**ACTIVITY ORIENTED LESSON PLAN - 2**

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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 : IV Chapter : Chemical Bonding & Molecular Structure Topic : Formal charge, Bond parameters, Lattice enthalpy and Resonance. |

**II Types of Knowledge**

(i) **Factual Knowledge:**

**Terms:** Formal charge, Bond length, Bond angle, Bond enthalpy, Bond order, Latticeenthalpy and Resonance.

**Facts:**

(1) In the case of polyatomic ions, the net charge is possessed by the ion as a whole not by a particular atom and that is feasible to assign a formal charge on each atom.

(2) The stability of ionic compound is provided by its Lattice enthalpy formation and not simply by achieving octet of electrons.

**(ii) Conceptual Knowledge:**

**Concepts:** Formal charge, Bond length, Bond angle, Bond enthalpy, Bond order, Latticeenthalpy and Resonance.

**Definitions**:

(1) The formal charge is defined as the difference between the number of valence electrons of that atom in an isolated or free state and the number of electrons assigned to that atom in the Lewis structure.

(2) The bond parameters refer to the characterization of covalent bond on the basis of various parameters like Bond length, Bond angle, Bond enthalpy and Bond order.

(3) Lattice enthalpy is defined as the amount of energy released when one mole of ionic solid is formed by the close packing of gaseous ions.

(4) A molecule or ion with delocalized electrons is represented by several contributing structures is called Resonance.

**(iii) Procedural Knowledge:**

(1) Expression and calculation of formal charge on oxygen in ozone O3

**Steps**

1. Write the equation of formal charge.
2. Using this equation, calculate formal charge on each oxygen atom in ozone O3

(2) Calculation of Lattice enthalpy of NaCl.

**Steps**

1. Definition of Lattice enthalpy.
2. Na+(g) + Cl- (g) → NaCl + U

(3) Formation of resonance in Ozone, O3

1. Write the electronic configuration of oxygen atom and its six-valence electron.
2. Write the structure of O3 using covalent bond.
3. In ozone, the number of paired and unpaired electrons remains unchanged.

**(iv) Meta Cognitive Knowledge**

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

Formal charge, Bond length, Bond angle, Bond enthalpy, Bond order, Latticeenthalpy and

Resonance.

**III Instructional objectives and Learning Outcomes**

1. Define the above-mentioned facts and concepts.
2. Explains, describes, summarises the above-mentioned facts and concepts.
3. Calculation of formal charge of ozone O3 and lattice enthalpy of NaCl.
4. Differentiating and analysing the structure of ozone in resonance.
5. Predict the structure of ozone through formal charge and in resonance.
6. Create the structure of bisulphate ion and calculate its formal charge.

**IV Previous knowledge and lattice enthalpy**

The students have the knowledge about the bond pairs and lone pairs of electrons in molecules or compounds.

**V Learning aids**

1. Chart showing definition of Formal charge, Bond length, Bond angle, Bond enthalpy, Bond order, Latticeenthalpy and Resonance.
2. Calculation of formal charge of ozone O3 and lattice enthalpy of NaCl in the chart.
3. Resonance structures of ozone is given in the chart.

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| **Constructivist Learning Design** | |
| Activity | Student response with Assessment |
| **Phase I Situation**  Can you give the Lewis structure of O2  molecule. Predict the type of bonds present in the O2 molecule.  Give the number of bond pair (BP) and lone pair (LP) of electrons in O2 molecule.  **Phase II Grouping**  Students are grouped on the basis of expression of formal charge.  **Phase III Bridging**  Can you give the Lewis structure of O3  molecule.  Here the valence electron of oxygen is six and two more required to complete its octet.  **Phase IV Question**  How many bonds are formed in ozone molecule ? Identify the bond?  What is formal charge ?  Can you define formal charge in ozone molecule ?  How formal charge assigned in the case of polyatomic ions ? | Student share their experiences.          Covalent bond mutual sharing of electrons between two oxygen atoms.  BP = 2 LP = 4 (2 from each oxygen atom)  Students are grouped into 4 groups as formal charge, valence electrons, lone pair electron and bond pair electron.  Co-ordinate covalent bond    Two covalent bond (one double bond) and one co-ordinate bond.  Group define formal charge in the chart. The formal charge is defined as the difference between the number of valence electrons of that atom in an isolated or free state and the number of electrons assigned to that atom in the Lewis structure.  In the case of polyatomic ions, the net charge is possessed by the ion as a whole not by a particular atom and that is feasible to assign a formal charge on each atom. |
| **Factual Knowledge**  The students recognise the formal charge assigned in the case of polyatomic ions. | |
| Can you give equation of formal charge ?  What are Bond parameters?  What is Bond length?  Can you define Bond angle ?  What is bond Enthalpy?  What is Bond order ?  Can you give the equation for bond order ?  What is lattice Enthalpy?  Give the equation of Lattice Enthalpy?  What is resonance? | Four groups present the equation of formal charge in the chart.  FC = [(total valence electrons in free atom) – (total LP electrons) – 1/2 (total BP electrons)]  F C = V – L – ½ S  Where V is the total valence electrons. L is the total LP electrons. S is the total BP electrons.  Formal charge group hangs the chart of Lewis structure of ozone, O3  Bond parameters refer to the characterization of covalent bond on the basis of various parameters like bond length, bond order, bond angle and bond enthalpy.  Bond length is defined as the equilibrium distance. between the center of nuclei of 2 bonded atoms in a molecule. It is expressed in angstrom, A0 or picometer, pm  Bond angle is defined as the average angle between the lines representing the orbitals containing bonding electrons.  Bond Enthalpy is defined as the average energy required to break one mole of a particular kind of bond in a molecule.  Bond order gives the number of covalent bonds in a molecule.  Bond order is defined as the half of the difference between number of electrons in BMO and number of electrons in AMO.  B.O = ½ (Nb – Na)  = ½ (BMO - AMO)  Lattice Enthalpy is defined as the amount of energy released when one mole of ionic solid NaCl is formed by the close packing of gaseous ions  Na +(g) +Cl-(g) → NaCl (s) + U  Where U is the lattice enthalpy |
| **Conceptual knowledge**  Students define the equation of formal charge. | |
| Can you give an example of Resonance ?  Calculate the formal charge on oxygen in ozone, O3  **Phase V Exhibit**  Students calculate the formal charge of O3  With the help of teacher.  How will you express formal charge? | Other three group calculate F C of O3  FC on the central O atom marked 1 = (V- L- 1/2 S) = 6 – 2 - 1/2 (6) = +1  FC on the end O atom marked 2= 6-4-1/2 (4) = 0  FC on the end O atom marked 3 = 6 - 6- 1/2 (2) = -1  Groups exhibit formal charge of O3 in the chart. |
| Procedural knowledge  Students calculate the formal charge in ozone. | |
| **Phase VI Reflection**  Give the advantages of Formal charge?  Give any three characteristics of resonance ? | The structure which has smallest FC on its atoms is associated with lowest energy and thus maximum stable.  Resonance will shorten bond length.  It stabilizes a molecule.  The number of paired and unpaired electrons remains unchanged. |
| **Meta cognitive knowledge** The students can acquire the awareness of knowledge, thinking and learning strategies in in Formal charge, Bond length, Bond angle, Bond enthalpy, Bond order, Latticeenthalpy and Resonance. | |
| **Follow up Activities**  What are the factors depending on bond length ?  Give the significance of bond order ?  Calculate bond length of HCl. Given data.  r H-H = 74pm r Cl-Cl = 198pm | B.L decrease with increase in multiplicity (double or triple bonds)  B.L is found to increase in size of atom in a molecule.  The positive value of B.O indicate a stable molecule and negative or zero value of B.O indicates an unstable molecule.  B.O ᶑ Bond Enthalpy or BDE.  B.O ᶑ 1/ B. L  B.O increases, B.L decreases  If B.O is fractional, the molecule is paramagnetic it contains unpaired electron  B.O values 1,2,3 corresponds to single bond, double bond and triple bond  B.L of H-Cl = ½ [r H-H + r Cl-Cl] = ½ [74+ 198] = 136pm |