Engineering Chemistry – Unit 7 Premium Notes

Periodic Properties

RGPV Engineering Chemistry Notes

Unit Overview

This unit is very important in Engineering Chemistry because questions related to:

- Effective Nuclear Charge
- Electronic Configuration
- Atomic Size
- Ionic Size
- Electron Affinity
- Electronegativity
- Polarizability
- Oxidation States

are frequently asked in RGPV examinations.

This unit is scoring because:

- Theory is direct
- Definitions are important
- Trends are repeatedly asked
- Numerical concepts are simple

Periodic Properties

Definition

Properties of elements which change regularly in the periodic table are called periodic properties.

These properties depend upon:

- Atomic number
- Electronic configuration
- Nuclear charge

Effective Nuclear Charge

Definition

The net positive charge experienced by outermost electrons after shielding effect of inner electrons is called effective nuclear charge.

Represented by:

Zeff

Formula

Zeff = Z – S

Where:

- Z = Atomic number
- S = Shielding constant

Shielding Effect

Inner electrons repel outer electrons and reduce attraction of nucleus.

This is called shielding effect.

Importance of Effective Nuclear Charge

- Determines atomic size
- Controls ionization energy
- Affects electron affinity

Variation of Effective Nuclear Charge

Across Period

Effective nuclear charge increases.

Reason:

Atomic number increases while shielding remains almost same.

Down Group

Effective nuclear charge changes slowly.

Reason:

Increase in shielding effect.

Orbital Energies in Periodic Table

Energy of orbitals depends upon:

- Principal quantum number
- Shielding effect
- Penetration power

Order of Orbital Energies

s < p < d < f

Penetration Power

Definition

Ability of electron to approach nucleus.

Order:

s > p > d > f

Characteristics of Orbitals

s-Orbital

- Lowest energy
- Highest penetration power
- Spherical shape

---

p-Orbital

- Dumbbell shape
- Higher energy than s orbital

---

d-Orbital

- More complex shape
- Higher energy than p orbital

---

f-Orbital

- Highest energy
- Complex shape

Electronic Configuration

Definition

Arrangement of electrons in different orbitals of atom is called electronic configuration.

Aufbau Principle

Electrons fill lower energy orbitals first.

Pauli Exclusion Principle

No two electrons can have same set of quantum numbers.

Hund’s Rule

Electrons occupy degenerate orbitals singly first.

Examples of Electronic Configuration

Sodium (Na)

$1s^2\ 2s^2\ 2p^6\ 3s^1$

Chlorine (Cl)

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

Atomic Size

Definition

Distance between nucleus and outermost electron is called atomic size.

Variation in Atomic Size

Across Period

Atomic size decreases.

Reason:

Increase in effective nuclear charge.

Down Group

Atomic size increases.

Reason:

Increase in number of shells.

Ionic Size

Definition

Size of ion formed after gain or loss of electrons.

Cation

Positive ion formed after loss of electrons.

Cation size is smaller than atom.

Anion

Negative ion formed after gain of electrons.

Anion size is larger than atom.

Electron Affinity

Definition

Amount of energy released when an electron is added to neutral atom.

Variation of Electron Affinity

Across Period

Electron affinity increases.

Down Group

Electron affinity decreases.

Electronegativity

Definition

Tendency of atom to attract shared electron pair towards itself.

Variation of Electronegativity

Across Period

Electronegativity increases.

Down Group

Electronegativity decreases.

Factors Affecting Electronegativity

- Atomic size
- Effective nuclear charge
- Shielding effect

Polarizability

Definition

Ability of electron cloud to get distorted by external electric field.

Factors Affecting Polarizability

- Ionic size
- Charge on ion
- Number of electrons

Oxidation State

Definition

Apparent charge present on atom in compound is called oxidation state.

Rules for Oxidation State

- Oxidation state of free element = 0
- Oxygen usually = –2
- Hydrogen usually = +1

Example

For H_2SO_4:

Hydrogen = +1

Oxygen = –2

Sulphur = +6

Applications of Oxidation State

- Balancing redox reactions
- Electrochemistry
- Corrosion studies

Difference Between Atomic Size and Ionic Size

Atomic Size	Ionic Size
Size of neutral atom	Size of ion
Depends on electron shells	Depends on gain/loss of electrons

Difference Between Electron Affinity and Electronegativity

Electron Affinity	Electronegativity
Energy released	Attraction of shared electrons
Measured in energy units	Relative property

Numerical Concept – Effective Nuclear Charge

Formula

$Z_{eff} = Z - S$

Example

For sodium:

$Z = 11$

$S = 10$