UNIT 09

Group Properties & Elements

Descriptive Questions

Q.1 (Ex. Q.4 (i)) Explain the role of catalytic converter in an automobile. 09209001

Ans. A catalytic converter is a device used in the exhaust of an automobile which converts more harmful gases produced in the engine to such gases which do not pollute the atmosphere. Platinum, palladium and rhodium are the catalysts used in catalytic converters. **e.g:** They convert CO to CO_2 and oxides of nitrogen NO_x to N_2 before it enters in air.

Q.2 (Ex. Q.4 (ii)) Why do the chemical reactivities of alkali metals increase down the group whereas they decrease down the group in case of halogens? 09209002

Ans. The trend in chemical reactivity for alkali metals and halogens can be explained by looking at their atomic size and how it affects their ability to lose or gain electrons.

Alkali Metals: All the elements present in group 1 have ns^1 configuration in their outermost shells. This single electron can be removed easily which makes these metals very reactive except the first element hydrogen which is a gas and a non-metal. When we move from top to bottom in this group, the atomic size increases and nuclear charge decreases. Owing to this, it becomes easier for elements to lose electron down the group which increases reactivities of the lower members of the group.

Reaction with water: Lithium reacts with water steadily giving hydrogen and lithium hydroxide. Sodium reacts vigorously while potassium reacts violently with water giving their respective water soluble hydroxides.

$$Li_{(s)} + H_2O_{(\ell)} \xrightarrow{\text{Heat}} LiOH_{(aq)} + H_{2(g)}$$

$$Na_{(s)} + H_2O_{(\ell)} \xrightarrow{\text{Heat}} NaOH_{(aq)} + H_{2(g)}$$

$$K_{(s)} + H_2O_{(\ell)} \xrightarrow{\text{Heat}} KOH_{(aq)} + H_{2(g)}$$

Reaction with halogens: Reaction of these metals with chlorine becomes more vigorous as we go down the group.

$$2Li_{(s)} + Cl_{2(g)} \xrightarrow{\text{Heat}} 2LiCl_{(s)}$$

$$2Na_{(s)} + Cl_{2(g)} \xrightarrow[\text{Vigorous reaction}]{\text{Heat}} 2NaCl_{(s)}$$

$$2K_{(s)} + Cl_{2(g)} \xrightarrow[\text{Violent reaction}]{\text{Heat}} 2KCl_{(s)}$$

Halogens: Halogens react with alkali and alkaline earth metals to give salts. These elements are thus named was halogens which means salt-forming elements. Unlike metals, the reactivity of halogens decreases from top to bottom in the group. This is due to the fact that atomic size increases down the group and tendency to accept electron from other atoms decreases making them less reactive. **e.g.** Reactivity order of halogens F > Cℓ > Br > I .

Q.3 (Ex. Q.4 (iii)) Why are metals generally tough and strong whereas non-metals are neither tough nor strong? 09209003

Ans. Metals are generally tough and strong due to their unique atomic structure and bonding characteristics, while non-metals do not exhibit these properties for several reasons.

Metallic Bonding: Metals have metallic bonds, which involve a sea of electrons that are free to move throughout the metal lattice. This allows metals to absorb and distribute energy effectively, making them tough and able to withstand significant stress without breaking. The strong attraction between the positively charged metal ions and the electrons contributes to their strength.

Crystal Structure: Metals typically have a crystalline structure which means their atoms are arranged in a regular, repeating pattern. This arrangement allows for the layers of atoms to slide over each other without breaking the metallic bond contributing to their ductility and toughness.

In contrast, non-metals have different bonding characteristics:

Covalent Bonding: Non-metals usually form covalent bonds which are generally weaker than metallic bonds. This results in non-metals being more brittle and less able to withstand stress.

Molecular Structure: Many non-metals exist as discrete molecules (like gases or simple covalent compounds), which do not have the same structural integrity as metals. This lack of a strong, organized structure contributes to their lower toughness and strength.

Q.4 (Ex. Q.4 (iv)) Both alkali metals and halogens are very reactive elements with roles opposite to each other. Explain. 09209004

Ans. Alkali metals and halogens are indeed very reactive elements, but they have opposite roles in chemical reactions due to their positions in the periodic table and their electronic configurations.

Alkali Metals:

Alkali metals are located in Group 1 of the periodic table. They have one electron in their outermost shell which they readily lose to achieve a stable electronic configuration.

This tendency to lose one electron makes alkali metals highly reactive, especially with non-metals. When they react, they form positive ions (cations) with a charge of +1.

For example, when sodium (Na) reacts with chlorine (Cl), sodium loses one electron to form Na^+ ions.

Halogens:

Halogens are located in Group 17 of the periodic table. They have seven electrons in their outermost shell and need one more electron to achieve a full outer shell which gives them stability.

This makes halogens highly reactive as well but they tend to gain an electron during reactions. When they react, they form negative ions (anions) with a charge of -1.

For example, chlorine (Cl) gain one electron from sodium to form Cl^- ions.

Q.5 (Ex. Q.4 (v)) Why hydrogen bromide is thermally unstable as compared to hydrogen chloride? 09209005

Ans. Bond length between hydrogen and halogen increases down the group because as the halogen atom gets bigger the bonding pairs of electron get further away from the halogen nucleus. The bond between hydrogen and halogen therefore gets weaker. The weaker the

bond, the less heat energy it will need to break it. Hence the thermal stability of hydrogen halides decreases down the group.

Bond Strength:

The H-Cl bond is stronger than the H-Br bond. This is because atomic size of chlorine is smaller than bromine. A stronger bond is less likely to break under thermal conditions. The bond dissociation energy for H-Cl is about 431 kJ/mol, while for H-Br, it is around 366 kJ/mol. The lower bond strength in HBr makes it easier to break apart when heated.

Molecular Size and Stability:

Bromine is larger than chlorine, which leads to a longer and weaker bond in HBr. The increased distance between the hydrogen and bromine atoms results in less effective orbital overlap and a more unstable bond.

Thermal Decomposition:

When subjected to heat, HBr can decompose into hydrogen (H_2) and bromine (Br_2) more readily than HCl to decompose into hydrogen (H_2) and chlorine ($C1_2$). This decomposition reaction is more favorable for HBr due to its weaker bond.

$$2\,HBr_{(g)} \rightarrow H_{2(g)} + Br_{2(g)}$$
$$2\,HCl_{(g)} \rightarrow H_{2(g)} + Cl_{2(g)}$$

Q.6 (Ex. Q.4 (vi)) Compare the properties of metals and non-metals. 09209006

Ans.

	Metals	Non-metals
Melting and boiling points:	i. Metals usually have high melting and boiling points.	i. Non-metals may be solids, liquids or gases at room temperature. They show wide range of melting and boiling points.
Conductivity	ii. Metals are good conductors of heat and electricity.	ii. Non-metals are bad conductors of heat and electricity (except graphite).
Strength	iii. Metals can be made into different shapes by applying pressure. Metals can therefore be easily drawn into wires and sheets.	iii. Non-metals are brittle.
Appearance	iv. Metals are usually lustrous solids (except mercury).	iv. Non-metals are dull and cannot be polished (except iodine).
Hardness	v. Metals are generally tough and strong.	v. Non-metals are neither tough nor strong.

Q.7 (Ex. Q.4 (vii)) V_2O_5 catalyst is preferred over platinum in the oxidation of Sulphur dioxide. Give reasons. 09209007

Ans. Platinum was originally used as a catalyst in the contact process for the manufacture of sulphuric acid. Because it is expensive catalyst, however, rendered inactive due to the presence of arsenic as impurity in sulphur dioxide. That is why vanadium pentoxide (V_2O_5) is now preferred as a catalyst.

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{V_2O_5} 2SO_{3(g)}$$
$$SO_{3(g)} + H_2O_{(\ell)} \longrightarrow H_2SO_{4(aq)}$$

Investigative Questions

Q.1. (Ex. Q.5 (i)) Explain the role of sodium as heat transfer agent in the atomic nuclear power plant. Which property of sodium is utilized in this role? 09209008

Ans.

Sodium plays a crucial role as a heat transfer agent in atomic nuclear power plants, particularly in sodium-cooled fast reactors. The primary property of sodium that is utilized in this role is its excellent thermal conductivity and its ability to remain liquid at high temperature.

High Thermal Conductivity:

Sodium has a high thermal conductivity, which means it can efficiently transfer heat from the reactor core to the heat exchanger. This property is essential in maintaining the temperature within the reactor and ensuring that the heat generated from nuclear fission is effectively removed.

Liquid State at High Temperatures:

Sodium remains in a liquid state at elevated temperatures (its melting point is around 98 °C). This allows it to circulate freely within the reactor system, absorbing heat from the reactor core and transferring it to the secondary cooling system.

Low Neutron Absorption:

Sodium has a low neutron absorption cross-section, which means it does not interfere with the nuclear fission process. This property is vital in fast reactors where maintaining the neutron economy is crucial for sustaining the fission reaction.

Chemical Stability:

Sodium is chemically stable and can be used in a closed-loop system without significant corrosion or degradation which is important for the durability and safety of the reactor system.

Q.2. (Ex. Q.5 (ii)) Why and how does lithium behave differently from the rest of the alkali metals? 09209009

Ans. Lithium behaves differently from the other alkali metals due to its unique properties and smaller size.

Size and Charge Density:

Lithium is the smallest alkali metal, which gives it a higher charge density as compared to the larger alkali metals like sodium, potassium, and others. This high charge density leads to stronger interactions with surrounding ions or molecules, resulting in different chemical behavior.

Ionization Energy:

Lithium has high ionization energy than the other alkali metals. This means it requires more energy to remove the outermost electron from lithium compared to the other alkali metals. As a result, lithium is less reactive than other alkali metals.

Covalent Bonding:

Lithium tends to form covalent bonds more readily than the other alkali metals, which typically form ionic bonds. This is due to the small size and high charge density of lithium which allows it to share electrons more effectively.

Solubility in Organic Solvents:

Unlike other alkali metals, lithium can dissolve in some organic solvents. This property makes lithium useful in organic synthesis and various chemical reactions.

Lithium Compounds:

The compounds formed by lithium, such as lithium carbonate or lithium hydroxide have different properties compared to similar compounds of other alkali metals. For example, lithium carbonate is less soluble in water than sodium carbonate.

Q.3. (Ex. Q.5 (iii)) Why aluminum metal is used in the manufacture of cooking utensils whereas magnesium is not considered useful for this purpose? 09209010

Ans. Aluminium is commonly used in the manufacture of cooking utensils for several reasons, while magnesium is not typically chosen for this purpose. Such as

Corrosion Resistance:

Aluminium has a natural oxide layer that protects it from corrosion. This makes it ideal for cooking utensils that are often exposed to moisture and acidic foods. Magnesium, on the other hand, is more chance to corrode which can lead to deterioration over time.

Weight and Strength:

Aluminium is lightweight yet strong, making it easy to handle while still being durable enough for cooking applications. Magnesium is even lighter than aluminium, but it is also more brittle and can break or deform under stress, making it less suitable for cookware.

Thermal Conductivity:

Aluminium has excellent thermal conductivity, allowing for even heat distribution when cooking. This property is essential for effective cooking. Although magnesium also has good thermal conductivity, its other drawbacks make it less desirable for cooking utensils.

Cost and Availability:

Aluminium is relatively inexpensive and widely available, making it a practical choice for mass production of cooking utensils. Magnesium can be more costly and less readily available for such applications.

Reactivity:

Magnesium is more reactive than aluminium, especially at higher temperatures. This reactivity can lead to undesirable chemical reactions with certain foods or cooking processes, making it less suitable for cookware.

SLO Based Additional Long Questions

Q.4. Describe important chemical properties of Group-1 elements. 09209011

Ans. Introduction of Alkali Metals

Elements present in a group of the periodic table show similar chemical properties owing to the presence of same number of electrons in their outermost shells. However, a small variation in the chemical properties of elements is expected because the atomic size increases down the group.

Definition:

All the elements present in group 1 have ns^1 configuration in their outer shells. They are also called alkali metals.

Reactivity:

This single electron can be removed easily which makes these metals very reactive except the first element hydrogen which is a gas and a non-metal. When we move from top to bottom in this group the atomic size increases. Owing to this, it becomes easier for

elements to lose electron down the group which is reflected in the increased reactivties of the lower members of the group.

Reaction with water

Lithium reacts with water steadily giving hydrogen and lithium hydroxide. Sodium reacts vigorously while potassium reacts violently with water giving their respective water soluble hydroxides.

$$Li_{(s)} + H_2O_{(\ell)} \longrightarrow Li\,OH_{(aq)} + H_{2(g)}$$
$$Na_{(s)} + H_2O_{(\ell)} \longrightarrow NaOH_{(aq)} + H_{2(g)}$$
$$K_{(s)} + H_2O_{(\ell)} \longrightarrow KOH_{(aq)} + H_{2(g)}$$

Reaction with halogens:

Reaction of these metals with chlorine becomes more vigorous as we go down the group.

$$2Li_{(s)} + Cl_{2(g)} \xrightarrow{\text{Heat}} 2LiCl_{(s)}$$
$$2Na_{(s)} + Cl_{2(g)} \xrightarrow[\text{Vigorous reaction}]{\text{Heat}} 2NaCl_{(s)}$$
$$2Ka_{(s)} + Cl_{2(g)} \xrightarrow[\text{Violent reaction}]{\text{Heat}} 2KCl_{(s)}$$

Q.5. Discuss Halogens act as Reducing Agent? 09209012

Ans.

- Halogens generally do not act as reducing agents in their elements form (e.g F_2, Cl_2, Br_2, I_2) because they tend to gain electrons than lose them.
- Instead, Halogens are typically strong oxidizing agents However their halide Ions (e. g F^-, $C\ell^-$, Br^-, I^-) can act as reducing agents under specific conditions.
- The reducing strength of halides increase in the order $F^- < C\ell^- < Br^- < I^-$
- Halogens are reducing agents & their reducing power decreases down the group.

$$F_2 > Cl_2 > Br_2 > I_2$$

This fact gives a unique property to halogens when a halogen having more oxidizing reducing power displace an ion of another halogen from its compound.

$$Cl_{2(g)} + 2NaBr_{(aq)} \longrightarrow 2NaCl_{(aq)} + Br_{2(g)}$$
$$Cl_{2(g)} + 2NaI_{(aq)} \longrightarrow 2NaCl_{(aq)} + I_{2(v)}$$
$$Br_{2(aq)} + 2NaI_{(aq)} \longrightarrow 2NaBr_{(aq)} + I_{2(v)}$$

Q.6. Discuss the Stability of Hydrogen Halides: 09209013

Ans: Halogens react with hydrogen to give hydrogen halides, Hydrogen halides behave as strong acids in water

$$H_2 + X_2 \longrightarrow 2HX$$

All halides exist in gaseous state at ordinary temperature except hydrogen fluoride which is a liquid. Bond length between hydrogen and halogen increases down the group because as the halogen atom gets bigger the bonding pairs of electron get further away from the halogen nucleus. The bond between hydrogen and halogen therefore gets weaker. The weaker the bond, the less heat energy it will need to break it. Hence the thermal stability of hydrogen halides decreases down the group.

$$HF > HCl > HBr > HI$$

Q.7. Discuss the properties of Noble Gases. 09209014

Ans. Elements present in group 18 of the modern periodic table are called **Noble elements**

Properties of Noble gases:

i. All Noble elements are monoatomic gases having very low boiling points Helium (He), Neon (Ne), Krypton (Kr), Xenon (Xe) and Radon (Rn).

ii. All these gases have eight electrons (s^2p^6) in their outermost shells except He which has s^2 electronic configuration.

iii. Since their outer shells are complete. They show very little chemical reactivity.

Q.8. What are the physical properties of metals? 09209015

Ans. Definition of metals:

Metals are defined as the elements which can generally form cations easily. They also tend to form metallic bond.

Physical properties of metals:

i. Metals can be hammered into thin sheets. This property is called malleability.

ii. Metals can also be drawn into wires and this property is named as ductility

iii. Metallic bond in metals allows metals to be the best conductor of heat and electricity.

iv. Metals are lustrous which means that they have a shiny appearance.

v. Due to high tensile strength metals can hold heavy weights.

vi. When metals are hit by an object, they make a ringing sound.

vii. Metals cannot be cut easily because they are hard substances

viii. Due to the presence of strong metallic bond metals generally have high melting and boiling points.

ix. Their densities are also very high.

x. Alkali metals being soft metals are treated as exceptions

Example: Metals include copper, silver, iron, lead aluminum, gold, platinum, zinc etc.

Q.9. What are the physical properties of non-metals? 09209016

Ans. Physical properties of non-metals are given below:

i. Non-metals show a greater variety of colours and physical states compared to metals.

ii. Non-metals cannot be beaten into thin sheets because being brittle they break into pieces when hammered. Sulphur and phosphorous exist in powdered forms and cannot be made into sheets: Non-metals cannot be melted and drawn into wires.

iii. Non- metals do not have free electrons due to which the bonds between their atoms are weak and they break down when stretched.

iv. As there are no free electrons so non-metals cannot conduct heat and electricity. Graphite is the only exception. It conducts electricity because of its special crystalline arrangements.

v. Non-metals cannot be polished because they either exist in powder or gaseous form. Most of the powders are dull in texture.

vi. Due to non-ductile and non-malleable properties, non-metals are not strong at all. Their bonds being weak break easily.

vii. All non-metals have low melting and boiling points. The melting point of sulphur is 115^0C. Graphite and diamond have high melting points and these are exceptions.

viii. Non-metals have low densities as compared to metals. This means that in non-metals atoms are not strongly bound with each other.

Examples: Non-metals are oxygen, nitrogen, chlorine, sulphur, carbon, bromine, etc.

Exercise Short Question

Q.1 Why does it become easier to cut an alkali metal when we move from top to bottom in a group I? 09209017

Ans. As we go down Group 1 of the periodic table, alkali metals become easier to cut because their atomic size increases. This means the outermost electron is farther away from the nucleus and experiences less attraction. Additionally, the inner electrons shield the outer electron, making it easier to remove. These factors weaken the metallic bonds, allowing the metals to be cut more easily.

Q.2 Predict the reactivity of potassium towards halogens. 09209018

Ans. Potassium reacts vigorously with halogens to form potassium halides.

Reaction with Chlorine ($C\ell_2$):

When potassium reacts with chlorine gas, the reaction is highly exothermic and produces potassium chloride ($KC\ell$).

$$2\,K_{(s)} + C\ell_{2\,(g)} \rightarrow 2\,KC\ell_{(s)}$$

Reaction with Bromine (Br_2):

Similarly, when potassium reacts with bromine, it forms potassium bromide (KBr).

$$2\,K_{(s)} + Br_{2\ell)} \rightarrow 2\,KBr_{(s)}$$

In both reactions, potassium donates its outer electron to the halogen, resulting in the formation of ionic compounds.

Q.3 In the following reaction, chlorine acts as a reducing agent. What is the oxidizing agent in this reaction? 09209019

Ans. $Cl_{2(aq)} + 2NaBr_{(aq)} \longrightarrow 2NaCl_{(aq)} + Br_{2(g)}$

According to this equation chlorine does not act as reducing agent;

$C\ell_{2(aq)} + 2NaBr_{(aq)} \rightarrow 2NaC\ell_{(aq)} + Br_{2(g)}$

Chlorine ($C\ell_2$) is act as a oxidizing agent because it is being reduced to chloride ions($C\ell^-$) while causing bromide ions (Br^-) to be oxidized to bromine (Br_2).

To identify the oxidizing agent, we look for the speeies that is being reduced. In this case, the bromide ions (Br^-) are oxidized to bromine (Br_2). Therefore, the reducing agent in this reaction is the bromide ion (Br^-), as it is losing electrons.

Q.4 Why does iodine exist in the solid state at room temperature? 09209020

Ans. Iodine exists in the solid state at room temperature due to its molecular structure and the type of intermolecular forces present.

Iodine (I_2) consists of diatomic molecules held together by intermolecular forces. These forces are relatively weak, but as the size of the iodine molecules increases, the strength of these forces also increases.

At room temperature, the energy is not sufficient to overcome these intermolecular forces, which keeps iodine in the solid state. Additionally, iodine has a relatively high molecular mass as compared to other halogens, which contributes to its solid state at room temperature.

Q.5 How does Ni catalyse the reaction involving hydrogenation of oil? 09209021

Ans. Nickel (Ni) catalyzes the hydrogenation of oils by providing a surface for the reaction. It helps to absorb both the unsaturated oil and hydrogen gas.

$$\text{Vegetable Oil} + H_2 \rightarrow \text{Margarine}$$

The nickel breaks the H-H bond in hydrogen, creating reactive hydrogen atoms. These atoms then add to the double bonds in the oil, converting them to single bonds. Finally, the saturated fats are released, allowing nickel to be reused.

Q.6 Keeping in view the trends of reactivity in first group elements how would they react with oxygen? 09209022

Ans. Reaction of alkali metals with oxygen becomes more vigorous as we go down the group.

$$4Li + O_2 \xrightarrow{\text{Heat}} 2Li_2O$$

$$4Na + O_2 \xrightarrow[\text{Vigorous reaction}]{} 2Na_2O$$

$$4K + O_2 \xrightarrow[\text{Vigorous reaction}]{} 2K_2O$$

Q.7 How do halogens react with water? 09209023

Ans. Halogens, which include fluorine, chlorine, bromine, and iodine, react with water in different ways depending on their position in the periodic table.

Fluorine (F_2):

Fluorine is highly reactive and can react explosively with water. The reaction produces hydrofluoric acid and oxygen.

$$2F_2 + 2H_2O \xrightarrow{\text{Dark and cold}} 4HF + O_2$$

Chlorine (Cl_2):

Chlorine reacts with water to form hydrochloric acid and hypochlorous acid. This reaction is less violent than that of fluorine.

$$Cl_2 + H_2O \xrightarrow{\text{Sunlight}} HCl + HOCl$$

Bromine (Br_2):

Bromine also reacts with water, but the reaction is less vigorous than that of chlorine. It produces hydrobromic acid and hypobromous acid.

$$Br_2 + H_2O \xrightarrow{\text{Heat}} HBr + HOBr$$

Iodine (I_2):

Iodine does not react with water under the conditions of temperature and catalyst.

$$I_2 + H_2O \xrightarrow{\text{Heat}} \text{No Reaction}$$

Q.8 Transition metal have high tensile strength. What does it mean? 09209024

Ans. Tensile strength refers to the maximum amount of tensile (pulling) stress that a material can withstand before breaking or deforming. When we say that transition metals have high tensile strength, it means that these metals can endure a significant amount of stretching or pulling forces without breaking.

This property is primarily due to the strong metallic bonds present in transition metals. Transition metals are not only strong but also ductile, meaning they can be stretched into wires without breaking.

SLO Based Additional Short Question

Properties of Group 1 Elements

Q.9 What are alkali metals? 09209025

Ans. All the elements present in group 1 have ns^1 configuration in their outer shells. They are also called alkali metals. This single electron can be removed easily which makes these metals very reactive except the first element hydrogen which is a gas and a non-metal.

Q.10 What is the relationship between water and alkali metals? 09209026

Ans. Li, Na and K are lighter than water but rubidium sinks in water. Cesium explodes on contact with water, possibly shattering the container.

Q.11 Why does reactivity of metals increase down the group? 09209027

Ans. When we move from top to bottom in group, the atomic size increases and

nuclear charge decreases. Owing to this, it becomes easier for elements to lose electron down the group which is reflected in the increased reactivities of the lower members of the group.

Q.12 How does alkali metals react with water? 09209028

Ans. Lithium reacts with water steadily giving hydrogen and lithium hydroxide. Sodium reacts vigorously while potassium reacts violently with water giving their respective water soluble hydroxides.

$Li_{(s)} + H_2O_{(\ell)} \longrightarrow Li\,OH_{(aq)} + H_{2(g)}$

$Na_{(s)} + H_2O_{(\ell)} \longrightarrow NaOH_{(aq)} + H_{2(g)}$

$2K_{(s)} + H_2O_{(\ell)} \longrightarrow KOH_{(aq)} + H_{2(g)}$

Q.13 How does alkali metals react with chlorine? 09209029

Ans. Reaction of alkali metals with chlorine becomes more vigorous as we go down the group.

$2Li_{(s)} + C\ell_{2(g)} \xrightarrow{\text{Heat}} 2LiC\ell_{(s)}$

$2Na_{(s)} + C\ell_{2(g)} \xrightarrow[\text{Vigorous reaction}]{\text{Heat}} 2NaC\ell_{(s)}$

$2K_{(s)} + C\ell_{2(g)} \xrightarrow[\text{Violent reaction}]{\text{Heat}} 2KC\ell_{(s)}$

Q.14 How does alkali metals become soft? 09209030

Ans. Increase in the atomic size down the group also weakens the interatomic attraction of the atomic metals. This fact makes alkali metals softer down the group and their melting points decrease.

Q.15 What is the trend of variation in densities of alkali metals? 09209031

Ans. As we go down the first group, both the size and volume of the atoms increase as the number of electrons and protons increases. But the increase in mass of the elements is greater than the increase in volume; so the density which is defined as the mass per unit volume increases gradually down the group.

e.g:

Metal	Li	Na	K	Rb	Cs
Melting point °C	180	98	64	39	28
Density g/cm^3	0.53	0.97	0.86	1.53	1.87

Properties of Group 17 Elements

Q.16 How water of swimming pool can be sterilized? 09209032

Ans. It is the addition of chlorine solution in water. Chlorine kills bacteria and other microorganisms. Chlorine itself does not kill microorganisms. Chlorine itself does not kill rather it dissociate in water to from hypochlorous acid ($HOC\ell$) and hydrochloric acid ($HC\ell$).

$C\ell_{2(g)} + H_2O_{(\ell)} \longrightarrow HOC\ell_{(aq)} + C\ell^-_{(aq)} + H^+_{(aq)}$

$HOC\ell$ further ionizes to produces hypochlorite and proton.

$HOC\ell_{(aq)} \longrightarrow OC\ell^-_{(aq)} + H^+_{(aq)}$

So, swimming people are cleaned by chlorination. Both the products: $HOC\ell$ and $OC\ell^-$ kill bacteria and microorganisms.

Q.17 What do you know about group 17 elements? 09209033

Ans. All the elements in the group 17 have seven electrons in their outermost shells (ns^2np^5). They are electronegative non-metals because they have strong tendency to accept one electron to become an anion. They exist as diatomic molecules and behave as very reactive non-metals. They are also called halogens (salt forming elements)

Q.18 Why do the melting and boiling points of halogens increase from top to bottom in group? 09209034

Ans. Melting and boiling points of halogens increase when you go down the group. This is because the atoms get larger as they have more electrons. Because of their larger size they experience stronger intermolecular forces between molecules. Because of this, they

require more heat energy to overcome their intermolecular forces and so their melting and boiling points are increased.

Q.19 What is the trend variation in reactivity of halogens? 09209035

Ans. Unlike metals, the reactivity of halogens decreases from top to bottom in the group. This is due to the fact that atomic size increases down the group and tendency to accept electron from other atoms decreases making them less reactive.

Q.20 What is the trend of densities of halogens? 09209036

Ans. The attractive forces present between the halogen molecules increase down the group so as we go down the group the halogens become more dense.

Q.21 How metal halides are formed? 09209037

Ans. Metal halides are formed when halogens react directly with alkali and alkaline earth metals. Metal halides behave usually as ionic compounds. **e.g.**

$2Na + C\ell_2 \rightarrow 2NaC\ell_{(s)}$

Q.22 Define oxidation and reducing agent. Give example. 09209038

Ans. Oxidation is a process in which an electron is lost. The substance which loses an electron is called a reducing agent.

$$Na_{(s)} \longrightarrow Na^+ + e^-$$

Q.23 Define reduction and oxidizing agent. 09209039

Ans. Reduction is a process in which an electron is gained and the substance which accepts the electron is called oxidizing agent.

$$Cl_2 + 2e \longrightarrow 2C\ell^-$$

Q.24 What is the relationship between bond length and thermal stability? 09209040

Ans. Bond length between hydrogen and halogen increases down the group because as the halogen atom gets bigger the bonding pairs of electron get further away from the halogen nucleus. The bond between hydrogen and halogen therefore gets weaker. The weaker the bond, the less heat energy it will need to break it. Hence the thermal stability of hydrogen halides decreases down the group.

$$HF > HCl > HBr > HI$$

Group Properties of Transition Elements

Q.25 Define transition elements. 09209041

Ans. Elements present at the center of the modern periodic table from group 3 to group 12 are called d block elements or transition elements.

Q.26 Transition metals have high tensile strength. What does it mean? 09209042

Ans. It means that transition metals can with stand high levels of stress before breaking.

Q.27 Write down the physical properties of transition elements. 09209043

Ans. All transition elements are metals having the similar properties:

i. Transition elements are often hard with higher densities.
ii. Their melting and boiling points are also high.
iii. These metals show variable oxidation states.
iv. The compounds they form are often coloured.
v. They are malleable and ductile.

Q.28 What is the use of nickel as a catalyst? 09209044

Ans. A transition metal nickel is used as a catalyst for the hydrogenation of oils to give solid margarine. Margarine is less likely to spoil than butter. **e.g:**

$$\text{Vegetable oil} + H_2 \xrightarrow[250\ 300^\circ C]{Ni} \text{Margarine}$$

Q.29 What are noble elements? 09209045

Ans. Elements present in group 18 of the modern periodic table are called Noble elements. All noble elements are monoatomic gases having very low boiling points, Helium (He), Neon (Ne), Krypton (Kr), Xenone (Xe) and Radon (Ra). All these gases have eight electrons (s^2p^6) in their outermost shells except He which has s^2 electronic configuration. Since their outer shells are complete, they show very little chemical reactivity.

Physical Properties of Metals and Non-metals

Q.30 What do you mean by malleable and ductile? 09209046

Ans. Malleable means a material that can be hammered into sheets and ductile means a material that can be drawn into wires.

Q.31 Write down physical properties of metals. 09209047

Ans. Physical Properties of Metals:

i. Almost all metals are solid except mercury.
ii. They have high melting and boiling points. (except alkali metals)
iii. They possess metallic luster and can be polished.
iv. They are malleable (can be hammered into sheets), ductile (can be drawn into wires) and give off a tone when hit. (Sonorous)
v. They are good conductor of heat and electricity.
vi. They have high densities.
vii. They are hard (except sodium and potassium).

Q.32 What are non-metals? 09209048

Ans. Non-metals are the elements which form negative ions (anions) by gaining electrons. They are electronegative in nature and form acidic oxides.

Q.33 Non-metals are bad conductor of electricity except graphite why? 09209049

Ans. Non-metals cannot conduct heat and electricity. Graphite is the only exception. It conducts electricity because of its special crystalline arrangements. The electrons which are present between the layers of graphite crystal are loosely held and hence they can become mobile. The conduction of electricity of graphite is due to the mobility of these electrons.

Q.34 Why non-metals cannot be polished? 09209050

Ans. Non-metals cannot be polished because they either exist in powder or gaseous form. Most of the powders are dull in texture.

Q.35 Why non-metals are weak as compared to metals? 09209051

Ans. Due to non-ductile and non-malleable properties, non-metals are not strong at all. Their bonds being weak break easily. All non-metals have low melting and boiling points. The melting point of sulphur is 115°C. Graphite and diamond have high melting points and these are exceptions. Non-metals have low densities as compared to metals. This means that in non-metals atoms are not strongly bound with each other.

Q.36 How many elements are facing serious threat of extinction? Write their names? 09209052

Ans. According to one report nine elements are facing serious threat of extinction. Some of those elements are arsenic, gallium, gold, helium and zinc.

Q.1 (Ex. Q.3 (i)) Which noble gas should have the lowest boiling point and why? 09209053

Ans. The noble gas with the lowest boiling point is helium (He).

Helium has the smallest atomic size and the lowest molar mass among all the noble gases. Since helium atoms are very light and have fewer electrons, they exhibit very weak intermolecular forces as compared to heavier noble gases like neon (Ne) or argon (Ar). These weak forces mean that less energy is required to separate helium atoms from each other, resulting in a lower boiling point.

Q.2 (Ex. Q.3 (ii)) Compare the reactivity of alkali metals with chlorine. 09209054

Ans. Reaction of alkali metals with chlorine becomes more vigorous as we go down the group.

$$2Li_{(s)} + C\ell_{2(g)} \xrightarrow{\text{Heat}} 2LiC\ell_{(s)}$$

$$2Na_{(s)} + C\ell_{2(g)} \xrightarrow[\text{Vigorous reaction}]{\text{Heat}} 2NaC\ell_{(s)}$$

$$2K_{(s)} + C\ell_{2(g)} \xrightarrow[\text{Violent reaction}]{\text{Heat}} 2KC\ell_{(s)}$$

Q.3 (Ex. Q.3 (iii)) Why are almost all the metals solids while non-metals generally exist as gases and solids? 09209055

Ans. **Metals** have a crystalline structure where atoms are closely packed together in a lattice arrangement. This strong metallic bonding, which involves the sharing of free electrons among a lattice of positively charged ions gives metals their solidity, high melting points and malleability.

Non-metals can exist as gases, liquids or solids at room temperature because of their different bonding and molecular structures. Non-metals tend to form covalent bonds which can lead to the formation of molecules that are not as tightly packed as in metals.

For example

Gases like oxygen (O_2) and nitrogen (N_2) consist of small individual molecules that are far apart, allowing them to exist in a gaseous state.

Some non-metals, like sulphur and phosphorus can form solid structures but they do not have the same degree of metallic bonding that gives metals their solid state.

Q.4 (Ex. Q.3 (iv)) Name any three elements in the periodic table which exist as liquids? 09209056

Ans. Three elements in the periodic table that exist as liquids at room temperature are:

Mercury (Hg): It is the only metal that is liquid at room temperature.

Bromine (Br): This is a non-metal that is a reddish-brown liquid at room temperature.

Francium (Fr): While it is highly radioactive and rare, francium is predicted to be a liquid at room temperature.

Q.5 (Ex. Q.3 (v)) Why are transition elements different from normal elements? 09209057

Ans.

Properties	Normal Elements	Transition Elements
Electronic Configuration	Typically have filled s and p orbitals.	Have partially filled d orbitals.
Oxidation state	Usually have a fixed oxidation state.	Exhibit multiple oxidation states.
Physical properties	Can have a wider range of melting and boiling points, often lower than transition metals.	Generally have high melting and boiling points.
Conductivity	Conductivity varies; non-metals are	Good conductors of electricity

	usually poor conductors.	and heat.
Color of compound	Typically form colorless compounds, although some can be colored.	Often form colored compounds.
Nature of element	Include metals, non metals, metalloid	All are metals

Q.6 (Ex. Q.3 (vi)) Compare the reactivity of chlorine and bromine as reducing agent. 09209058

Ans. To illustrate the differences in reactivity between chlorine and bromine as reducing agents following example is given.

Chlorine (Cl_2) can react with sodium bromide (NaBr) to oxidize bromide ions (Br^-) to bromine (Br_2).

$$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$

In this reaction, chlorine is acting as an oxidizing agent because it gains electrons from bromide ions, which are oxidized to bromine go in this reaction and more reducing than chlorine. Bromine acts as a reducing Agent.

Q.7 (Ex. Q.3 (vii)) Which element is the most reactive and which is the least reactive among halogens? Give two reasons to explain your answer. 09209059

Ans. Among the halogens, fluorine is the most reactive element, while iodine is the least reactive.

Fluorine's Reactivity:

i. Fluorine has the highest electronegativity of all elements, which means it has a strong tendency to attract electrons. This property makes it very reactive as it readily forms bonds with other elements by accepting electrons.

ii. Fluorine has a small atomic radius, which allows its outer electrons to be held tightly by the nucleus. This tight hold makes it easier for fluorine to react with other elements to achieve a stable electronic configuration.

Iodine's Reactivity:

i. Iodine has a lower electronegativity as compared to fluorine, making it less effective at attracting electrons. As a result, it does not react as readily with other elements.

ii. Iodine has a larger atomic radius, which means its outer electrons are further from the nucleus and are held less tightly.

Multiple Choice Questions (Exercise)

1. Which halogen will have the least reactivity with alkaline earth metals? 09209060

(a) Chlorine (b) Iodine
(c) Bromine (d) Fluorine

2. Which compound do you expect to be coloured? 09209061

(a) KCl (b) $BaCl_2$
(c) $AlCl_3$ (d) $NiCl_2$

3. In which element there exists the strongest forces of attraction between atoms? 09209062

(a) Mg (b) Ca
(c) Sr (d) Ba

4. Elements of which group are all coloured? 09209063

(a) Second group (b) Sixth group
(c) Fourth group (d) Fifth group

5. **Which halogen acid is unstable at room temperature?** 09209064
(a) HBr (b) HI
(c) HCℓ d) HF

6. **Which oxide is the most basic oxide?** 09209065
(a) Na_2O (b) Li_2O
(c) MgO (d) CO

7. **Which group elements are the most reactive elements?** 09209066
(a) Transition metal Group
(b) First group
(c) Second group
(d) Third group

8. **The following solutions of a halogen and a sodium halide are mixed together. Which solution will turn dark because of a reaction?** 09209067
(a) Br_2 and NaCℓ (b) Br_2 and NaF
(c) $Cℓ_2$ and NaF (d) $Cℓ_2$ and NaI

9. **X is a monoatomic gas, which statement about this is correct?** 09209068
(a) X burns in air
(b) X is coloured
(c) X is unreactive
(d) X will displace iodine from it

10. **Which property is correct for group 1 elements?** 09209069
(a) Low catalytic activity
(b) High density
(c) Low electrical conductivity
(d) High melting point

SLO Based Additional MCQ's

Properties of Group 1 Elements

11. **Metals can form ions carrying charges:** 09209070
(a) Uni-positive (b) Di-positive
(c) Tri-positive (d) All of these

12. **Sodium is extremely reactive metal, but it does not react with:** 09209071
(a) Hydrogen (b) Nitrogen
(c) Sulphur (d) Phosphorus

13. **Which one of the following is the lightest metal?** 09209072
(a) Calcium
(b)Magnesium
(c)Lithium (d)Sodium

14. **Pure alkali metals can be cut simply by knife but iron cannot because of alkali metals have:** 09209073
(a) Strong metallic bonding
(b) Weak metallic bonding
(c) Non-metallic bonding
(d) Moderate metallic bonding

15. **Which of the following is less malleable?** 09209074
(a) Sodium (b) Iron
(c) Gold (d) Silver

16. **Metals lose their electrons easily because:** 09209075
(a) They are electronegative
(b) They have electron affinity
(c) They are electropositive
(d) Good conductors of heat

Properties of Group 17 Elements

17. **Which one of the following is brittle?** 09209076
(a)Sodium (b)Aluminum
(c)Selenium (d)Magnesium

18. **Which one of the following non-metal is lustrous?** 09209077
(a) Sulphur
(b) Phosphorus
(c)Iodine
(d)Carbon

19. **Non-metals are generally soft, but which one of the following is extremely hard?** 09209078
(a) Graphite (b)Phosphorus
(c)Iodine (d)Diamond

20. Metals are the elements which have: 09209079
(a) Electropositive character
(b) Electronegative character
(c) Both a & b
(d) None of the above

21. Which one is the most reactive metal? 09209080
(a) Potassium (b) Sodium
(c) Gold (d) All of these

22. Identify least reactive metal/s among the following: 09209081
(a) Copper (b) Mercury
(c) Silver (d) All of these

23. Which metal exists in liquid form at room temperature: 09209082
(a) Sodium
(b) Potassium
(c) Mercury
(d) None of these

24. Which are good conductor of heat and electricity? 09209083
(a) Metals (b) Non-metals
(c) Metalloids (d) All of these

25. All metals bear: 09209084
(a) Positive charge
(b) Negative charge
(c) Both a & b
(d) None of these

26. Metals possess: 09209085
(a) Ionic bond
(b) Covalent bond
(c) Co-ordinate Covalent bond
(d) Metallic bond

27. Sodium metal has electrons: 09209086
(a) 10 (b) 12
(c) 11 (d) 14

28. Which group of elements has low ionization energies? 09209087
(a) Alkali Metals
(b) Alkaline earth metals
(c) Halogens (d) Noble gases

29. Non-metals form: 09209088
(a) Positive ion
(b) Negative ion
(c) Neutral atom
(d) None of these

30. Non-metallic oxides are: 09209089
(a) Basic in nature
(b) Acidic in nature
(c) Amphoteric
(d) All of these

31. Metal oxides are: 09209090
(a) Basic in nature
(b) Acidic in nature
(c) Neutral
(d) None of these

32. Non-Metals are of heat and electricity: 09209091
(a) Good Conductor
(b) Bad Conductor
(c) Moderate Conductor
(d) None of the above

33. The melting and boiling points of non-metals are: 09209092
(a) High (b) Low
(c) Moderate (d) None of these

34. Which element has high electronegativity Value? 09209093
(a) Fluorine (b) Oxygen
(c) Chlorine (d) Nitrogen

35. Group 17 elements are called: 09209094
(a) Alkali Metals
(b) Alkaline Earth Metals
(c) Halogens
(d) (d)Noble gases

36. Which is strongest oxidizing agent? 09209095
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

37. The order of stability of Hydrides is: 09209096
(a) HF>HCl>HBr>HI
(b) HF>HBr>HCl>HI
(c) HI >HBr>HCl>HF
(d) HCl>HI>HF>HBr

38. Which is a weak acid? 09209097
(a) HF (b) HCl

(c) HBr (d) HI

39. Which non-metal is good conductor of electricity? 09209098
(a) Iodine (b) Graphite
(c) Sulphur (d) Phosphorus

40. Which one of the following is a metal? 09209099
(a) Hydrogen (b) Carbon
(c) Nitrogen (d) Magnesium

41. The heaviest metal is: 09209100
(a) Iron (b)Platinum
(c) Osmium (d)Lead

42. The non-metal which is present in group-15 of periodic table. 09209101
(a) Carbon (b) Sulphur
(c) Nitrogen (d) Iodine

Group Properties of Transition Elements

43. The elements in which d-orbital is in the process of filling constitute a group of metals called: 09209102
(a) Alkali Metals
(b) Alkaline Earth Metals
(c) Transition Metals
(d) Noble gases

44. Platinum alloyed with which metal is used as catalyst in automobiles as catalytic convertor? 09209103
(a) Palladium (b) Rhodium
(c) Gold (d) Both a & b

Physical Properties of Metals and Non-metals

45. What % of the elements in the periodic table are metals? 09209104
(a) 80% (b) 65%
(c) 75% (d) 90%

46. How many total non-metals exist in solid, liquid or gas at room temperature? 09209105
(a) 10 (b) 20
(c) 30 (d) 40

Answer Key

1	b	2	d	3	d	4	c	5	b
6	a	7	b	8	b	9	c	10	a
11	d	12	b	13	c	14	b	15	a
16	c	17	c	18	c	19	d	20	a
21	a	22	d	23	c	24	a	25	a
26	d	27	c	28	a	29	b	30	b
31	a	32	b	33	b	34	a	35	c
36	a	37	a	38	a	39	b	40	d
41	c	42	c	43	c	44	d	45	c
46	b								