FACULTY OF ENGINEERING

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DEPARTMENT OF INFORMATION AND COMMUNICATION ENGINEERING

Assignment

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Submitted By:

Name:Sayara Tasnim Shipra

Roll:220631

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Abrar Yasir Abir

Lecturer

Department of chemistry

Pabna University of Science and Technology

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5.a. Give the defects of rutherfords model of atom.what suggestion were given by Bohr tp remove these defects?

Answer:1. Instability of Electrons (Based on Classical Electromagnetism):

According to classical physics, an electron moving in a circular orbit around the nucleus should continuously emit energy (since it's accelerating).

As a result, it should spiral inward and crash into the nucleus.

But atoms are stable in reality, which contradicts this idea.

2.Lack of Explanation for Atomic Spectra:

Rutherford’s model couldn’t explain the discrete lines observed in atomic spectra (e.g., hydrogen's line spectrum).

If electrons could orbit at any distance, they should emit a continuous spectrum, not specific lines.

🔵 Bohr’s Suggestions (Bohr's Atomic Model):

Quantized Orbits (Stationary States):

Bohr proposed that electrons revolve around the nucleus in specific discrete orbits (energy levels) without radiating energy.

These orbits are called stationary states.

Energy Quantization:

Electrons can only gain or lose energy by jumping from one allowed orbit to another.

The energy emitted or absorbed corresponds to the difference between the energy levels:

$\Delta E = h$,ΔE=hν

where h

h is Planck's constant and ν

ν is the frequency of radiation.

Angular Momentum Quantization:

The angular momentum of an electron in an orbit is quantized and given by:

$L = n\hbar = nh2\pi$

L=n$\hbar$= 2πnh

where

n

n is a positive integer (principal quantum number).

5.b: what do you understand by the term Quantum number .How many quentum number has an electron in an orbital?explain the significance of each quentum number?

Answer: A quantum number is a value that describes specific properties of an electron in an atom. These numbers arise from the solutions of the Schrödinger equation and help us understand the position, energy, and orientation of electrons in atoms.

1. Principal Quantum Number (

n

n):

Indicates: Energy level or shell of the electron.

Values: Positive integers (1, 2, 3, …)

Significance:

Larger

n

n = higher energy and farther from the nucleus.

Determines the size of the orbital.

Example:

n

=

1

n=1 is the K-shell,

n

=

2

n=2 is the L-shell, etc.

2. Azimuthal Quantum Number (

l

l):

Indicates: Subshell or shape of the orbital.

Values: From 0 to

n

−

1

n−1 for each value of

n

n.

Significance:

Determines the shape of the orbital.

Also helps classify the type of orbital:

l

=

0

l=0: s-orbital

l

=

1

l=1: p-orbital

l

=

2

l=2: d-orbital

l

=

3

l=3: f-orbital

3. Magnetic Quantum Number (

m

l

m

l

):

Indicates: Orientation of the orbital in space.

Values: From

$-l$–l to+l+l, including 0.

Significance:

Tells us how many orbitals are present in a subshell.

For example:

If

l=1

l=1 →

m

l=−1,0,+1

m l=−1,0,+1 → 3 p orbitals.

4. Spin Quantum Number (

msm s

):

Indicates: Direction of the electron’s spin.

Values:

+1/2

+ 2/1

or

$-1/2$

− 21

Significance:

Electrons in the same orbital must have opposite spins (Pauli Exclusion Principle).

Only two electrons can occupy the same orbital.

6a. compare the properties of ionic and covalent bond .give two example of each type of compounds?

Answer: Comparison: Ionic Bond vs Covalent Bond

Property	Ionic Bond	Covalent Bond
Formation	Formed by transfer of electrons from a metal to a non-metal	Formed by sharing of electrons between two non-metals
Type of Elements	Metal + Non-metal	Non-metal + Non-metal
Bond Strength	Strong electrostatic attraction	Usually weaker than ionic bonds
Physical State	Solid at room temperature	Can be solid, liquid, or gas
Melting & Boiling Points	High	Usually low (except in giant covalent structures like diamond)

Electrical Conductivity   Conducts electricity in molten or aqueous form (ions are free to move)   Does not conduct electricity (except in some polar covalent compounds)

Solubility Soluble in water   Usually insoluble in water, soluble in organic solvents

Examples

Sodium chloride (NaCl), Magnesium oxide (MgO)   Water (H_2O), Carbon dioxide (CO_2)

Example of ionic bond:

Sodium chloride (NaCl) – formed by transfer of 1 electron from Na to Cl.

Magnesium oxide (MgO) – Mg gives away 2 electrons to O.

◈ Examples of Covalent Compounds:

Water (H_2O) – each H shares 1 electron with O.

Carbon dioxide (CO_2) – each O shares 2 electrons with C (double bonds).

7a. what do you understant by the Hydrogen bond?classify them with example .explain why water has abnormaly high boiling point?

What is a Hydrogen Bond?

A hydrogen bond is a special type of intermolecular force that occurs when hydrogen is covalently bonded to a highly electronegative atom (like fluorine, oxygen, or nitrogen), and this hydrogen atom is attracted to a lone pair of electrons on another electronegative atom in a nearby molecule.

➡ It's stronger than Van der Waals forces but weaker than covalent or ionic bonds.

📚 Classification of Hydrogen Bonds:

1. Intermolecular Hydrogen Bond:

Occurs between molecules.

Example: Water (H_2O) – hydrogen atom of one water molecule forms a bond with the oxygen atom of another.

Illustration:

H–O

\cdotp

\cdotp

\cdotp

H–O

\cdotp

\cdotp

\cdotp

H–O

H–O\cdotp\cdotp\cdotpH–O\cdotp\cdotp\cdotpH–O

Effect: Leads to high boiling point, surface tension, and ice floating.

2. Intramolecular Hydrogen Bond:

Occurs within the same molecule, between two groups.

Example: Ortho-nitrophenol – hydrogen bonds form between –OH and $–NO_2$ within the same molecule.

Effect: Affects molecular shape, boiling point (lower than expected), and solubility.

🔥 Why Does Water Have an Abnormally High Boiling Point?

Water's boiling point is unusually high (100°C) compared to other group 16 hydrides like H_2S, H_2Se, etc. Here's why:

✅ Due to Hydrogen Bonding:

Each water molecule can form up to 4 hydrogen bonds (2 through lone pairs on O, and 2 through H atoms).

This creates a strong, extensive network of hydrogen bonds.

A lot of energy is required to break these bonds during boiling.

So, despite being a small molecule, water needs more heat to change from liquid to gas — hence, the high boiling point.

7b. why bond angle of H2O AND NH3are104.5and 107respectivelyalthough central atoms are sp3 hybridization?

Answer: Basic Idea: sp^3 Hybridization

In sp^3 hybridization, one s-orbital and three p-orbitals mix to form four equivalent orbitals arranged in a tetrahedral geometry.

The ideal bond angle for a perfect tetrahedron is 109.5°.

Reason: Lone Pair–Bond Pair Repulsion

Here’s what causes the bond angles to shrink:

Lone pairs take up more space than bonding pairs because they are only attracted to one nucleus (the central atom), not shared between atoms.

This creates greater repulsion, which pushes the bonded atoms closer together, decreasing the bond angle.

📊 Order of Repulsion Strength (VSEPR Theory):

Lone pair–lone pair (strongest)>Lone pair–bond pair>Bond pairbond pair (weakest)

Lone pair–lone pair (strongest)>Lone pair–bond pair>Bond pair–
bond pair (weakest)

🔍 Explanation for Each:

□ NH_3 (Ammonia):

Has 3 bond pairs and 1 lone pair on nitrogen.

The lone pair repels the bonding pairs more strongly than they repel each other.

This reduces the angle from 109.5° to 107°.

🌊 H_2O (Water):

Has 2 bond pairs and 2 lone pairs on oxygen.

Now there are two lone pairs, which repel even more strongly.

This squashes the H–O–H angle down to 104.5°.

8a. what doyoumean by ionizationpotentialof an element?why thefirst ionizationpotentialof an elementisless tansecondionizationpotential?how does the ionaizationpotentialof an element vary with atomic volume?

Answer: ⚡ What is Ionization Potential?

Ionization potential (or ionization energy) is the amount of energy required to remove the most loosely bound electron (usually from the outermost shell) from an isolated gaseous atom.

$$X(g) + \text{Ionization energy} \rightarrow X^{+}(g) + e^{-}$$

X(g)+Ionization energy→X

+

(g)+e

−

It's measured in kJ/mol or eV.

Indicates how tightly an electron is held by the nucleus.

🔥 Why is the First Ionization Potential Less Than the Second?

First Ionization Potential (IP_1):

Energy to remove the first electron from a neutral atom.

Second Ionization Potential (IP_2):

Energy to remove the second electron from the already positively charged ion (X^+).

✅ Reason:

After removing the first electron, the atom becomes a positively charged ion (X^+).

Now the remaining electrons are held more strongly due to greater effective nuclear charge (less electron shielding).

So, more energy is required to remove the second electron.

In short:

IP

2

>

IP_1

IP_2

$>IP_1$

because it's harder to pull an electron from a positively charged ion than from a neutral atom.

📉 How Does Ionization Potential Vary with Atomic Volume?

There is an inverse relationship between atomic volume and ionization potential.

▼ Larger Atomic Volume = Lower Ionization Potential

As atomic size increases (going down a group in the periodic table), the outermost electrons are farther from the nucleus.

The nuclear attraction decreases, so less energy is required to remove an electron.

Hence, ionization potential decreases with increasing atomic volume.

📈 Smaller Atomic Volume = Higher Ionization Potential

Smaller atoms (like in the top right of the periodic table) have electrons closer to the nucleus.

These electrons are held more tightly, so more energy is needed to remove them.

8b. what doyoumean by f blockelement ?whyf bloct element arecalled innertransitionelement?

Answer: 🔷 What Do You Mean by f-block Elements?

f-block elements are the elements in which the last electron enters the f-orbital of the atomic structure.

They are found in the two rows placed separately at the bottom of the periodic table.

These include:

Lanthanides (4f block): Elements with atomic numbers 58 to 71 (Ce to Lu).

Actinides (5f block): Elements with atomic numbers 90 to 103 (Th to Lr).

➡ General electron configuration:

$(n-2)f1-14(n-1)d0-1ns2$

(n−2)f 1−14(n−1)d 0−1ns 2

🔶 Why are f-block Elements Called Inner Transition Elements?

They are called inner transition elements because:

Their f-orbitals are “inner” orbitals:

The electrons are being added to the inner f-subshell, which is buried below the outermost energy levels.

That’s different from transition elements (d-block), where electrons go into the outer d-orbitals.

They form a transition between s-block and d-block elements — but internally:

In the periodic table, they are placed separately to keep the table from being too wide.

They represent a transition within the inner electron shells.