative and non-metallic character from top to bottom:
(a) Increases (b) Decreases
(c) Remain same (d) stable
5. The electronic configuration of halogens is
(a) $ns^2 np^5$ (b) $ns^2 np^3$
(c) $ns^3 np^5$ (d) $ns^2 np^2$
6. Non-metals are electronegative in nature and form oxides.
(a) acidic (b) basic
(c) neutral (d) suboxide
7. The highest electronegative element in periodic table is
(a) fluorine (b) chlorine
(c) bromine (d) iodine
8. Sodium is a
(a) Soft metal (b) Hard metal
(c) Hot metal (d) None of these

9. Sodium react with
- (a) Ca
(b) ~~H₂O~~
(c) HO
(d) None of these

ALKALI AND ALKALINE EARTH METALS

10. Magnesium react with
- (a) ~~Steam~~
(b) water
(c) Calcium
(d) Both a and c
11. All alkali metals have the largest size and the lowest in their respective periods.
- (a) Electro negativity
(b) ~~Ionization energy~~
(c) Electron affinity
(d) Electropositivity

ELECTRO POSITIVE CHARACTER

12. Metals have tendency to lose their valence electrons. This property of metal is termed as
- (a) Electro negativity
(b) ~~Electro positivity~~
(c) electron affinity
(d) Ionization power
13. Silver is an
- (a) ~~Excellent conductor~~
(b) Utensil
(c) Both a and b
(d) None of these

NON METALS

14. Non metal are generally
- (a) Metals
(b) ~~Gases~~
(c) Solids
(d) Liquid
15. Elements that conduct heat and electricity poorly are called
- (a) Metal
(b) Non metal
(c) Solid
(d) ~~None of these~~
16. A metal in a compound always exists in which oxidation state
- (a) Negative
(b) ~~Positive~~
(c) Neutral
(d) Zero
17. Ionization energy of sodium is less than
- (a) Aluminum
(b) ~~Magnesium~~
(c) Copper
(d) All of these
18. Elements that conduct heat and electricity or attached in order to make a pattern called circuit
- (a) ~~Metal~~
(b) Non metal
(c) ~~Catalyst~~
(d) None of these

19. Chip contains
 (a) Million of working part (b) Thousand of working part
 (c) Hundred of working part (d) Both a & b
20. Which one of the following non-metal is lustrous?
 (a) Sulphur (b) Phosphorus
 (c) Iodine (d) Carbon
21. Non-metals are generally soft, but which one of the following is extremely hard?
 (a) Graphite (b) Phosphorus
 (c) Iodine (d) Diamond
- COMPARISON OF REACTIVITY OF HALOGENS**
22. All the halogens react with metal to form salt called
 (a) Halogen ion (b) Halids
 (c) Halogen (d) Oxidation
23. Sodium metal react with Cl gas to form.
 (a) Halides (b) Sodium Chloride
 (c) Sodium ion (d) None of these
24. The acidic strength increase in the following
 (a) $HF < HCl < HBr < HI$ (b) $HCl < HF < HBr < HI$
 (c) $HI < HF < HBr < HCl$ (d) None of these
25. Chlorine only reacts with methane in
 (a) darkness (b) sunlight
 (c) yellow light (d) screened light
26. These are highly oxidizing agents
 (a) alkali metals (b) alkaline earth metals
 (c) transition metals (d) halogens
27. The highest electronegative element in periodic table is
 (a) fluorine (b) chlorine
 (c) bromine (d) iodine

ANSWER KEY

Q.	Ans	Q.	Ans	Q.
1	c	11	b	21
2	a	12	b	22
3	a	13	a	23
4	b	14	b	24
5	a	15	b	25
6	a	16	b	26
7	a	17	d	27
8	a	18	c	
9	b	19	a	
10	a	20		

SHORT QUESTIONS**ALKALI AND ALKALINE EARTH METALS**

Q.1 Comparison of Alkali metals and alkaline earth metals.

Ans: **Comparison of Alkali and Alkaline earth Metals:**

Alkali Metals:

Alkali metals have general electron

Configuration ns^1 in their valence shell

Alkaline Earth Metal :

Alkaline earth metals electrons

Configuration ns^2 in their valence Shell

Q.2 Why alkali metals are more reactive than alkaline earth metals?

Ans: Alkali metals are more reactive than alkaline earth metals because alkali metals have the valency electrons. This property of metal is called metallic character or electropositivity.

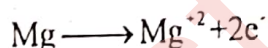
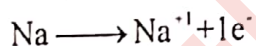
Example:

Metallic increases from top to bottom and decreases from left to right as sodium is less electropositive than potassium.

ELECTRO POSITIVE CHARACTER

Q.3 Define Electropositive.

Ans: The tendency of metal to lose electron is called electropositivity.



Q.4 Give the example of Normal oxide.

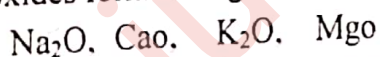


Ans:



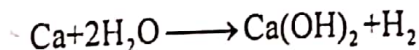
Q.5 What is the nature of metal oxide?

Ans: When metals react with oxygen. They form oxides which are basic in nature because these oxides form strong alkalies in water. E.g.

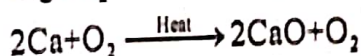
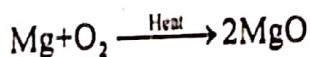


Q.6 Why Ca is more reactive than Mg

Ans: Mg and Ca are the most common alkaline earth metal they are relatively reactive but less reactive than alkali metals. Mg reacts with steam but Ca reacts with cold water.



Mg react with oxygen high temperature whereas ca reacts with oxygen at room temperature.



Hence Ca is a more reactive than Mg.

Q.7 What is the melting and boiling point of Na.

Ans: Melting point is 97.8°C and boiling point is 881.4°C .

Q.8 Name the best ductile and malleable metal?

Ans: The most best ductile and malleable metal is gold.

Q.9 What do you mean by malleable and ductile?

Ans: **Malleable:-** Malleability is the property of metals. Malleable mean metal can be hammered and converted into sheets.

Ductile: Metals are also ductile because they can be drawn into wires.

IMPORTANCE OF Ag, Au, Pt

Q.10 Importance of the platinum compounds.

Ans: A platinum compound called Cis-platin is useful as an anti cancer agent.

Q.11 What is Rolled Gold.

Ans: Rolled Gold is a thin layer of Gold that is bonded onto brass nickel-silver alloy.

Q.12 What is Aqua Regia

Ans: Aqua regia is mixture of three parts by volume of HCl and one part by volume of concentrate HNO_3 .

Q.13 Give the applications of silver?

Ans. Following are the important applications of silver.

(a) Alloys of copper with silver are widely used in making coins.

Silver used in ornaments and in jewelry.

(b) Silver has also important application in mirror industry.

Q.14 Why platinum is used for making jewelry?

Ans. Platinum is used to make jewelry items because of its unique characteristics like colour, beauty, strength, flexibility and resistance to tarnish. It provides a secure setting for diamonds and other gemstones, enhancing their brilliance.

Q.15 How platinum is used as a catalyst in automobiles and what are the advantages of this use?

Ans. Platinum alloyed with palladium and rhodium are used as catalyst in automobiles as catalyst converter.

Q.16 Discuss function of Silicon chip?

Ans: Computer exist because of an amazing invention called the integrated circuit known as the silicon chip or just chip.

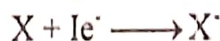
ELECTRONEGATIVE CHARACTER

Q.17 Define electronegative character and discuss its trend in period

Ans: Electronegative character is the reverse of electropositive character it is the tendency to gain electron to form anions.

Trend in Period.

As you move from left to right across a period, the tendency to gain electron increase.



Reason:-

This is due to increase in nuclear charge and is atomic size.

Q.18 Why fluorine is more non-metallic than chlorine?

Ans. Small size elements having high nuclear charge, more electronegative in nature and have high electron affinity. Fluorine is the first member of group. Non- Metallic character decrease down the group. That is why, fluorine is more electronegative and non-metallic character in nature as compared to chlorine.

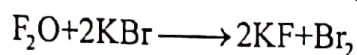
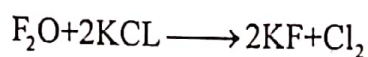
Q.19 Why the oxygen is called non-metal?

Ans. Non-metals form negative ions (anions) by gaining electrons oxygen atom can accept 2 electrons, therefore its valency is 2. $O + 2e^- \longrightarrow O^{-2}$

COMPARISON OF REACTIVITY OF HALOGENS

Q.20 Discuss the oxidizing nature of F_2

Ans: It means F_2 can oxidizes all the halides ions into the free halogens for example.



Q.21 Why fluorine is more non-metallic than chlorine?

Ans. Small size elements having high nuclear charge, more electronegative in nature and have high electron affinity. Fluorine is the first member of group. Non-Metallic character decrease down the group. That is why, fluorine is more electronegative and non-metallic character in nature as compared to chlorine.

Q.22 Name the most abundant non-metal in the earth's crust

Ans. Oxygen has the highest percentage in earth's 47% and in oceans 86% but 2nd highest in percentage of oxygen in atmosphere 21%.

Q.23 Why do the non-metals accept electrons readily?

Ans. Non-metals accept electrons readily because they are usually electron deficient in nature. So they form an anion by gaining electrons.

LEARNING OUTCOMES

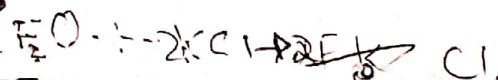
Understanding:

Students will be able to:

- Show how cations and anions are related to the terms metals and non-metals. (Analyzing)
- Explain why alkali metals are not found in the free state in nature. (analyzing)
- Identify elements as an alkali metal or an alkaline earth metal. (Applying)
- Explain the differences in ionization energies of alkali and alkaline earth metals. (understanding)
- Describe the position of sodium in periodic table, its simple properties and uses. (understanding)
- Differentiate between soft and hard metals (iron and sodium). Analyzing)
- Describe the inertness of noble metals. (understanding)
- Identify the commercial value of silver, Gold and platinum. (Analyzing)
- Compile some important reactions of halogens. (Applying)
- Name some elements, which are found in uncombined state in nature. (understanding)

MAJOR CONCEPTS

- 8.1 Metals
- 8.2 Non-Metals
- 8.1 Metals



LONG QUESTIONS

- Q.1** (a) What is meant by chemical reactivity? How it is related to outermost electrons in atoms?
(b) What is the role of chemical reaction in chemistry?

Ans:

(a) Chemical Reactivity

An atom or molecules are electrically neutral species because each atom or molecule having same number of charge particles i.e. electrons and protons. An atom (metals or non metals) tries for getting nearest noble gas structure (for getting stability either by the loss of electron (s) or by the gain of electron (s) by involving valence electrons. The easiest way in which an atom (metal) loses an electron (s) from outermost shell or an atom (non-metal) gain an electron in an outer most shell is called chemical reactivity and the species will be called reactive in nature. E.g. In the periodic table, 1A group elements (Li, Na, K) contains one valence electron, so easily loses and change into Li^{+1} , Na^{+1} , K^{+1} becomes most reactive metals while VIIA group elements (F, Cl, Br, I) contains seven valence electron, so easily gain electron and change into F^{-1} , Cl^{-1} , Br^{-1} , I^{-1} becomes most reactive non metals.

(b) Role of Chemical Reaction In Chemistry

Chemical reaction are heart and soul of chemistry, which is explained with the help of the following example.

- (i) An iron (metal) is reactive metal as compared to Gold or platinum can react easily with moist air and forms rust.
- (ii) Copper is one of the important metal is widely used for making electrical cables, ornaments, coins and Brass, Bronze Alloys etc. When low grade copper ores is treated with dil H_2SO_4 then CuSO_4 solution is formed from which pure copper metal is obtained with the chemical reaction of iron. The iron is more reactive than copper so displace copper from CuSO_4 solution while copper cannot displace iron because less reactive.
- (iii) Iodine is an essential element for thyroid gland and an important disinfectant. It is used for making tincture which is commercially prepared by the oxidation of iodide salt by Cl_2 . Cl_2 and Br_2 are more reactive than iodine so easily displace iodine from its salt.

Q.2 Define metals, non metals and metalloids. Give example of each.

Ans: Metals:

Those elements which have ability to conduct heat and electricity and easily lose electron (s) are called metals. E.g. Iron, Gold, Silver etc.

Non-Metals: Those elements which don't have the ability to conduct heat and electricity and easily gain electron (s) are called non-metals.

e.g. Sulphur Phosphorous, carbon etc.

Metalloids:

Those elements which have both the properties of metals and non metals are called metalloids.

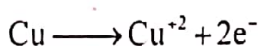
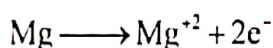
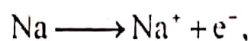
e.g. Silicon, Germanium, Boron etc.



- Q.3 (a) What is meant by electropositive character?
 (b) Why electropositive increases in a Group and decreases in a period?
 (c) Why chemical Reactivity of metals with oxygen increases in a group while decrease in a period?
 (d) Discuss the trends in electropositive from the nature of the oxides.

Ans: (a) **Electropositive character/electropositivity**

The Tendency of an element to lose electron (s) and form positive ions (cations) is called electropositive character or electropositivity. Metals like sodium, magnesium and copper etc are electropositive in nature.



Generally $\text{M} \longrightarrow \text{M}^{+n} + n\text{e}^-$ Where "M" stands for any metal.

(b) Electropositivity down the group increases because of increase of atomic size and decreases of ionization energy. Thus less energy is required down the group to remove electrons (s) e.g: Na is more electropositive than Li because size of sodium is more than that of Lithium. Similarly in IIA group, Mg is more electropositive than Be.

On the other hand, the tendency to lose electron decreases as we move from left to right in a same period because of decrease of atomic size and increase of ionization energy.

e.g; In second period, Li, Be are metals, B is metalloid where as C, N, O, F, are non metals.

(c) The electropositive trend is also reflected in chemical reactivity of metals. In a group; the reactivity of metals with oxygen increases because of increase of atomic size and increase in affinity on exposure to air e.g; Lithium forms normal oxide with oxygen (oxidation No. -2)



Sodium forms per oxide with oxygen (oxidation No. -1)



And K, Rb, Cs form super oxides with oxygen (oxidation No. $-\frac{1}{2}$)

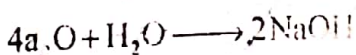
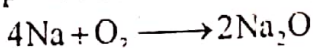


On the other hand, in a period from left to right, the reactivity of metals with oxygen decreases because of decrease of atomic size and increase of ionization energy.

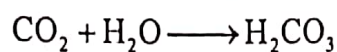
e.g.; In the third period, Na readily reacts with oxygen to form sodium oxide, at room temperature, Mg reacts on ignition and Al on heating. It is superficially oxidized at room temperature. To form Al_2O_3 which serves as a protective covering that prevents further reaction and Al become passive.

(d) **Nature of the oxides**

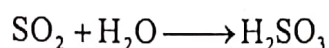
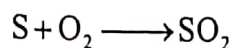
Metals oxides are generally basic in character because metal oxides dissolved in water produces bases.



Non-metallic oxides are generally acidic because their oxides when dissolved in water produces acids



e.g:



Thus nature of the oxides trend in a same period move from strongly basic to basic, amphoteric, weakly acidic, acidic and finally very strong acidic in nature as shown in the table.

Nature of oxides of elements in the period No.3

On the other hand basic character of metal oxides of main group elements increase down the group. For example, in group IIA, the basic character of oxides increases in the following order.



Group	IA	IIA	IIIA	IVA	VA	VIA	VIIA
3 rd period	Na	Mg	Al	Si	P	S	Cl
Oxide	NaO	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₂	Cl ₂ O ₇
Nature of oxide	Strongly Basic	Basic	Amphoteric both acidic and basic	Weakly Acidic	Acidic	Strongly Acidic	Very Strongly acidic

Example:

Identifying the more metallic element in a pair of elements.

In each of the following pairs of elements, identify which element is more metallic

- (a) Na, K (b) Be, Na

Problem Solving Strategy:

Apply the trends of increasing electropositive character down a group and decreasing electropositive character across a period. Check the periodic table to see which elements is more metallic.

Solution:

(a) K is more metallic

(b) Na is more metallic

Q.4 Define Alkali and Alkali earth metals with examples.

What is the position of Alkali and Alkaline earth metals in the periodic table?

Compare the Reactivity of both metals.

Ans: (a)

Alkali Metals	Alkaline Earth metals
The elements of group IA except hydrogen are called Alkali metals. These metals include the elements lithium, sodium, potassium, Rubidium cesium and francium. These are very reactive metals, produce strong alkaline	The elements of group IIA (Beryllium Magnesium, Calcium, Strontium, Barium and Radium) are called Alkaline earth metal because these metals are extracted from earth crust and their solutions in water are alkaline in

solutions with water.	nature
$4\text{Na} + \text{O}_2 \longrightarrow 2\text{Na}_2\text{O}$	$2\text{Ca} + \text{O}_2 \longrightarrow 2\text{CaO}$
$\text{Na}_2\text{O} + \text{H}_2\text{O} \longrightarrow 2\text{NaOH}$	$\text{CaO} + \text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2$
Alkali means water soluble base	

(b) Position of Alkali and Alkaline Earth metals

Alkali metals have general electronic configuration ns^1 in their valence shell. "n" indicate the number of period (shell), "s" block of periodic table and "1" indicate the 1st group of this block (valence electron) while alkaline earth metals have general electronic configuration ns^2 in their valence shell, "2" indicate the 2nd group of this block (valence electrons)

(c) Comparison of Reactivity of both metals

The alkali metals contains one valence electron easily lost by applying small ionization energy so called reactive in nature as compare to alkaline earth metals which contains two valence electrons which required high energy than alkali metals. Hence alkali metals are more reactive than alkaline earth metals. Their reactivity down the group increase because of the increase of atomic size.

Q.5 (a) Define ionization energy. Discuss the trend of ionization energy of Alkali and alkaline earth metals in a periodic table.

(b) Why alkali metals are kept under a kerosene oil?

Ans: Ionization Energy:

It is the minimum amount of energy which is required to remove the most loosely bounded electron from the outer most orbital in its isolated state. It is abbreviated as I.E and measured in KJ/mole.

Variation of I.E values in the periodic table:

I.E values vary systematically in periods and Groups as shown in the table.

Variation in period:

As we go from left to right in a same period, I.E values increase because of decrease of atomic size and increasing nuclear charge. Hence reactivity decreases in a period.

Variation In a Group

I.E values decreases down the group because of the increasing atomic size. Reactivity of both groups element increase down the group as shown in the table.

(b) The alkali and alkaline earth metals show increased reactivity down the group. They are all so reactive that they may react with air or moist air at room temperature, so they are kept under a inert atmosphere or liquid such as kerosene oil.

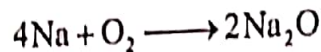
Q.6 What are the properties of some alkali and alkaline earth metals?

Justify that potassium superoxide (KO_2) is useful in breathing equipment for mountaineers.

Ans: (a) Important properties of some Alkali metals.

The most alkali metals in sodium. It is a soft metal can be cut with a knife and given silvery look. It melt at 97.8°C and boils at 881.4°C . Sodium atoms have weak metallic bond because of the presence of one valence electron. It is an extremely reactive metal can react with water violently to sodium Hydroxide and liberates Hydrogen gas $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$. This reaction is highly exothermic and proceeds with explosion. For this reason it should not be picked with fingers. In a limited supply of

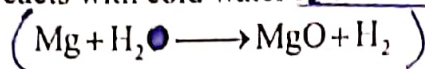
oxygen, sodium burns to form sodium oxide (Na_2O). But in excess, it forms yellow solid sodium per oxide (Na_2O_2)



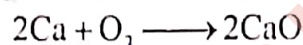
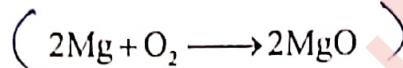
Sodium mixed with potassium to forms a liquid Alloy that is used as a coolant in nuclear reactors. Sodium is also used in sodium lamps to illuminate highways. The petroleum industry utilizes sodium in the production of antiknock compounds for gasoline.

Important Properties of Alkaline Earth Metals

Mg and Ca involve two electrons in metallic bonding. Therefore these metals are relatively soft but are harder than alkali metals. They are also reactive but less than alkali metals. Mg react with steam but Ca reacts with cold water releases H_2 gas



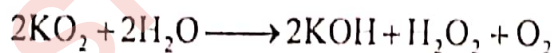
Mg reacts with oxygen at high temp. Whereas Ca reacts with oxygen at room temperature.



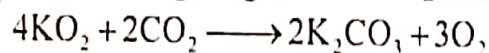
Hence Ca is more reactive than Mg. (Mg has relatively low density and used in making light weight alloy with Aluminium that are used for making frames of automobiles, air craft and spaceship etc. Mg burns brilliantly with white smoke, it is used in photoflash guns. $\text{Mg}(\text{OH})_2$ called milk of magnesia is commonly used as antacid.)

Ca is an important component of teeth and bones. Ca^{+2} are found in all living cells. They are involved in clotting of blood.

- (b) Potassium in excess air, forms potassium super oxide (KO_2) which react with water to give oxygen gas.



This reaction is utilized in breathing equipments for mountaineers and in space craft. It has the ability to absorb CO_2 while giving out fresh O_2 at the same time.



This fresh O_2 used by mountaineers.

- Q.7** (a) Describe inertness of Noble metals.
 (b) Strontium -90 is dangerous for health justify.
 (c) Why copper, silver and Gold have been used for jewellery and Coins.
 (d) What is Carat? Which metals is used as a standard for world currency?

Ans: (a) Inertness of Noble metals.

The chemistry of metals is characterized by their ability to lose electrons to form cations. Some metals such as copper, gold, silver and platinum are relatively difficult to oxidize. Therefore, these metals are often called Noble Metals.

- Gold and platinum exist mostly as free element in nature.
 - Copper and silver exist in both free and combined states.
 - All active metals react with HCl but noble metals do not
 - Copper and silver react with strong oxidizing agents such as conc. HNO_3 and HClO_4
- Gold and (platinum react only with aqua regia (mixture of HCl: HNO_3 with 3:1)

(b) Use of strontium-90

Strontium-90 (Atomic mass of strontium isotope), a radioactive isotope, is a major product of an atomic Bomb explosion. Constant exposure of the body to high energy radiations emitted by Sr-90 can lead to anaemia, leukemia and other chronic illnesses.

(c) Copper, silver and gold have beautiful high luster and malleability. Due to these properties, these metals have been used for thousands of years to make jewellery, Coins, alloys etc.

(d) Carat

Carat is the standard of purity of Gold. So Gold is the standard of world currency. The purity of gold is expressed in Carat. So carat is defined as, the number of parts of Gold in 24 parts of the alloy is called one Carat. 24 Carat gold is pure Gold coinage gold is 22 carat or $\frac{22}{24} \times 100 = 92\%$ Gold.

In Pakistan, Coins are made from cupro-nickel alloy. Rolled Gold is a thin layer of Gold Alloy that is bonded on to brass or Nickel-silver alloy.

Q.8 What are the uses of Gold, Platinum, and silver?

Ans: Uses of Gold

1. It is used for making ornaments. For this purpose it is alloyed with copper. The purity of gold alloy is expressed in carat. Carat is defined as the number of parts of gold in 24 parts of the alloy. 24 carat gold is pure gold.
2. Gold salts are used in photography.
3. One form of colloidal gold i.e, purple of casius is used for coloring glass and enamels.
4. Gold is the standard of world currency.
5. Gold alloys are extensively used in dentistry.
6. Salts of Gold are used to treat rheumatoid arthritis.

Uses of Silver

1. Silver is used in jewellery.
2. It is used in making coins since ancient times.
3. The compounds of silver are used in making photographic plates (Ag_2S is used in photographic plates) and silver plating.
4. Silver leaves are used in medicines.
5. Silver amalgam is used in silvering of mirrors and in filling teeth.
6. It is used for making utensils.

Uses of platinum

1. Platinum finds many applications in electrical and medical fields.
2. It is used in spinneret nozzles, special laboratory vessels, etc., usually in the form of alloys with other members of the group.
3. Platinum and its alloys are used in dentistry, jewellery manufacture and in the electrical and chemical industries.
4. It is used in industrial processes as catalysis e.g. in the manufacture of 100% pure H_2SO_4 , in contact process and in the preparation of HNO_3 in Ostwald process.
5. It is used as electrode as a part of Hydrogen electrode and in fuel cells.
6. In automobile exhaust, platinum converters are equipped inside which catalyzed the complete combustion of CO_2 and Hydrocarbons into CO_2 and reduces the air pollution.
7. A platinum compound called Cis-platin is useful as an anticancer agent.

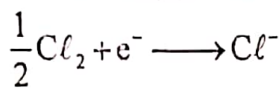
Chapter-8

Q.9 What are characteristics of electronegative elements and how do their character vary in groups and periods?

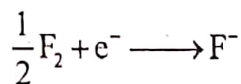
Ans: Electronegative or non-metallic character
The tendency of an element to accept an electron to form an anion is called its nonmetallic or electronegative character.
The elements having high electron affinity or high electronegativity have high tendency to gain electrons and form negative ion.
The elements in the upper right hand portion of the periodic table are electronegative or non-metallic in nature.

Example

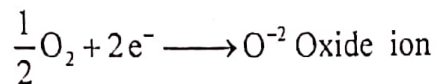
Fluorine, oxygen and phosphorus are non-metallic in nature.



(Chloride ion)



(Fluoride ion)



Greater the tendency to form an anion greater is the non-metallic character of the element.

Characters in a group:

The electronegative character decreases as we go down in a group. This is due to the increase in atomic size. For example, the elements of group VIIA(17) are non-metals. The non-metallic or electronegative character decreases down the group. Hence fluorine (${}_{9}F$) is the most electronegative and iodine (${}_{53}I$) the least electronegative. The atomic radius increases in going from fluorine (${}_{9}F$) to iodine (${}_{53}I$).

Element:	${}_{9}F$	${}_{17}Cl$	${}_{35}Br$	${}_{53}I$
Atomic radius (pm):	72	99	114	153

Atomic radius increases \rightarrow

Most electronegative \rightarrow

Least electronegative \rightarrow

Decrease of electronegative character \longrightarrow

Or we can say that:

- (1) In a group electronegative character decreases from top to bottom
- (2) In a period the electronegative character increases from left to right.

Example 8.1

Identifying the more non-metallic element in a pair of elements.

In each of the following pairs of elements, identify which element is more non metallic.

(a) N or O

(b) F or Cl

Problem solving strategy

Apply the trends of increasing electronegative character in a period and decreasing electronegative character in a group. Check the periodic table to see which element is more electronegative or non metallic.

Solution

(a) O is more non-metallic

(b) F is more non-metallic

Q.10 What are Halogens? Compare the Reactivity of the Halogens.

Ans. Halogens:

The element in group VII-A are called halogens. The name halogen is derived from the Greek words "halous" meaning salt and "gen" meaning former. Halogens include fluorine, chlorine, bromine, iodine and astatine (astatine is a radioactive element. Little is known about its properties).

All halogens are reactive non-metals. They all exist as diatomic molecular substances.

Fluorine (F₂) → Pale yellow gas

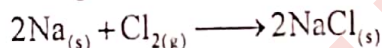
Chlorine (Cl₂) → Greenish yellow gas

Bromine (Br₂) → Reddish brown liquid

Iodine (I₂) → Bluish black solid

Comparison of Reactivity of the Halogens

All the halogens react with metals to form salts called halides. In these reactions metals are oxidized. So, halogens act as oxidizing agents. Fluorine is the most reactive element known. Chlorine is less reactive, but combines vigorously with many metals. For instance sodium metal burns in chlorine gas to form sodium chloride.



Bromine and iodine react with metals less vigorously. The reactivity of halogens decrease down the group. Thus, the order of decreasing oxidizing power is:



The halogens react with hydrogen to form hydrogen halides.



When X = F, Cl, Br, I

Reaction of fluorine with hydrogen is explosive. The hydrogen halides dissolve in water to form hydrohalic acid e.g, hydrochloric acid HCl, hydrofluoric acid HF etc. Except HF, other hydrohalic are strong acids. The acidic strength increases in the following order:



Oxidizing power of F₂ is the highest and that of I₂ is lowest. Due to the relative strength as oxidizing agent, it is possible for a free halogen to oxidize the ion of halogen next to it in the group. This means F₂ can oxidize all the halide ions to free halogen. For example,



Similarly Cl₂ can oxidize Br⁻ and I⁻ ions. But I₂ cannot oxidize any halide ion while Br₂ can oxidize I⁻

Activity 8.1

Identifying cations such as NH₄⁺, Ca⁺², mg⁺², ba⁺² and Zn⁺²

- You will need:
 - Test tubes.
 - Four Glass watches.
 - Glass rods.
 - Conc HCl, Co (NO₂)₂, NOH
 - A platinum wire
 - Salts containing NH₄⁺, Ca⁺², mg⁺², ba⁺² and Zn⁺² ion.

Carry out the following

- (1) Make a thick paste of each salt with conc HCl. Take a little of the paste on a clean platinum wire and place it into the non-luminous flame of burner. Note the colour of the flame. Apple green flame indicates Ba^{+2} ion. Brick red flame indicates Ca^{+2} ion. Other cation NH_4^+ , Mg^{+2} , Zn^{+2} , Zn^{+2} do not give coloured flame.
- (2) Shake each salt with a few drop of cobalt nitrate solution in separate test tubes. Dip a piece of filter paper in each test tube, dry it and burn. Note the colour of the ash. This test is called as filter as test. Pink colour of as indicates Mg^{+2} salt while green colour of ash indicates Zn^{+2} salts.
- (3) Take each salt in separate test tubes and add NaOH solution to it and boil. Note the test tube in which pungent odour gas evolves. Test this gas with a glass rod dipped in conc HCl. This gas will give dense white fumes of NH_4Cl . This test will confirm that the salt contains NH_4^+ ion.

Activity 8.2

Identifying anions such as CO_3^{2-} , SO_4^{2-} , Cl^- , and NO_2^-

- You will need:
- Test tubes, glass rods.
- Chemical such as dilute H_2SO_4 , conc. H_2SO_4 , $FeSO_4$, NH_4OH , starch solution, limewater $BaCl_2$ solution.
- Salts containing CO_3^{2-} , SO_4^{2-} , Cl^- , I^- , and NO_2^-

Carry out the following:

Take small quantity of each in separate dry test tubes. Add few drops of dil H_2SO_4 solution. Note the test tube in which a gas evolves. Test each gas as follows:

- (a) Pass colourless gas through lime water. It will turn milky. It indicates CO_3^{2-}
- (b) If reddish brown gas evolves, test it with a filter paper dipped in $FeSO_4$ solution. You will notice, paper will turn black. It indicates $\rightarrow NO_2^-$
- (c) Take small quantities of remaining salts in dry test tubes and this time add few drops of con H_2SO_4 heat, and analyze as follows:
 - (i) Note the salt that gives colourless gas having pungent odour. Test this gas with a glass rod dipped in liquid NH_3 or NH_4OH solution. It will give dense white fumes. It must be HCl. This indicates $\rightarrow Cl^-$ ion.
 - (ii) Now, after these tests only one salt is left that contains SO_4^{2-} ion To test this ion, dissolve small amount of this salt in water in a test tube and add $BaCl_2$ solution. You will observe white precipitate in the test tube. Add conc. HNO_3 to the ppt and shake. You will observe ppt remains undisclosed. This indicate $\rightarrow SO_4^{2-}$ ion.

Activity 8.2

Metal displacement reaction in aqueous medium

You will need:

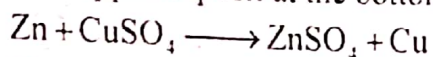
- Beaker
- Spatula
- Zinc plate
- Copper(II) Sulphate.



Fig. Zinc dipped in Copper (II) sulphate

Carry out the following

- (1) Mix one spatula full of copper (II) Sulphate in 20cm³ of water in a beaker.
- (2) Place zinc plate in the copper (II) Sulphate solution and leave for few hours (as shown in figure)
- (3) Look for the signs of red-brown particles on the surface of zinc plate.
- (4) Also notice the change in the colour of copper (II) Sulphate solution.
- (5) Write conclusion: Copper (II) Sulphate solution fades and pink/ yellowish colour copper deposit at the bottom.



- (6) Is zinc more active than copper?

Yes, Zinc oxidizing power is more than copper.

KEY POINTS

- The tendency of a metal to lose electrons is called electropositivity.
- As ionization energy decreases down the group, the electropositivity increase
- Metal oxides are generally basic in character since they produce bases in water.
- Non-metal oxides are generally acidic since they produce acids in water.
- Basic character of metal oxides of main group elements increases as we move down the group.
- The ionization energies of Group IIA elements are greater than those for the elements of Group IA. So alkaline earth metals are less reactive than alkali metals.

SELF ASSESSMENTS

EXERCISE 8.1

- (1) In each of the following pairs identify, which elements is more metallic

(a) Be, B (b) Si, Al (c) K, Li

Solution:

(a) Be (period) (b) Al (period) (c) K (group)

- (2) Using the periodic table, rank each set of elements in order decreasing metallic character.

(a) Na, Li, K (b) Al, Na, Mg

Solution:

(a) $\text{K} > \text{Na} > \text{Li}$ (period movement)

- (3) Which is more basic Li_2O or Na_2O ?

Solution:

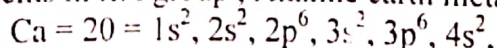
Na_2O is more basic than Li_2O because basic character increases down the group.

EXERCISE 8.2

Identify the position of Mg and Ca in the periodic table.

Solution:

Magnesium, atomic number is 12 and electronic configuration is $1s^2, 2s^2, 2p^6, 3s^2$. So according to the valence orbital i.e $3s^2$, magnesium present in 3rd period and belong to 2nd group of S-block elements in IIA group, Alkaline earth metals, similarly,



So it is present in 4th period and belong to 2nd group of S-block elements i.e IIA group (Alkaline earth metals)

EXERCISE 8.3

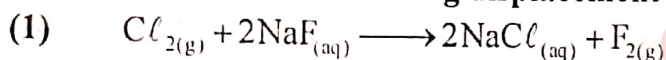
- (1) In each of the following pairs, identify which element is less non-metallic.
 (a) B or C (b) C or Si (c) Cl or Br
- (2) Using periodic table rank each set of elements in order of increasing non-metallic character.
 (a) N, F, O (b) Cl, Br, I (c) Si, S, P

Solution:

- (1)
 (a) Boron (B) is less non metallic than Carbon (C)
 (b) Silicon (Si) is less non metallic than carbon (C) because in a same group (IVA) Non metallic character decreases
 (c) bromine (Br) is less non-metallic than chlorine (Cl)
- (2)
 (a) $N < O < F$, non-metallic characters increases in a period
 (b) $I < Br < Cl$, non-metallic character decreases in a group.
 (c) $Si < P < S$, non-metallic characters increase in a period
 In generally (a), Fluorine is more non-metallic than oxygen and oxygen is more than nitrogen, In "b" Cl is more non-metallic than Br and Br is more than I. In "C" sulphur is more non-metallic than P and P than silicon.

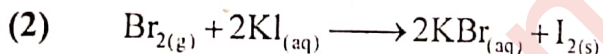
EXERCISE 8.4

Which of the following displacement reaction will occur?



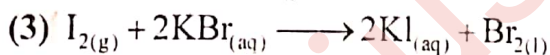
Solution:

Cl_2 cannot displace F^-



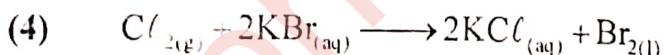
Solution

Br_2 can displace I^-



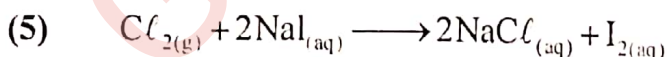
Solution

I_2 cannot displace Br



Solution:

Cl_2 can displace Br^-



Solution:

Cl_2 can displace I

- Sodium mixed with potassium forms an alloy that is used as a coolant in nuclear reactors.
- Metals such as copper, silver, gold and platinum are relatively difficult to oxidize. Therefore, these metals are often called noble metals.
- Elements that conduct heat and electricity poorly are called non-metal (except graphite all the halogens react with metals to form salts called halides)

TEXT BOOK EXERCISE

1. Which of the following oxides is the most basic oxide?
(a) MgO (b) BaO (c) CaO (d) SrO
2. Which of the following oxides is amphoteric oxide?
(a) Na₂O (b) Al₂O₃ (c) MgO (d) SO₂
3. Which of the following elements is most metallic?
(a) Al (b) Na (c) Mg (d) Li
4. Valence shell electronic configuration of alkaline earth metals is:
(a) ns¹ (b) ns²np¹ (c) ns² (d) ns²np⁶
5. Which of the following metals is not noble metal.
(a) Au (b) Cu (c) Hg (d) Ag
6. Which of the following elements is the least non-metallic?
(a) Si (b) S (c) P (d) Cl
7. Oxidizing power of _____ is the highest
(a) I₂ (b) Cl₂ (c) Br₂ (d) F₂
8. Chlorine cannot oxidize _____ ion.
(a) Iodide (b) Fluoride (c) Bromide (d) Astatine
9. Na is more reactive than Li, but less reactive than
(a) Mg (b) Al (c) Rb (d) All of these
10. Which of the following is the strongest acid?
(a) HI (b) HCl (c) HF (d) HBr

SHORT ANSWER

- (i) In a group the reactivity of metals with oxygen increases? Give example.
- (ii) Which element is more metallic Mg or Al? Explain.
- (iii) What is the importance of Mg?
- (iv) Arrange the following in order of increasing acidic strength HF, HI, HBr, HCl
- (v) Can F₂ oxidize all the halides ions to free halogen?

Answer:

- (i) See Q-3c **231**
- (ii) Al is more metallic than Mg because Al atom release three valence electron and change into Al³⁺ while Mg loses two electrons so formed Mg²⁺. High the net charge more will be the metallic nature.
- (iii) See Q-6a (important properties of Mg metal)
- (iv) HF < HCl < HBr < HI (HI will be the strongest acid easily given H⁺ in water)
- (v) Yes, because the oxidizing power of F₂ is the highest and that of I₂ is lowest.

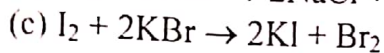
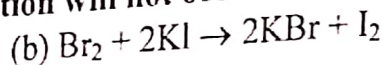
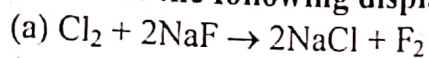
Q.3 Arrange the following oxides in order of decreasing basic character. BeO, CaO, MgO, SrO

Ans. Basic character of alkaline earth metals i.e be, Mg, Ca, Sr, Ba oxides increases down the group. So order of decreasing basic character is as follows SrO > CaO > MgO > BeO. Strongest-basic character is SrO and weakest will be beO.

Q.4 Rank the each set of elements in order of increasing metallic character
(a) Al, Na, Mg (b) Na, Li, K

Ans. (a) $\text{Na} < \text{Mg} < \text{Al}$ so Al will be more metallic
 (b) $\text{Li} < \text{Na} < \text{K}$ because down the group reactivity increases due to decreases of ionization of energy.

Q.5 Which of the following displacement reaction will not occur? Give reason?



Ans. (a) Cl_2 cannot displace F^- ions from NaF because oxidizing power of Cl_2 is lesser than F_2
 (b) Br_2 can displace I-1 from KI because oxidizing power of Br_2 is more than that of I_2
 (c) I_2 cannot displace Br^- ions from KBr because oxidizing power of I_2 is lesser than Br_2 .

Q.6 Give some important applications of Platinum.

Ans. See Q.8 (uses of pt)

Q.7 Identify the position of potassium and calcium in the periodic table

Ans. Potassium belong to alkali metal and its atomic No is 19 and distribution of electrons is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$ while calcium = 20 ($1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$) so potassium, calcium present in 4th period and 1A and IIA group respectively.

Q.8 What is aqua region?

Ans. It is a mixture of two acids HCl and HNO_3 with proportion 3:1 respectively. It is also called royal water because it is used to dissolve approximately all metals (Gold, pt)

THINK TANK

Q.1 Why it is advisable, not to pick sodium metal with fingers.

Ans. Sodium metal is so reactive that it may react with the moisture of fingers and produces irritation so it is advisable, not to pick sodium metal with fingers.

Q.2 Arrange the following elements in order of increasing non-metallic character. Si, Al, P

Ans. $\text{Al} < \text{Si} < \text{P}$, Phosphorous is more non-metallic in character.

Q.3 Design an experiment to show that iron is more reactive than copper.

Ans. You will need

(a) Beaker

(b) Spatula

(c) Iron plate

(d) copper (II) Sulphate solution

Carry out the following

1. Mix one spatula full of Cu(II) SO_4 in 100cm^3 of water in a beaker.
2. Place iron plate in a solution and leave for few hours as shown in the figure.
3. Look for the sign of Green particle, on the surface of iron rod.
4. Also observe the fade column of copper Sulphate solution.
5. Fe can displace Cu from CuSO_4 i.e $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
6. Give column of FeSO_4 will be formed and pink metal Cu deposit.
7. Iron is more reactive than copper. so displace it at the bottom.

Q.4 Design an experiment to differentiate between Cl^- and I^- .

Ans. You will need

- (a) Beakers
- (b) spatula
- (c) silver nitrate solution
- (d) Cl^- and I^- containing salt solution
- (e) e.g: KCl and KI salts

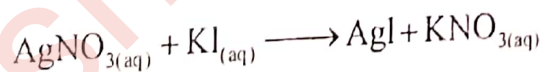
Carry out the following

- (1) Mix one spatula of KCl salt in 100 ml water in beaker A
- (2) Mix one spatula of KI salt in 100 ml water in beaker B
- (3) Add silver nitrate solution in beakers A and B
- (4) In beaker-A white ppt of AgCl will formed which indicate the presence of Cl^- in a solution.



white ppt.

- (5) Similarly in beaker-B bright yellow ppt of AgI will be form which indicate the presence of I^- in a solution.



Q.5 An iron bar is to be silver plated which metal would be the anode and which the cathode?

Ans. Iron bar will be anode while silver plate will be cathode.