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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 : Thermodynamics  Topic : Hess's law of Heat Summation, Lattice enthalpy and Born Haber cycle |

**Activity oriented Lesson plan 5 T**

**II. Types of knowledge**

i. **Factual knowledge**

Terms : Hess's law, Lattice enthalpy, Born Haber Cycle

Facts : 1. The Enthalpy is a state function and therefore Change in enthalpy is

independent of the path between initial state or reactants and final state or products.

2. Lattice enthalpy is a measure of the strength of an ionic compound.

ii. **Conceptual knowledge**

Concepts : Hess's law of Heat summation, Lattice enthalpy, Born Haber cycle

Definitions

1. Hess's law states that the enthalpy change of a chemical reaction is

same in one step or Several steps.

2. Lattice enthalpy is defined as the amount of energy released when I mole of ionic solid NaCl is formed by close packing of gaseous ions Na+(g) and Cl-(g) ions.

3. Born and Haber developed a simplified method to Correlate Lattice enthalpy of ionic solid to other thermodynamic data. This is primarily based on Hess's law.

iii. **Procedural Knowledge**

1.Calculation of Lattice enthalpy of Ionic solid NaCl.

Steps

a) Define Lattice Enthalpy and Born Haber cycle.

b) Convert metallic sodium to gaseous sodium through Sublimation process.

c) Convert chlorine molecule to chlorine atom through Dissociation.

d) Ionization enthalpy is used to convert gaseous sodium to gaseous sodium cation.

e) Electron gain enthalpy is used to convert gaseous chorine atom to gaseous anion.

f) I mole of lonic solid NaCl is formed by close packing of gaseous ions Na+(g) and Cl –(g) by releasing energy known as Lattice enthalpy.

g) Born Haber cycle is a cycle to measure Lattice enthalpy of lonic solid NaCl.

iv. **Meta Cognitive knowledge**

The student can acquire the awareness of knowledge, thinking and learning strategies in above-mentioned facts and Concepts.

**III. Instructional Objectives and learning Outcomes**

The students will be able to choose, define, explains, solves, draws, applies, suggest, generate, infer, assess and create the above-mentioned facts and concepts.

**V. Previous knowledge**

The students have the knowledge about Enthalpy H and Enthalpy change ΔH.

**VI. Learning Aids**

1. Work sheets: 1. Problem of Hess's law

2. Solution for the problem of Hess's law

3. Definition of Lattice Enthalpy and Born Haber cycle

4. Calculation of Lattice enthalpy of lonic solid NaCl.

1. Draws Born Haber cycle in the chart.

**Constructivist learning Design**

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| **Activity** | **Student response with Assessment** |
| **Phase I situation**  Can you define Enthalpy change  Is enthalpy a state function? Shows the photo of the scientist. He was a Swiss Russian chemist and doctor who formulated the law, an early principle of Thermodynamics.  Identify the scientist and name the law. | Students share their experiences. Enthalpy change is the heat evolved or absorbed at constant pressure.  Yes. Enthalpy a state function depends on initial state or reactants and final state or the products.  German Henri Hess  Hess’s law of Heat summation |
| **Factual knowledge**  The students recognize Enthalpy is a state function | |
| **Phase II Grouping**  The students are grouped into 3 groups based on the name of the scientist who discover Hess’s law.  **Phase III Bridging**  What is the enthalpy change in the formation CO2 in two different methods | The students are grouped into 3 groups as German group, Henri group and Hess group.  German group shows the worksheet (1) problems of Hess’s law and explains |
| State and explain Hess’s law of heat summation.  Can you define lattice enthalpy of an ionic solid NaCl.  Give the equation of Lattice enthalpy of NaCl.  What is Born Haber cycle. | Step I  C(s) + O2(g) CO2(g) H = -393.5 KJmol-1  Step II  C(s) +1/2O2(g) CO(g) △H= -110.3 KJmol-1 CO(g) +1/2O2(g) → CO2(g) △H=-283 KJmol-1  Is it same or different enthalpy change H.  Other student's groups solve the problem of Hess's law. Work sheet (2) Same enthalpy change. That is H is same in one step or several steps. This is Hess's law  Henri group states the Hess’s law. It states that ‘the enthalpy change of a chemical reaction is same in one step or several steps.  Hf for CO2 in both method is same and Hf is -393.5 KJmol-1  Hess group shows the worksheet (3)  Definition of Lattice Enthalpy. Lattice enthalpy is defined as the amount of energy released when 1 mole of ionic solid formed by close packing of gaseous ions, Na+(g) and C1- ions.  Na+(g) + Cl-(g) 1NaCl (g) + U  Where U represent Lattice Enthalpy  Germain group shows the Worksheet (3) Definition of Born Haber cycle and explains.  Born and Haber developed a Simplified method to correlate Lattice enthalpy of Ionic Solids to other thermodynamic data. This is primarily based on Hess’s Law. |
| **Conceptual knowledge**  The students define the concepts like Lattice Enthalpy and Born Haber cycle | |
| **Phase IV question**  Ask the student group to convert metallic sodium to gaseous sodium  How Cl2 molecule is converted into Cl atom?  How will you convert Na(g) into Na+(g)  Can you convert gaseous chlorine atom into gaseous anion  Then what is lattice Enthalpy.  **Phase V Exhibit**  Draw born Haber cycle and exhibit for others. | Student group share their leaning experiences.  Na(s) + S Sublimation process S  2(g) + Dissociation energy D  Na(g) + IE + e- *Ionization* enthalpy IE  Cl(g) + e-Cl-  + EGE Electron gain enthalpy  Students defines Lattice Enthalpy.  See in conceptual knowledge definition (2).    Na(s)+2(g)NaCl(s)    Na(g) Cl(g)  -e-IE +eEGE  Na+ (g) Cl-(g)  Hf = S+ ½ D + IE + EGE = U  Thus, enthalpy of formation is the sum of energy changes according to Hess’s law. | |
| **Procedural knowledge**  The student solves the problem of Lattice enthalpy using Born Haber cycle | | |
| **Phase VI Reflections**  Give one limitation of Born Haber cycle. | Hess group share their learning experiences.  Hess’s law can applied only to ionic solid or alkali halides. | |
| **Meta cognitive knowledge**  The students can acquire the awareness of knowledge, thinking and learning strategies in Hess’s law, Lattice enthalpy and Born Haber cycle. | | |
| **Follow up activities**  Which ionic compound has highest Lattice Enthalpy MgO Vs NaF | The students solve and analyses the problem  MgO.  Mg2+ higher charge smaller radii will result in higher Lattice Enthalpy. | |