

Classification of Elements and Periodicity in Properties — Assignment 2

Class 11 Chemistry · Higher-difficulty challenge set + integrated problems · Answer key included · Narayan Gurukul Academy

Instructions: (1) Attempt all questions; start with the topic-wise challenge set, then attempt the integrated (multi-topic) problems.
(2) Give all answers with correct SI units. $g = 10 \text{ m/s}^2$ unless stated.
(3) A final answer key is provided at the end — try the full set before checking it.

Part A — Topic-wise challenge questions

From Mendeleev to the Modern Periodic Law

1. State the modern periodic law and explain how it improved upon Mendeleev's periodic law.
2. State the main defects of Mendeleev's periodic table.
3. How many groups and periods are there in the modern periodic table?

Electronic Configuration and the Blocks

1. Classify the elements into s, p, d and f blocks with their general outer electronic configurations.
2. What are transition elements? Give an example and write its outer electronic configuration.
3. Name the block to which the halogens belong and give their general configuration.

Atomic and Ionic Radii

1. Explain the variation of atomic radius across a period and down a group.
2. Arrange the following in increasing order of size: Na, Na^+ , Cl, Cl^- . Justify your answer.
3. Compare the size of a cation and an anion with their parent atoms.

Ionisation Enthalpy

1. Define ionisation enthalpy and explain its variation across a period and down a group.
2. Explain why the first ionisation enthalpy of an element is less than its second.
3. Why is the ionisation enthalpy of nitrogen greater than that of oxygen?

Electron Gain Enthalpy and Electronegativity

1. Define electron gain enthalpy and electronegativity and state how each varies across a period.
2. Why is the electron gain enthalpy of chlorine more negative than that of fluorine?
3. Which is the most electronegative element and why?

Trends in Chemical and Physical Properties

1. Explain the variation of metallic and non-metallic character across a period and down a group.
2. Give one example each to illustrate the diagonal relationship in the periodic table.
3. How does the valency of an element change across a period from left to right?

Part B — Integrated problems (multi-topic)

1. Arrange the following in increasing order of atomic radius: Li, Na, K, Rb. Justify.
2. The first ionisation enthalpy of Mg is greater than that of Al. Explain.
3. Write the electronic configurations of Na, Cl and Fe and state the block to which each belongs.
4. Explain why the electron gain enthalpy of chlorine is more negative than that of fluorine.
5. Explain the diagonal relationship between lithium and magnesium with two points of similarity.

Answer Key

From Mendeleev to the Modern Periodic Law

Modern periodic law: properties are a periodic function of atomic number. It removed the anomalies of mass-based ordering (inverted pairs, ambiguous hydrogen, isotopes). The table has 18 groups and 7 periods.

Electronic Configuration and the Blocks

s: ns^{1-2} ; p: ns^2np^{1-6} ; d: $(n-1)d^{1-10}ns^{1-2}$; f: $(n-2)f^{1-14}$. Fe ($Z = 26$): $[\text{Ar}] 3d^6 4s^2$, a d-block (transition) element. Halogens (Group 17) are p-block with ns^2np^5 .

Atomic and Ionic Radii

Atomic radius decreases across a period (increasing nuclear charge) and increases down a group (new shells). A cation is smaller and an anion larger than the parent atom. Increasing size: $\text{Na}^+ < \text{Na} < \text{Cl}^-$ (Cl slightly $>$ Na).

Ionisation Enthalpy

Energy to remove an electron from a gaseous atom. Increases across a period, decreases down a group. Successive ionisation enthalpies increase ($\text{IE}_2 > \text{IE}_1$). $\text{N} > \text{O}$ because nitrogen has a stable half-filled $2p^3$ configuration.

Electron Gain Enthalpy and Electronegativity

Electron gain enthalpy: enthalpy change on adding an electron. Electronegativity: tendency to attract a shared pair. Both increase across a period. Cl has a more negative $\Delta_{\text{eg}}H$ than F because of the small size and electron-electron repulsion in fluorine; F is the most electronegative element.

Trends in Chemical and Physical Properties

Metallic character decreases across a period and increases down a group; non-metallic character is opposite; valency rises then falls. Diagonal relationship (Li–Mg, Be–Al) arises from similar size and electronegativity.

Integrated problems

1: $\text{Li} < \text{Na} < \text{K} < \text{Rb}$. 2: Mg has a filled $3s^2$ configuration, which is more stable than Al's $3s^2 3p^1$. 3: Na: $1s^2 2s^2 2p^6 3s^1$ (s-block), Cl: $1s^2 2s^2 2p^6 3s^2 3p^5$ (p-block), Fe: $[\text{Ar}] 3d^6 4s^2$ (d-block). 4: Cl is larger than F, so added electrons experience less repulsion. 5: Li and Mg both form nitrides and have similar electronegativity.