PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

পাবনা বিজ্ঞান ও প্রযুক্তি বিশ্ববিদ্যালয়

PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Assignment

Course Title : Chemistry

Course Code: CHE-2201

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Session: 2021-22
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5. (a) Defects of Rutherford’s Model and Bohr’s Improvements

Defects:

Instability of the atom: According to classical electromagnetic theory, electrons moving around the nucleus in circular paths should continuously lose energy, causing them to spiral into the nucleus. If that were true, atoms would collapse — but they don't!

Spectral lines mystery: Rutherford’s model couldn’t explain why atoms, like hydrogen, give off light at specific wavelengths (discrete line spectra) instead of a continuous range.

Bohr’s Solutions:

Bohr suggested that electrons orbit the nucleus in certain **fixed paths** or **stationary states** without radiating energy.

Energy is only absorbed or emitted when an electron **jumps** from one orbit to another, and the energy difference between orbits matches the energy of the emitted or absorbed light.

5. (b) Quantum Numbers and Their Meaning

Quantum numbers are like an electron’s "address" — they tell us exactly where an electron is and how it behaves inside an atom.

Principal Quantum Number (n): Shows the main energy level or shell (n = 1, 2, 3...). Higher ‘n’ means more energy and bigger distance from the nucleus.

Azimuthal Quantum Number (l): Describes the shape of the orbital (s, p, d, f shapes where l = 0, 1, 2, 3).

Magnetic Quantum Number (m): Tells the orientation or direction of the orbital (values between -l and +l).

Spin Quantum Number (s): Describes the spin of the electron: clockwise (+½) or counterclockwise (–½).

6. (a) Comparing Ionic and Covalent Compounds

Property	Ionic Compounds	Covalent Compounds
Bond Formation	Electron transfer	Electron sharing
State	Solid crystals	Solids, liquids, or gases
Melting/Boiling Points	Very high	Usually lower

Property	Ionic Compounds	Covalent Compounds
Solubility	Soluble in water	Soluble in non-polar solvents
Electrical Conductivity	Conducts when molten or dissolved	Usually poor conductors

Examples:

Ionic: Sodium chloride ($NaCl$), magnesium oxide (MgO)

Covalent: Carbon dioxide (CO_2), water (H_2O)

6. (b) What is a Co-ordinate Covalent Bond?

In a **coordinate covalent bond**, one atom donates **both electrons** for sharing, unlike in a regular covalent bond where each atom donates one.

Difference:

Normal Covalent Bond: Each atom gives one electron.

Coordinate Covalent Bond: One atom gives both electrons.

Example:
In the ammonium ion (NH_4^+), nitrogen donates a lone pair to bond with a hydrogen ion (H^+).

7. (a) Hydrogen Bonds and Water's Boiling Point

A **hydrogen bond** forms when a hydrogen atom attached to a highly electronegative atom (like O, N, or F) is attracted to another electronegative atom.

Types:

Intermolecular hydrogen bonding: Between different molecules (like between H_2O molecules).

Intramolecular hydrogen bonding: Within the same molecule (like in o-nitrophenol).

Water Has a High Boiling Point:

Water molecules are strongly held together by hydrogen bonds. It takes a lot of extra energy to break these bonds, leading to a much higher boiling point than expected.

7. (b) Why Bond Angles of H_2O and NH_3 are Different

Even though both water (H_2O) and ammonia (NH_3) have central atoms that are **sp^3 hybridized**, their bond angles differ because of **lone pair repulsion**:

NH_3 (ammonia): One lone pair causes the bond angle to shrink slightly to **107°**.

H_2O (water): Two lone pairs cause even stronger repulsion, shrinking the bond angle further to **104.5°**.

8. (a) What is Ionization Potential and How Does it Change?

Ionization Potential is the energy needed to remove the outermost electron from a neutral, gaseous atom.

First ionization energy is always lower than the **second** because once you remove one electron, the atom becomes positive and holds onto its remaining electrons more tightly.

Trends:

Across a period (left to right): Ionization potential increases (atoms get smaller and nuclear pull gets stronger).

Down a group: Ionization potential decreases (atoms get bigger and nuclear pull weakens).

8. (b) What are f-block Elements?

f-block elements are those in which the last electron enters an **f-orbital** (specifically, the (n-2)f orbital).

Inner Transition Elements:

They are positioned between the s- and d-blocks.

The filling of **inner orbitals** (f-orbitals) happens, while outer orbitals remain the same — hence called "inner" transitions.

Examples:

Lanthanides: Cerium (Ce), Neodymium (Nd)

Actinides: Thorium (Th), Uranium (U)