بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

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Class	9th	Chapter	09
Subject	Solved	Board	Punjab

CHAPTER 9: GROUP PROPERTIES AND ELEMENTS

1. TICK (✓) THE CORRECT ANSWER

(i) Which halogen will have the least reactivity with alkaline earth metals?

Answer: (b) Iodine

(ii) Which compound do you expect to be coloured?

Answer: (d) $NiCl_4$

(iii) In which element do the strongest forces of attraction exist between atoms?

Answer: (a) Mg

(iv) Elements of which group are all coloured?

Answer: (d) Fifth group

(v) Which halogen acid is unstable at room temperature?

Answer: (b) HI

(vi) Which oxide is the most basic oxide?

Answer: (b) Li_2O

(vii) Which group elements are the most reactive elements?

Answer: (b) First group

(viii) The following solutions of a halogen and a sodium halide are mixed together. Which solution will turn dark because of a reaction?

Answer: (d) Cl_2 and NaI

(ix) X is a monoatomic gas. Which statement about it is correct?

Answer: (c) X is unreactive

(x) Which property is correct for Group 1 elements?

Answer: (a) Low catalytic activity

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2. QUESTIONS FOR SHORT ANSWERS

(i) Why does it become easier to cut an alkali metal when we move from top to bottom in Group 1?

Answer: As we move down Group 1, atomic size increases and metallic bonding becomes weaker because the valence electrons are held less tightly by the nucleus. This makes the metals softer and easier to cut.

(ii) Predict the reactivity of potassium towards halogens.

Answer: Potassium is an extremely reactive alkali metal and reacts vigorously with halogens, such as chlorine and bromine, to form metal halide salts, releasing large amounts of heat.

(iii) In the following reaction, chlorine acts as an oxidising agent. Which is the reducing agent?

$Cl_2(aq) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br_2(aq)$

Answer: Sodium bromide (NaBr), specifically the bromide ion (Br^-), acts as the reducing agent because it loses electrons and is oxidised to Br_2.

(iv) Why does iodine exist in the solid state at room temperature?

Answer: Iodine molecules (I_2) are large and have many electrons, resulting in stronger intermolecular van der Waals forces of attraction than those between smaller halogen molecules. These forces are sufficient to hold iodine in a solid lattice at room temperature.

(v) How does Ni catalyse the reaction involving the hydrogenation of oil?

Answer: Nickel provides a catalytically active solid surface on which reactant molecules, including unsaturated oil and hydrogen gas, are adsorbed. This weakens their internal bonds and lowers the activation energy required for the addition reaction to form fats, such as vanaspati ghee.

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3. CONSTRUCTED RESPONSE QUESTIONS

(i) Which noble gas should have the lowest boiling point and why?

Answer: Helium has the lowest boiling point of all noble gases because it has the smallest atomic size and the fewest electrons, resulting in the weakest London dispersion forces between its atoms. These forces are easily overcome at extremely low temperatures.

(ii) Compare the reactions of alkali metals with chlorine.

Answer: Alkali metals react vigorously and exothermically with chlorine gas to form white ionic chloride salts.

Example:

$2Na + Cl_2 \rightarrow 2NaCl$

The vigour of the reaction increases down the group from lithium to caesium.

(iii) Why are almost all metals solids while non-metals generally exist as gases and solids?

Answer: Metals are bound by strong metallic bonds involving a sea of delocalised electrons that extend throughout a rigid crystal lattice. Non-metals consist of discrete molecules or simple covalent networks. Many molecular non-metals are held together by weak intermolecular forces, allowing them to exist as gases or low-melting solids.

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(iv) Name any three elements in the periodic table which exist as liquids.

Answer: Mercury (Hg), bromine (Br_2), and caesium (Cs) or gallium, which melts near room temperature.

(v) Why are transition elements different from normal elements?

Answer: Transition elements (d-block elements) differ from main-group elements because they possess partially filled d-subshells, exhibit multiple oxidation states, form coloured ions and complex compounds, and often act as effective catalysts.

(vi) Compare the reactivity of chlorine and bromine as oxidising agents.

Answer: Chlorine is a stronger oxidising agent than bromine because it attracts electrons more strongly. It can displace bromide ions from solutions, converting them into bromine.

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

Answer: Fluorine is the most reactive halogen, while iodine is less reactive than fluorine and the other halogens commonly considered in this trend.

Reasons:

1. Fluorine has a very small atomic size and high electronegativity, enabling it to attract electrons strongly.
2. The F–F bond is relatively weak, which helps explain fluorine's high reactivity.

4. DESCRIPTIVE QUESTIONS

(i) Explain the role of a catalytic converter in an automobile.

Answer: A catalytic converter uses precious metal catalysts, such as platinum, palladium, and rhodium, housed in the exhaust system to convert harmful combustion by-products, including carbon monoxide (CO), unburnt hydrocarbons, and nitrogen oxides (NO_x), into less harmful substances such as carbon dioxide (CO_2), nitrogen (N_2), and water vapour (H_2O).

(ii) Why does the chemical reactivity of alkali metals increase down the group, whereas it decreases down the group in the case of halogens?

Answer: For alkali metals, reactivity depends on losing an electron. Down the group, atomic radius increases and ionisation energy decreases, making electron loss easier.

For halogens, reactivity depends on gaining an electron. Down the group, atomic size increases and the attraction for an incoming electron generally decreases, making it harder to gain an electron.

(iii) Why are metals generally tough and strong, whereas non-metals are neither tough nor strong?

Answer: Metals derive strength from a continuous, non-directional sea of electrons binding positive ions into a metallic lattice that resists deformation. Many non-metals consist of individual molecules held together by weak intermolecular forces, while solid non-metals may form brittle covalent networks that can break under stress.

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

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Answer: Alkali metals have a single valence electron that they readily lose to achieve a stable electronic configuration, so they act as reducing agents. Halogens need one additional electron to complete their outer shell and readily accept an electron, so they act as oxidising agents.

(v) Why is hydrogen bromide thermally unstable compared with hydrogen chloride?

Answer: The H–Br bond is longer and weaker than the H–Cl bond because of the larger size of the bromine atom. Therefore, less energy is required to break the H–Br bond.

(vi) Compare the properties of metals and non-metals.

Answer:

Metals:

- Good conductors of heat and electricity.
- Generally malleable and ductile.
- Usually have a lustrous appearance.
- Often have high melting points.
- Generally form basic oxides.
- Tend to lose electrons and form cations.

Non-metals:

- Generally poor conductors of heat and electricity.
- Solid non-metals are often brittle.
- Usually have a dull appearance in the solid state.
- Often have lower melting points than metals.
- Generally form acidic or neutral oxides.
- Tend to gain electrons and form anions, or share electrons in covalent bonds.

(vii) V_2O_5 catalyst is preferred over platinum in the oxidation of sulphur dioxide. Give reasons.

Answer: Vanadium pentoxide (V_2O_5) is considerably cheaper than platinum and is an effective catalyst for the oxidation of sulphur dioxide in the Contact Process. It offers an economical alternative for large-scale industrial production of sulphuric acid.

5. INVESTIGATIVE QUESTIONS

(i) Explain the role of sodium as a heat-transfer agent in an atomic nuclear power plant. Which property of sodium is utilised in this role?

Answer: Liquid sodium metal can be pumped through nuclear reactor cores to absorb and transfer thermal energy efficiently to heat exchangers or steam generators. Its high thermal conductivity and ability to remain liquid over a wide temperature range make it useful as a heat-transfer agent.

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(ii) Why and how does lithium behave differently from the rest of the alkali metals?

Answer: Lithium behaves differently because of its extremely small atomic size and high charge density, which give it strong polarising power. Unlike heavier alkali metals, lithium forms a normal oxide (Li_2O) when burned in air, reacts less vigorously with water than the heavier alkali metals, and its salts often show significant covalent character.

(iii) Why is aluminium metal used in the manufacture of cooking utensils, whereas magnesium is not considered as useful for this purpose?

Answer: Aluminium forms a thin, stable, and adherent protective oxide layer (Al_2O_3) that helps prevent further corrosion. It is also lightweight and conducts heat well, making it suitable for cooking utensils. Magnesium is more reactive and can burn under suitable conditions, so it is generally less suitable for ordinary cookware.

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