**ACTIVITY ORIENTED LESSON PLAN - 7**

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| **I Preliminary Details**  Name of the Teacher: SHANAVAS K E Standard: XI Science Name of the Institution: JHSS Thandekkad Time : 45 minutes Subject: Chemistry Unit: VI  Chapter: Chemical bonding and Molecular structure.  Topic: Molecular orbital Theory (MOT), Energy level diagram for Molecular orbitals. |

**II Types of Knowledge**

(i) **Factual Knowledge:** Terms: Bonding Molecular Orbitals (BMO), Antibonding Molecular Orbitals (AMO), Sigma and Pi Molecular Orbitals.

Facts:

(1) The number of molecular orbitals formed is equal to the number of combining

atomic orbitals.

(2) When addition of two atomic orbitals form BMO and subtraction form AMO

**ii) Conceptual Knowledge:**

**Concepts:** MOT, BMO, AMO, Sigma and Pi molecular orbitals.

**Definitions**:

(1) BMO is formed by addition of atomic orbitals has lower energy than combining orbitals.

(2) AMO is formed by subtraction of atomic orbitals has higher energy than combining

orbitals.

(3) Sigma molecular orbitals is formed by overlap of atomic orbitals along internuclear axis.

(4) Pi molecular orbitals is formed by overlap of atomic orbitals perpendicular to inter

nuclear axis.

**(iii) Procedural Knowledge:**

**(**1**)** Formation of Sigma and Pi molecular orbitals.

**Steps**

1. Write the addition and subtraction of atomic orbitals.
2. Draw the shape of BMO and AMO
3. Identifies the BMO and AMO

(2**)** Energy level diagram of N2 or O2

**Steps**

1. Write energy sequence of N2 or O2
2. Draw the atomic and molecular orbitals through the energy level diagram.

**(iv) Meta Cognitive Knowledge**

The students can acquire the awareness of knowledge, thinking and learning strategies in

MOT and energy level diagrams for molecular orbitals.

**III Instructional objectives and Learning Outcomes**

Defines, explain, draws, analyses, predict and create the formation of BMO and AMO through MOT and the energy level diagram.

**IV Previous knowledge**

The students have the knowledge about the atomic orbitals and its electronic configuration.

**V Learning aids**

(a) Chart showing diagrams of BMO, AMO, Sigma and Pi molecular orbitals.

(b) Energy sequence and energy level diagram of N2 and O2.

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| **Constructivist Learning Design** | |
| **Activity** | **Student response with Assessment** |
| **Phase I Situation**  Can you give the subshell wise electronic configuration of H atoms to form H2 molecules?  Give the shape of H atoms to form H2 molecule.  Here atomic orbital of one H atom overlap with another H atom to form molecular orbitals (M.O).  That is, bonding molecular orbital (BMO) and anti-bonding molecular orbital (AMO) are formed.  Who proposed molecular orbital theory. (MOT)  **Phase II Grouping**  Students are grouped on the scientist who proposed molecular orbital theory  **Phase III Bridging**  Can you give the Salient features of molecular orbital theory? | Students share their experiences.  H + H → H2  Is1 1s1 1s2    Hund and Mullickan  Students are grouped into two groups as Hund group and Mullickan group  Hund group hang the chart of MOT  The number of M.O formed is equal to the number of atomic orbitals combined. Here Bonding Molecular Orbital (BMO) and Anti bonding Molecular Orbital (AMO) are formed.  Like atomic orbitals, the molecular orbitals are filled in accordance with Aufbau, Pauli’s exclusion principle and Hund’s rule |
| **Factual knowledge**  Students recognise the formation of molecular orbital. | |
| **Phase IV Questions**  How will you express BMO and AMO  What are the orbitals overlap along inter nuclear axis?  Name their molecular orbitals.  **Phase V Exhibit**  How sigma molecular orbitals formed? | Mullikan group write the expression of BMO and AMO.  BMO is formed by addition of atomic orbitals has lower energy than combining orbitals. It favours bond formation.    AMO is formed by subtraction of atomic orbitals has higher energy than the combining orbitals. It opposes bond formation.    Hund group writes it on the board  1s, 2s, 2pz orbitals  Sigma molecular orbitals  Mullikan group hang the chart of sigma  M. O’s.  Sigma molecular orbitals is formed by overlap of atomic orbitals along internuclear axis. Overlapping is maximum. strong bond. One electron cloud. Symmetrical around the internuclear axis. |
| **Procedural knowledge**  Students draws the shape of sigma molecular orbital. | |
| How pi molecular orbitals formed? | Hund group hang the chart of pi molecular orbitals.  Pi molecular orbitals is formed by sidewise overlap of atomic orbitals. Overlapping is weak.  Two electron cloud. Not symmetrical around inter nuclear axis. |
| **Conceptual Knowledge**  Students define BMO, AMO, sigma and pi molecular orbitals | |
| What type of molecular orbitals formed by mixing?   1. 2Px and 2Py atomic orbitals perpendicular to inter nuclear axis 2. 2Pz, 2s atomic orbitals along inter nuclear axis   Write the energy sequence for  a) B2, C2, and N2 (π→σ).  b) O2, F2 and Ne2 (σ→π)  **Phase VI Reflection**  Draw the energy sequence and energy level for O2 molecule. Identify the magnetic nature. Calculate bond order  Can you give energy sequence of O2 molecule?  The draw energy level diagram for O2 molecule? | Students group write it on the board.   1. Π 2px = Π 2py BMO’S   Π \*2px = Π \*2py AMO’S  b) σ2pz BMO by addition  σ\*2pz AMO by subtraction  2s form σ 2s and σ \*2s M. O’S  Students group hang the chart for energy sequence.  \* IS < 2S< \*2S< 2PX= 2PY< 2PZ < \*2PX= \*2PY< \*2PZ  10 orbitals. It contains 20 electrons  The small energy difference between 2s and 2p orbital. Orbital mixing effect.  1\*1s< 2s< \*2s pz <2px =2py < \*2px=\*2py < \*2pz  The large energy difference between 2s and 2p orbital. Sigma overlapping is stronger.  Students group hang the chart of energy level for O2 molecule.  The energy sequence of O2 molecule (above). O2 = O + O = 8+8 +16 electrons.  B.O =½ (Nb - Na)  Where Nb = number of electrons in Bonding Molecular Orbital (BMO)  Na = number of electrons in Anti bonding Molecular Orbital (AMO)  B.O = ½ (10 - 6) =2  Bond order 2 means double bond. O = O  **1\*1s2 < 2s2 < \*2s2 < 2pz2 <2px2 =2py2 < \*2px1 =\*2py1**    Fig. Energy level diagram for O2 molecule.  Unpaired electron indicates para magnetic nature. |
| **Meta cognitive knowledge** The students can acquire the awareness of knowledge, thinking and learning strategies in Sigma and Pi molecular orbitals. | |
| **Follow up Activities**  Draw the energy sequence and energy level diagram for N2+ molecule ion ?  Calculate bond order of N2+ molecule ion ? | Assign to two groups  N2+ ion (N + N+) = 7 + 6 = 13  The energy sequence for N2+ molecule ion is  **\* IS2 < 2S2< \*2S2 < 2PX2= 2PY2< 2PZ1**  Unpaired electron. Paramagnetic nature.  The energy sequence and energy level diagram for N2+ molecule ion is    **B.O = ½ (Nb – Na) = ½ (9 – 4) = 5/2 = 2½** |