Pabna University of Science and Technology

Faculty of Engineering and Technology

Department of Information and Communication Engineering

Assignment

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Course title**: Chemistry**

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5(a): Give the defects of Rutherford‟s model of atom. What suggestions were given by Bohr to remove these defects?

Answer:

Defects of Rutherford‟s model of atom:

(i) The planets of Solar system are chargeless but atom electrons are negative charged, Sciencetist Ratherford can’t tell about this charge.

(ii) From the electromagnetic theory of Maxwell about light ,we know that if a charged particle move in a circular path , it’s path gradually decrease and at last it go to the center of circle. But here electrons are moves in a certain axis, they won’t go to the incur of nucleus.

(iii) He can’t tell about H spectrum . It can’t tell about the created lines spectrum that are unbroken.

(iv) The path of rolling electron how wiwidest or it’s shapes this model can’t tell.

(v)This model can’t tell how the electrons move around nucleus which atom has more than one electron.

Proposal of Bohrs atom model:

(i)Electrons remove in fixed energy level: The negatively charged particles revolves around the positively charged nucleus in specific circular path or orbit. While electron revolves ,it’s neither emits nor absorbs any energy. This path are known as energy levels or stationary states or orbit.

(ii)Quantization of angular momentum:

$$mvr = nh/2\pi$$

where m= mass of electron
v= velocity of electron
r= radius of orbit
n- principal quantum number
h= 6.626*10^-34 Js

(iii) **Emission or absorption of Energy:**

Electrons emit or absorb energy only when they jump from one stationary orbit to another.
The energy difference between the two orbits is given by:

$\Delta E = h\nu$

where h is Planck's constant and ν is the frequency of radiation.

5(b):.What do you understand by the term, " Quantum number". How many quantum numbers has an electron in an orbital? And its significance.

Answer:

Quantum Number: Quantum numbers are numbers that describe the unique position and energy of an electron in an atom. They specify the electron’s orbit (energy level), shape of the orbital, orientation of the orbital, and spin direction.

The Four Quantum Numbers

(i) Principal Quantum Number (n):

- Tells: Main energy level or shell (like K, L, M...).
- Values: $n=1,2,3,4,\ldots n$
- **Significance**:
    - Determines the size and energy of the orbital.
    - Larger n → farther electron from nucleus → higher energy.

(ii) Azimuthal Quantum Number (l):

- Tells: Shape of the orbital (s, p, d, f).
- Values: $l=0$ to $(n-1)(n-1)(n-1)$
  Significance:
    - $l=0$ → s-orbital (spherical)
    - $l=1$ → p-orbital (dumbbell-shaped)
    - $l=2$ → d-orbital (cloverleaf)
    - $l=3$ → f-orbital (complex shapes)

(iii) Magnetic Quantum Number (m):

- Tells: Orientation of the orbital in space.
- Values: $m1 = -l$ to $+l$ (including 0)
- **Significance:**

   - Describes how the orbital is oriented around the nucleus.
   - Example: For l=1 (p-orbital), m1 = -1, 0, +1 (three p-orbitals: px,py,pz)

(iv) Spin Quantum Number (ms):

- Tells: Direction of the electron's spin.
- Values: ms=+1/2 or -1/2
- **Significance:**
   - Two electrons in the same orbital have opposite spins (one clockwise, one anticlockwise).
   - It helps explain the magnetic properties of atoms.

6(a): Compare the properties of ionic and covalent compounds. Give two examples of each type of compounds.

Answer:

Ionic Compounds	Covalent Compounds
Formed by complete transfer of electrons	Formed by sharing of electrons
Constituent Particles is Ions	Constituent Particles is Molecules
Generally solid	Can be solid, liquid, or gas
Melting and Boiling Points is High	Melting and Boiling Points is Low
Soluble in water (polar solvents)	Soluble in organic solvents (non-polar solvents)

- Ionic Compounds:
    1. Sodium chloride (NaCl)
    2. Magnesium oxide (MgO)
- Covalent Compounds:
    1. Water (H_2O)
    2. Carbon dioxide (CO_2)

6(b):. What is a co-ordinate covalent bond? How does it differ from a normal covalent bond?

Answer: It is a type of covalent bond where both the shared electrons come from the same atom. One atom donates a lone pair (already paired electrons) to another atom that has an empty orbital.

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

Normal Covalent Bond	Co-ordinate Covalent Bond
Each atom contributes one electron	One atom contributes both electrons
Formed by mutual sharing of electrons	Formed by donation of lone pair
Shown by a single line (–)	Often shown by an arrow (→) from donor to acceptor
Example H_2, O_2, CO_2	Example NH_4^+, H_3O^+, CO

7(a): What do you understand by hydrogen bonds? Classify them with examples. Explain why water has abnormally high boiling point.

Answer:

Hydrogen Bond: A hydrogen bond is a weak bond formed when a hydrogen atom, already bonded to a highly electronegative atom (like F, O, or N), is attracted to another electronegative atom nearby. It is stronger than vander Waals forces but weaker than covalent bonds.

Classification of Hydrogen Bonds:

(i) Intermolecular Hydrogen Bond:

- Formed between two different molecules.
- Example:
  - Between two water molecules ($H_2O \cdots H_2O$)
  - Between two ammonia molecules ($NH_3 \cdots NH_3$)

(ii) Intramolecular Hydrogen Bond:

- Formed within the same molecule between different parts of it.
- Example:
  - In *ortho*-nitrophenol, a hydrogen bond forms between $-OH$ and $-NO_2$ groups inside the same molecule.

Cause of water have an abnormally high boiling point:

- In water (H_2O), strong intermolecular hydrogen bonds are present between water molecules.
- A lot of energy is needed to break these strong hydrogen bonds during boiling.
- That's why water has a much higher boiling point than expected for a small molecule.

7(b): Why bond angles of H2O and NH3 are 104.5° and 107° respectively although central atoms are sp3 hybridized.

Answer:

In NH_3 (Ammonia):

- Nitrogen has one lone pair and three bond pairs (N-H bonds).
- Lone pair electrons are more repulsive than bond pair electrons because lone pairs are localized closer to the nucleus.
- So, the lone pair pushes the bond pairs closer together, slightly reducing the bond angle from 109.5° to 107°.

In H_2O (Water):

- Oxygen has two lone pairs and two bond pairs (O-H bonds).
- Now, with two lone pairs, the repulsion is even stronger compared to NH_3.

- The two lone pairs push the bond pairs even closer, so the bond angle reduces further from 109.5° to 104.5°.

8(a): What do you mean by the „ionization potential" of an element? Why the first ionization potential of an element is less than the second ionization potential? How does the ionization potential of an element vary with atomic volume?

Answer:

Ionization Potential: Ionization Potential (IP) means the energy required to remove the outermost electron from an isolated gaseous atom. It is also called Ionization Energy.

In short: Ionization potential = energy needed to pull an electron away from an atom.

First Ionization Potential less than the Second Ionization Potential:

- The first ionization potential is the energy to remove one electron from a neutral atom.
- After removing one electron, the atom becomes a positive ion (cation).
- Now, the positive ion holds the remaining electrons more tightly (due to greater effective nuclear charge).

Ionization Potential vary with Atomic Volume

- Atomic volume means how big the atom is (how much space it occupies).
- If atomic volume is large, the outermost electrons are farther from the nucleus and are less tightly held.
  → So, less energy is needed to remove an electron → Lower ionization potential.
- If atomic volume is small, electrons are closer to the nucleus and tightly held.
  → So, more energy is needed → Higher ionization potential.

- So, more energy is needed to remove the second electron.
  → Therefore, second ionization potential is greater than the first.

8(b): What do you mean by f-block elements? Why f-block elements are called inner transition elements

Answer:

f-block elements:

- f-block elements are the elements where the last electron enters into the f-orbital.
- In the periodic table, they are shown separately at the bottom in two rows:

    - Lanthanides (atomic numbers 58 to 71)

Cause why the known as Inner Transition Elements:

- They are called inner transition elements because:
    - Their f-electrons are deep inside (inner shells), *not* in the outermost shell.
    - The outermost electrons are generally in s- or d-orbitals, while the f-orbitals are filling up inside.
- Compared to d-block (normal transition metals), their transition (electron filling) happens internally.