

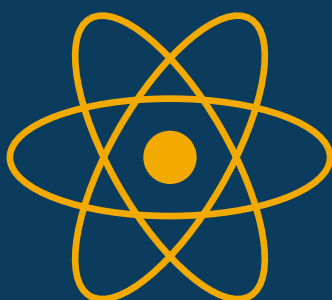
CLASS 9 • CHEMISTRY

CHAPTER 9

Group Properties and Elements

Complete Exercise Solutions

MCQs • Short • Constructed • Descriptive • Investigative



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1. Tick (✓) the correct answer.

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

(a) Chlorine

(b) Iodine ✓

(c) Bromine

(d) Fluorine

✓ **Correct Answer: (b) Iodine**

Explanation: The reactivity of halogens decreases as you move down the group in the periodic table. This is because atomic size increases, and the ability to attract electrons (electronegativity) decreases. Fluorine is the most reactive, while Iodine is the least reactive among the given options.

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

- (a) KCl
- (b) BaCl₂
- (c) AlCl₃

(d) NiCl₂



✓ **Correct Answer: (d) NiCl₂**

Explanation: Compounds of transition metals are typically coloured due to the presence of partially filled d-orbitals, which allow for d-d electronic transitions. Nickel (Ni) is a transition metal, so NiCl₂ is coloured (usually yellow or green depending on hydration). KCl, BaCl₂, and AlCl₃ are salts of main-group metals (s-block and p-block) and are generally white or colourless.

(iii) In which element there exists the strongest forces of attraction between atoms?

(a) Mg ✓

(b) Ca

(c) Sr

(d) Ba

✓ **Correct Answer: (a) Mg**

Explanation: Moving down Group 2 (alkaline earth metals), the atomic size increases. This means the valence electrons are further from the nucleus, weakening the metallic bond. Magnesium (Mg) has the smallest atomic radius among the options, resulting in the strongest forces of attraction between its atoms.

(iv) Elements of which group are all coloured?

(a) Second group

(b) Sixth group



(c) Fourth group

(d) Fifth group

✓ Correct Answer: (b) Sixth group

Explanation: The Sixth group consists of transition metals (Chromium, Molybdenum, Tungsten). Transition metals are well-known for forming coloured compounds due to electronic transitions within their partially filled d-orbitals. In contrast, Group 2 (alkaline earth metals) are silvery-white, and Groups 4 and 5 are mostly silvery-grey.

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

(a) HBr

(b) HI



(c) HCl

(d) HF

✓ Correct Answer: (b) HI

Explanation: The bond between hydrogen and iodine is the weakest among the hydrogen halides. This is because iodine has the largest atomic size, leading to poor orbital overlap with the small hydrogen atom. As a result, HI readily decomposes at room temperature, making it the least stable.

(vi) Which oxide is the most basic oxide?

(a) Na_2O



(b) Li_2O

(c) MgO

(d) CO

✓ **Correct Answer: (a) Na_2O**

Explanation: Metallic oxides are basic in nature. Basicity increases as you move down a group and towards the left of the periodic table. Sodium (Na) is an alkali metal (Group 1), making Na_2O a very strong base. Li_2O is also basic but less so than Na_2O . MgO is amphoteric/basic, and CO is a neutral oxide.

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

(a) Transition metal group

(b) First group



(c) Second group

(d) Third group

✓ Correct Answer: (b) First group

Explanation: Group 1 elements (alkali metals) have a single valence electron in their outermost shell. They have very low ionization energies, meaning they lose this electron readily to achieve a stable noble gas configuration. This makes them the most reactive metals in the periodic table.

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

(a) Br_2 and NaCl

(b) Br_2 and NaF

(c) Cl_2 and NaF

(d) Cl_2 and NaI



✓ **Correct Answer: (d) Cl_2 and NaI**

Explanation: A more reactive halogen can displace a less reactive halogen from its salt solution. Chlorine (Cl_2) is more reactive than Iodine (I). Therefore, when Cl_2 is mixed with NaI , it displaces iodine, forming NaCl and free I_2 . Free iodine in solution gives a dark brown/black colour.

(ix) X is a monoatomic gas, which statement about this is correct?

- (a) X burns in air
- (b) X is coloured
- (c) X is unreactive** ✓
- (d) X will displace iodine from it

✓ **Correct Answer: (c) X is unreactive**

Explanation: Monoatomic gases are the noble gases (Group 18). They have completely filled valence electron shells, which makes them highly stable and chemically inert. They do not burn, are generally colourless, and do not displace halogens.

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

(a) Low catalytic activity ✓

(b) High density

(c) Low electrical conductivity

(d) High melting point

✓ Correct Answer: (a) Low catalytic activity

Explanation: Group 1 elements (alkali metals) have low catalytic activity. They are highly reactive chemically but do not act as good catalysts like transition metals. They have low density (they float on water), high electrical conductivity, and low melting points.

2. Questions for Short Answers

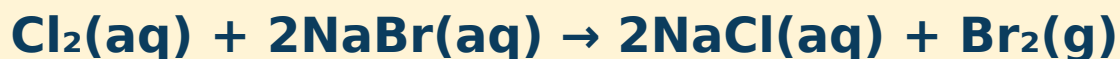
i. Why does it become easier to cut an alkali metal when we move from top to bottom in a group?

Answer: As we move from top to bottom in Group 1, the atomic size increases. This results in weaker metallic bonding because the valence electron is further from the nucleus. Consequently, the metals become softer and are easier to cut.

ii. Predict the reactivity of potassium towards halogens.

Answer: Potassium is an alkali metal and is highly reactive. It will react vigorously with halogens (like chlorine, bromine, and iodine) to form corresponding potassium halides (e.g., KCl, KBr). Its reactivity is higher than that of sodium.

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



Answer: NaBr (or the bromide ion, Br^-) is the reducing agent. It loses electrons (undergoes oxidation) to form Br_2 , causing chlorine to be reduced.

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

Answer: Iodine molecules (I_2) are large and have a high molecular mass. This results in strong van der Waals forces of attraction between the molecules. To overcome these strong intermolecular forces, a higher amount of energy is required, which is why iodine remains solid at room temperature.

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

Answer: Nickel acts as a heterogeneous catalyst. It provides a solid surface for the reactant molecules (hydrogen gas and unsaturated oil) to adsorb. This adsorption weakens the chemical bonds and lowers the activation energy required for hydrogen to add across the double bonds of the oil, converting it into solid fat (vanaspati ghee).

3. Constructed Response Questions

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

Answer: Helium should have the lowest boiling point. It has the smallest atomic size and the weakest van der Waals forces of attraction between its atoms among all noble gases. Therefore, very little energy is required to overcome these forces, resulting in the lowest boiling point.

ii. Compare the reactions of alkali metals with chlorine.

Answer: Alkali metals react vigorously with chlorine gas to form ionic chlorides (MCl). The reaction is highly exothermic.

Reactivity increases down the group:

$Li < Na < K < Rb < Cs$.

Lithium reacts gently, sodium burns with a bright yellow flame, and potassium reacts explosively.

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

Answer: Metals have strong metallic bonding (electrostatic forces between metal cations and delocalized electrons). This requires a lot of energy to break, so they are solid at room temperature. Non-metals either exist as individual atoms/molecules with weak van der Waals forces (gases like noble gases, O₂, N₂) or as covalent network/molecular solids with relatively weaker intermolecular forces compared to metals.

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

Answer: Mercury (Hg), Bromine (Br), and Gallium (Ga).

v. Why are transition elements different from normal elements?

Answer: Transition elements have partially filled d-orbitals in their atomic or common oxidation states. This unique electronic configuration leads to properties like variable oxidation states, formation of coloured compounds, catalytic activity, and paramagnetism, which are not typically observed in normal s-block or p-block elements.

vi. Compare the reactivity of chlorine and bromine as an oxidizing agent.

Answer: Chlorine is a stronger oxidizing agent than bromine. Chlorine has a smaller atomic size, higher electronegativity, and higher electron affinity than bromine. Therefore, chlorine can easily gain electrons and displace bromine from its salt solutions (e.g., $\text{Cl}_2 + 2\text{NaBr} \rightarrow 2\text{NaCl} + \text{Br}_2$).

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

Answer: **Most reactive:** Fluorine. **Least reactive** (among common halogens): Iodine.

Reason 1: Electronegativity decreases down the group from Fluorine to Iodine.

Reason 2: Atomic size increases down the group, which decreases the effective nuclear attraction on incoming electrons, lowering electron affinity and reactivity.

4. Descriptive Questions

i. Explain the role of catalytic converter in an automobile.

Answer: A catalytic converter is an exhaust emission control device. It uses precious metal catalysts (like Platinum, Palladium, and Rhodium) to convert toxic gases and pollutants in exhaust gas into less toxic pollutants. It oxidizes carbon monoxide (CO) to carbon dioxide (CO_2), and unburnt hydrocarbons to CO_2 and water, while reducing nitrogen oxides (NO_x) to nitrogen (N_2) and oxygen.

ii. Why do the chemical reactivities of alkali metals increase down the group whereas they decrease down the group in case of halogens?

Answer: Alkali metals (Group 1) react by *losing* their single valence electron. Down the group, atomic size increases, and ionization energy decreases. Therefore, it becomes easier to lose the electron, increasing reactivity. Halogens (Group 17) react by *gaining* an electron. Down the group, atomic size increases, and the effective nuclear charge on the incoming electron decreases. Thus, electron affinity decreases, making it harder to gain an electron, which decreases reactivity.

iii. Why are metals generally tough and strong whereas non-metals are neither tough nor strong?

Answer: Metals have a strong metallic bond where positively charged metal ions are held together by a sea of delocalized electrons. This allows them to withstand deformation (malleability and ductility) and makes them tough and strong. Non-metals generally have weak intermolecular forces (van der Waals) or directional covalent bonds that break easily when stress is applied, making them brittle and weak.

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

Answer: Alkali metals have one extra valence electron and act as strong reducing agents (they lose electrons easily) to achieve a stable noble gas configuration. Halogens have one less electron than a noble gas and act as strong oxidizing agents (they gain electrons easily). Thus, alkali metals donate electrons while halogens accept them, showing opposite chemical roles.

v. Why hydrogen bromide is thermally unstable as compared to hydrogen chloride?

Answer: The thermal stability of hydrogen halides decreases down the group. The H-Br bond is weaker than the H-Cl bond because the atomic size of Bromine is larger than Chlorine. This leads to poorer orbital overlap between the 1s orbital of Hydrogen and the larger orbital of Bromine, requiring less energy to break the bond.

vi. Compare the properties of metals and non-metals.**Answer:**

Metals	Non-metals
Shiny (lustrous), malleable, ductile, sonorous	Dull, brittle, non-sonorous
Good conductors of heat and electricity	Poor conductors of heat and electricity (except graphite)
Generally high melting and boiling points	Generally low melting and boiling points
Form basic oxides	Form acidic or neutral oxides

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

Answer: Vanadium pentoxide (V_2O_5) is preferred over platinum because it is much cheaper. More importantly, platinum is easily poisoned by impurities (such as arsenic) present in the raw materials, which reduces its catalytic efficiency. V_2O_5 is more resistant to poisoning and has a longer lifespan.

5. Investigative Questions

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?

Answer: In some nuclear reactors, liquid sodium is used as a coolant to transfer heat from the reactor core to the steam generator. The properties utilized are its high specific heat capacity (ability to absorb a lot of heat), high thermal conductivity, and relatively low melting point (so it remains liquid and circulates easily).

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

Answer: Lithium behaves anomalously (differently) from the rest of the alkali metals due to its very small atomic size and high charge density. This causes:

1. High hydration energy.
2. Covalent character in its compounds (e.g., LiCl is covalent).
3. It reacts less vigorously with water compared to sodium or potassium.
4. It forms different oxides (Li_2O) compared to peroxides/superoxides formed by other alkali metals.

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

Answer: Aluminum is used for cooking utensils because it is lightweight, a very good conductor of heat, and forms a protective layer of aluminum oxide (Al_2O_3) on its surface that prevents it from corroding further. Magnesium, on the other hand, is highly reactive, burns easily in air, and corrodes rapidly. It does not form a protective oxide layer as effectively, making it unsafe and unsuitable for cooking utensils.

Thank You!

You have completed the exercise of
Group Properties and Elements

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