

UNIT 9

Group Properties & Elements

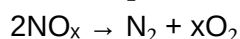
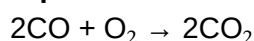
Descriptive Questions

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

Ans. A catalytic converter is a device used in the exhaust system of an automobile which converts more harmful gases produced in the engine into gases that do not pollute the atmosphere. Platinum, palladium, and rhodium are the catalysts used in catalytic converters. They convert CO to CO₂ and oxides of nitrogen (NO_x) to N₂ before the exhaust gases enter the air.

Equations:



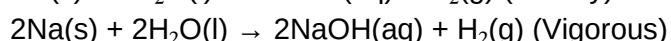
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Q.2 (Ex. Q.4 (ii)) Why do the chemical reactivities of alkali metals increase down the group whereas they decrease down the group in the case of halogens?

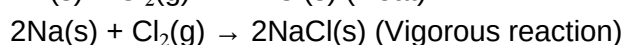
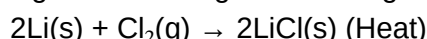
Ans. The trend in chemical reactivity for alkali metals and halogens can be explained by looking at their atomic size and how it affects their ability to lose or gain electrons.

Alkali Metals: All the elements present in Group 1 have ns¹ 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 electrons down the group, which increases the 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.



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



Halogens: Halogens react with alkali and alkaline earth metals to give salts. These elements are thus named 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 the tendency to accept electrons from other atoms decreases, making them less reactive. e.g., Reactivity order of halogens: F₂ > Cl₂ > Br₂ > I₂.

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

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 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.

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

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 the 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 the 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) gains one electron from sodium to form Cl^- ions.

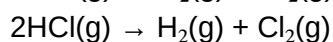
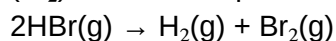
Q.5 (Ex. Q.4 (v)) Why is hydrogen bromide thermally unstable as compared to hydrogen chloride?

Ans. Bond length between hydrogen and halogen increases down the group because as the halogen atom gets bigger, the bonding pair of electrons gets 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 the 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 (H₂) and bromine (Br₂) more readily than HCl can decompose into hydrogen (H₂) and chlorine (Cl₂). This decomposition reaction is more favorable for HBr due to its weaker bond.



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

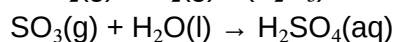
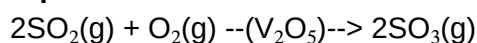
Ans.

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

Q.7 (Ex. Q.4 (vii)) V₂O₅ catalyst is preferred over platinum in the oxidation of Sulphur dioxide. Give reasons.

Ans. Platinum was originally used as a catalyst in the contact process for the manufacture of sulphuric acid. Because it is an expensive catalyst, however, it was rendered inactive due to the presence of arsenic as an impurity in sulphur dioxide. That is why vanadium pentoxide (V₂O₅) is now preferred as a catalyst.

Equations:



Investigative Questions

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

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 temperatures.

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?

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 higher 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 is aluminum metal used in the manufacture of cooking utensils whereas magnesium is not considered useful for this purpose?

Ans. Aluminum 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: Aluminum 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 prone to corrosion, which can lead to deterioration over time.

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

Thermal Conductivity: Aluminum 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: Aluminum 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 aluminum, 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.

Ans. Introduction of Alkali Metals: Elements present in a group of the periodic table show similar chemical properties owing to the presence of the 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.

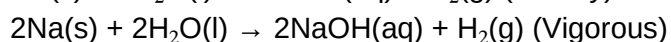
Definition: All the elements present in Group 1 have ns^1 configuration in their outer shells. They are also called alkali metals.

Reactivity: This single electron can be removed easily, which makes these metals very reactive except for 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 electrons down the group, which is reflected in the increased reactivities of the lower members of the group.

Reaction with Water:

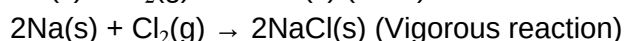
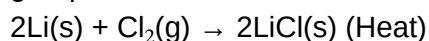
Lithium reacts with water steadily, giving hydrogen and lithium hydroxide.

Sodium reacts vigorously while potassium reacts violently with water, giving their respective water-soluble hydroxides.



Reaction with Halogens:

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



Q.5. Discuss Halogens acting as Reducing Agents.

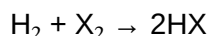
Ans.

- Halogens generally do not act as reducing agents in their elemental form (e.g., F_2 , Cl_2 , Br_2 , I_2) because they tend to gain electrons rather than lose them.
- Instead, halogens are typically strong oxidizing agents. However, their halide ions (e.g., F^- , Cl^- , Br^- , I^-) can act as reducing agents under specific conditions.
- The reducing strength of halides increases in the order: $\text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^-$.
- Halogens are reducing agents, and their reducing power decreases down the group.
 $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$

- This fact gives a unique property to halogens: a halogen having more oxidizing/reducing power can displace an ion of another halogen from its compound.
$$\text{Cl}_2 + 2\text{NaBr} \rightarrow 2\text{NaCl} + \text{Br}_2$$
Here, Cl_2 acts as an oxidizing agent (it is reduced to Cl^-), and Br^- acts as a reducing agent (it is oxidized to Br_2).
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Q.6. Discuss the Stability of Hydrogen Halides:

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



All hydrogen halides exist in a 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 pair of electrons gets 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.

Stability Order: $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$

Q.7. Discuss the properties of Noble Gases.

Ans. Elements present in Group 18 of the modern periodic table are called Noble gases.

Properties of Noble Gases:

1. All noble gases are monoatomic gases having very low boiling points: Helium (He), Neon (Ne), Krypton (Kr), Xenon (Xe), and Radon (Rn).
 2. All these gases have eight electrons (ns^2np^6) in their outermost shells except He, which has $1s^2$ electronic configuration.
 3. Since their outer shells are complete, they show very little chemical reactivity.
-

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

Ans. Definition of Metals: Metals are defined as the elements which can generally form cations easily. They also tend to form metallic bonds.

Physical Properties of Metals:

1. Metals can be hammered into thin sheets. This property is called malleability.
2. Metals can also be drawn into wires, and this property is named ductility.
3. Metallic bonds in metals allow metals to be the best conductors of heat and electricity.
4. Metals are lustrous, which means that they have a shiny appearance.
5. Due to high tensile strength, metals can hold heavy weights.
6. When metals are hit by an object, they make a ringing sound (sonorous).
7. Metals cannot be cut easily because they are hard substances.
8. Due to the presence of strong metallic bonds, metals generally have high melting and boiling points.
9. Their densities are also very high.
10. Alkali metals being soft metals are treated as exceptions.

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

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

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

1. Non-metals show a greater variety of colors and physical states compared to metals.

2. Non-metals cannot be beaten into thin sheets because, being brittle, they break into pieces when hammered. Sulphur and phosphorus exist in powdered forms and cannot be made into sheets. Non-metals cannot be melted and drawn into wires.
3. Non-metals do not have free electrons, due to which the bonds between their atoms are weak and they break down when stretched.
4. As there are no free electrons, non-metals cannot conduct heat and electricity. Graphite is the only exception. It conducts electricity because of its special crystalline arrangements.
5. Non-metals cannot be polished because they either exist in powder or gaseous form. Most of the powders are dull in texture.
6. Due to non-ductile and non-malleable properties, non-metals are not strong at all. Their bonds, being weak, break easily.
7. 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.
8. 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 Questions

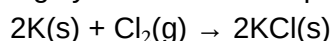
Q.1 Why does it become easier to cut an alkali metal when we move from top to bottom in Group I?

Ans. As we go down Group I 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.

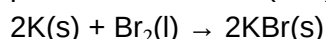
Q.2 Predict the reactivity of potassium towards halogens.

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

Reaction with Chlorine (Cl₂): When potassium reacts with chlorine gas, the reaction is highly exothermic and produces potassium chloride (KCl).



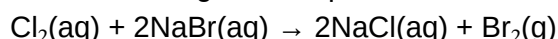
Reaction with Bromine (Br₂): Similarly, when potassium reacts with bromine, it forms potassium bromide (KBr).



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?

Ans. According to the equation:



Chlorine (Cl₂) is acting as an oxidizing agent because it is being reduced to chloride ions (Cl⁻) while causing bromide ions (Br⁻) to be oxidized to bromine (Br₂). To identify the oxidizing agent, we look for the species that is being reduced. In this case, chlorine is reduced. Therefore, the oxidizing agent is chlorine (Cl₂).

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

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 (London dispersion 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 catalyze the reaction involving hydrogenation of oil?

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

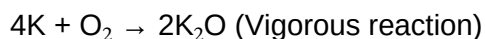
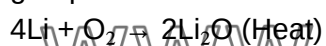
Vegetable Oil + H_2 $\xrightarrow{(Ni, 250-300^\circ C)}$ Margarine

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.

Practice Exercise

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

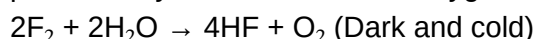
Ans. The reaction of alkali metals with oxygen becomes more vigorous as we go down the group.



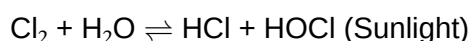
Q.7 How do halogens react with water?

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.



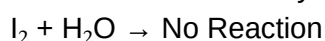
Chlorine (Cl_2): Chlorine reacts with water to form hydrochloric acid and hypochlorous acid. This reaction is less violent than that of fluorine.



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.



Iodine (I_2): Iodine does not react with water under normal conditions of temperature and in the absence of a catalyst.



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

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.

Properties of Group 1 Elements

Q.9 What are alkali metals?

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?

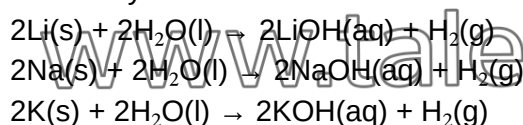
Ans. Li, Na, and K are lighter than water, but rubidium sinks in water. Cesium explodes on contact with water, possibly shattering the container.

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

Ans. When we move from top to bottom in a group, the atomic size increases and nuclear charge decreases. Owing to this, it becomes easier for elements to lose electrons down the group, which is reflected in the increased reactivities of the lower members of the group.

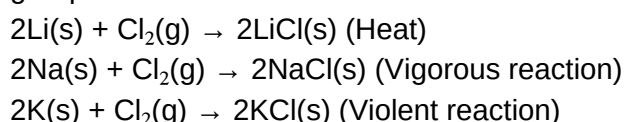
Q.12 How do alkali metals react with water?

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.



Q.13 How do alkali metals react with chlorine?

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



Q.14 Why do alkali metals become soft?

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

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

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.

Metal	Li	Na	K	Rb	Cs
Melting Point ($^{\circ}\text{C}$)	180	98	64	39	28

Metal	Li	Na	K	Rb	Cs
Density (g/cm ³)	0.53	0.97	0.86	1.53	1.87

Properties of Group 17 Elements

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

Ans. It is by the addition of chlorine solution in water. Chlorine kills bacteria and other microorganisms. Chlorine itself does not kill microorganisms; rather, it dissociates in water to form hypochlorous acid (HOCl) and hydrochloric acid (HCl).



HOCl further ionizes to produce hypochlorite and proton.



So, swimming pool water is cleaned by chlorination. Both the products, HOCl and OCl⁻, kill bacteria and microorganisms.

Q.17 What do you know about Group 17 elements?

Ans. All the elements in Group 17 have seven electrons in their outermost shells (ns²np⁵). They are electronegative non-metals because they have a 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 the group?

Ans. The 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 of variation in reactivity of halogens?

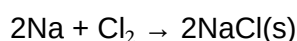
Ans. Unlike metals, the reactivity of halogens decreases from top to bottom in the group. This is due to the fact that atomic size increases down the group and the tendency to accept electrons from other atoms decreases, making them less reactive.

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

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.

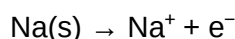
Q.21 How are metal halides formed?

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



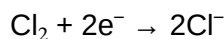
Q.22 Define oxidation and reducing agent. Give an example.

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



Q.23 Define reduction and oxidizing agent.

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



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

Ans. Bond length between hydrogen and halogen increases down the group because as the halogen atom gets bigger, the bonding pair of electrons gets 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.

Stability Order: $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$

Group Properties of Transition Elements

Q.25 Define transition elements.

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?

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

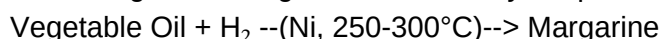
Q.27 Write down the physical properties of transition elements.

Ans. All transition elements are metals having similar properties:

1. Transition elements are often hard with higher densities.
 2. Their melting and boiling points are also high.
 3. These metals show variable oxidation states.
 4. The compounds they form are often colored.
 5. They are malleable and ductile.
-

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

Ans. The 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.



Q.29 What are noble gases?

Ans. Elements present in Group 18 of the modern periodic table are called Noble gases. All noble gases are monoatomic gases having very low boiling points: Helium (He), Neon (Ne), Krypton (Kr), Xenon (Xe), and Radon (Rn). All these gases have eight electrons (ns^2np^6) in their outermost shells except He, which has $1s^2$ 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?

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 the physical properties of metals.

Ans. Physical Properties of Metals:

1. Almost all metals are solid except mercury.
 2. They have high melting and boiling points (except alkali metals).
 3. They possess metallic luster and can be polished.
 4. They are malleable (can be hammered into sheets), ductile (can be drawn into wires), and give off a tone when hit (sonorous).
 5. They are good conductors of heat and electricity.
 6. They have high densities.
 7. They are hard (except sodium and potassium).
-

Q.32 What are non-metals?

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 conductors of electricity except graphite. Why?

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 the graphite crystal are loosely held and hence they can become mobile. The conduction of electricity by graphite is due to the mobility of these electrons.

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Q.34 Why can non-metals not be polished?

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 are non-metals weak as compared to metals?

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 a serious threat of extinction? Write their names.

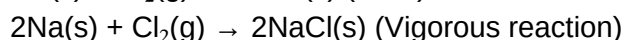
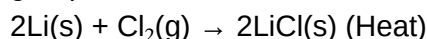
Ans. According to one report, nine elements are facing a serious threat of extinction. Some of those elements are arsenic, gallium, gold, helium, and zinc.

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

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.

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

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

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.

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?

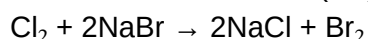
Ans.

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 usually poor conductors.	Good conductors of electricity and heat.
Color of Compound	Typically form colorless compounds, although some can be colored.	Often form colored compounds.

Properties	Normal Elements	Transition Elements
Nature of Element	Include metals, non-metals, and metalloids.	All are metals.

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

Ans. To illustrate the differences in reactivity between chlorine and bromine as reducing agents, the following example is given. Chlorine (Cl_2) can react with sodium bromide (NaBr) to oxidize bromide ions (Br^-) to bromine (Br_2).



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

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.

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

Fluorine's Reactivity:

1. 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.
2. 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:

1. 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.
2. 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?
(b) Iodine ✓
2. Which compound do you expect to be colored?
(d) NiCl_2 ✓
3. In which element does there exist the strongest forces of attraction between atoms?
(d) Ba ✓
4. Elements of which group are all colored?
(d) Fifth group (Note: The question likely refers to transition metals, but among the options, none are strictly all colored. The correct answer in the context of d-block elements is not available.)
5. Which halogen acid is unstable at room temperature?
(b) HI ✓
6. Which oxide is the most basic oxide?
(a) Na_2O ✓

7. Which group elements are the most reactive elements?
(b) First group ✓
8. The following solutions of a halogen and a sodium halide are mixed together. Which solution will turn dark because of a reaction?
(d) Cl_2 and NaI ✓
9. X is a monoatomic gas. Which statement about this is correct?
(c) X is unreactive ✓
10. Which property is correct for Group 1 elements?
(a) Low catalytic activity ✓

Properties of Group 1 Elements

11. Metals can form ions carrying charges:
(d) All of these ✓
12. Sodium is an extremely reactive metal, but it does not react with:
(b) Nitrogen ✓
13. Which one of the following is the lightest metal?
(c) Lithium ✓
14. Pure alkali metals can be cut simply by a knife but iron cannot because alkali metals have:
(b) Weak metallic bonding ✓
15. Which of the following is less malleable?
(a) Sodium ✓
16. Metals lose their electrons easily because:
(c) They are electropositive ✓

Properties of Group 17 Elements

17. Which one of the following is brittle?
(c) Selenium ✓
18. Which one of the following non-metals is lustrous?
(c) Iodine ✓
19. Non-metals are generally soft, but which one of the following is extremely hard?
(d) Diamond ✓
20. Metals are the elements which have:
(a) Electropositive character ✓
21. Which one is the most reactive metal?
(a) Potassium ✓
22. Identify the least reactive metal/s among the following:
(d) All of these (Note: All are less reactive than alkali metals.)
23. Which metal exists in liquid form at room temperature?
(c) Mercury ✓
24. Which are good conductors of heat and electricity?
(a) Metals ✓
25. All metals bear:
(a) Positive charge (Note: As ions, metals bear positive charges, but in their elemental state they are neutral.)
26. Metals possess:
(d) Metallic bond ✓
27. Sodium metal has _____ electrons:
(c) 11 ✓

28. Which group of elements has low ionization energies?

(a) Alkali Metals ✓

29. Non-metals form:

(b) Negative ion ✓

30. Non-metallic oxides are:

(b) Acidic in nature ✓

31. Metal oxides are:

(a) Basic in nature ✓

32. Non-metals are _____ of heat and electricity:

(b) Bad Conductor ✓

33. The melting and boiling points of non-metals are:

(b) Low ✓

34. Which element has the highest electronegativity value?

(a) Fluorine ✓

35. Group 17 elements are called:

(c) Halogens ✓

36. Which is the strongest oxidizing agent?

(a) Fluorine ✓

37. The order of stability of hydrogen halides is:

(a) $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$ ✓

38. Which is a weak acid?

(a) HF ✓

39. Which non-metal is a good conductor of electricity?

(b) Graphite ✓

40. Which one of the following is a metal?

(d) Magnesium ✓

41. The heaviest metal is:

(c) Osmium ✓

42. The non-metal which is present in Group 15 of the periodic table:

(c) Nitrogen ✓

Group Properties of Transition Elements

43. The elements in which d-orbital is in the process of filling constitute a group of metals called:

(c) Transition Metals ✓

44. Platinum alloyed with which metal is used as a catalyst in automobiles as a catalytic converter?

(d) Both a & b ✓

Physical Properties of Metals and Non-metals

45. What % of the elements in the periodic table are metals?

(c) 75% (Approximately 75-80% of elements are metals) ✓

46. How many total non-metals exist in solid, liquid, or gas at room temperature?

(b) 20 (There are about 20-22 non-metals) ✓