**Activity oriented Lesson plan 4 T**

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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 : Enthalpy changes during phase, Transformation, Third Thermodynamic function entropy, S and spontaneity. |

**II Types of knowledge**

i. **Factual knowledge**

Terms: Fusion, evaporation, sublimation, Entropy, Spontaneity.

Facts:

(1) Fusion is the process in which solid substance changes to liquid.

(2) Evaporation is the process in which liquid changes to gas

(3) Sublimation is the process in which solid substance changes to gas.

(4) The gaseous state is state of highest entropy.

(5) The entropy of the universe always increases in the course of every spontaneous process.

ii**. Conceptual knowledge**

Concepts: Enthalpy changes during phase transformations, standard enthalpy fusion, evaporation, sublimation, Entropy S.

Definitions:

(1) Standard enthalpy of Fusion is the enthalpy change accompanying the melting of 1mole of a solid substance into its liquid state at its melting point at 298 K and 1atm

(2) Standard Enthalpy of evaporation is the enthalpy change accompanying the vaporization of one mol of a liquid substance into its gaseous state at its boiling point at 298K and 1atm

(3) Standard Enthalpy of sublimation is the enthalpy change when one mole of a solid substance changes into its gaseous state at its boiling point at 298K and 1atm

(4) Standard enthalpy of formation is defined as the one mole of a compound from its elements in their standard states.

(5) Standard enthalpy of combustion is the enthalpy change accompanying the complete combustion of 1mole of substance in excess oxygen in their standard states.

(6) Entropy is defined as the measure of disorder or randomness in a system.

(7) The IInd law of T.D states that the entropy of the universe always increases in course of every spontaneous process.

iii. **Procedural knowledge**

1. To define the standard enthalpy of fusion, evaporation, sublimation, combustion and formation.

Steps:

a) write the name of phase transformations

i) S→ L ii) L→ 𝐺 iii) S → 𝐺 iv) Element → Compound v) Substance completely burnt in Oxygen

b) Define the above concepts in standard state at 298K and 1atm

iv. **Meta Cognitive knowledge.**

The student can acquire the awareness of knowledge in enthalpy changes during phase transformations, Third Thermodynamic function Entropy and spontaneity.

**III. Instructional Objectives and learning outcomes**

The students will be able to recall, understands, explains, solves, draws, compares, evaluate and create the definitions and application of standard enthalpy of fusion, evaporation, sublimation, combustion and formation, Entropy and spontaneity.

**IV Previous knowledge**

The students have the knowledge about different phase transformation like fusion, evaporation and sublimation, combustion and formation.

**V. Learning Aids**

a) Enthalpy change during different phase transformations (Chart): Definitions of Standard enthalpy of fusion, evaporation, sublimation, combustion and formation.

b) Experiments: Ice melting, salt dissolving, beaker, spatula, water boiling related to Entropy.

**Constructivist Learning Design**

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| **Activity** | **Student response with assessment** |
| **Phase I Situation**  Can you give the name of following phase transformations  a. Solid → Liquid  b. Liquid → Gas  c. Solid → Gas | Students share their own experiences  a) S → L Fusion  b) L → G Evaporation  c) S → G Sublimation |
| **Factual knowledge** The students recognize the process like Fusion, Evaporation and Sublimation | |

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| **Phase II Grouping**  The students are grouped on the basis of phase transformations  **Phase III Bridging**  The ice melts to water  H2O(s)→ H2O(g) ∆𝐻°fus = 6 KJmol-1  Can you define standard enthalpy of fusion    Can you define standard enthalpy of Evaporation  H2O(l)→ H2O(g) ∆𝐻° vap = 40.6 KJmol-1    Can you define standard enthalpy of sublimation  CO2(s) → CO(g) ∆𝐻° sub=25.2 KJmol-1 | The students are grouped into fusion group, evaporation group and sublimation group  Fusion group hang the chart of standard enthalpy of fusion.  In conceptual knowledge, definition (1). Standard enthalpy of fusion is the enthalpy change accompanying the melting point of 1 mole of a solid changes into its liquid state at its melting point at 298 K and 1 atm.  Evaporation group hang the chart of standard enthalpy of evaporation.  In conceptual knowledge, definition (2).  It is the enthalpy change accompanying the vaporization of one mole of a liquid changes into its gaseous state at its boiling point at 298 K and 1 atm.  Sublimation group hang the chart of standard enthalpy of sublimation.  In conceptual knowledge, definition (3).  It is the enthalpy change when one mole of a solid changes into its gaseous state at its boiling point at 298K and 1 atm. |
| **Conceptual knowledge**  The student defines the concepts like standard enthalpy of fusion, evaporation and sublimation | |
| **Phase IV Questions**  Can you define standard enthalpy of formation Cgraphite+2H2 (g) →CH4(g) ∆𝐻° f = 74.8 KJmol-1  Can you define enthalpy of combustion | The student group define the standard enthalpy of formation  In conceptual knowledge, definition (4).  It is defined as the one mole of a compound from its elements in their standard states.  In conceptual knowledge, definition (5).  It is the enthalpy change accompanying the complete combustion of 1 mole of substance in excess oxygen in standard state. |
| **Procedural knowledge**  The student explains the enthalpy changes during phase transformations | |
| What is the measure of disorder in solid, liquid and gas. Which has highest disorder?  Can you define entropy, S the third thermodynamic function.  What is 2nd law of T.D  **Phase V Exhibit**  Students, can you give the equation of 2nd law of T.D  a) Physical process  b) Chemical process  c) Reversible and isothermal process  d) Spontaneous process  What is Spontaneous process  **Phase VI reflections**  What are the criteria for spontaneity in chemical reactions  Can you predict spontaneity in non-isolated system? | Gas > Liquid > Solid  Gas has highest disorder.  Entropy is a measure of disorder of randomness in system.  It states that the entropy of universe always increases in the course of every spontaneous process.  Fusion group write the equation of 2nd law of T.D on the chart and exhibit for others  a) ∆𝑆 = S final – S initial  b) ∆𝑆 = S product – S reactant  c) ∆𝑆 = qrev/T = ∆𝐻/T  d) ∆𝑆total = ∆𝑆system + ∆𝑆surrounding > 0 ∆𝑆 = +ve for spontaneous process  It is a process take place either of its own or no initiation or need slight initiation or natural process.  Students group hang the chart of the criteria for spontaneity  a) Energy or enthalpy factor and spontaneity  1/2N2(g)+3/2H2(g) 2NH3(g) ∆𝐻F=-46.1 KJmol-1  ∆𝐻 = -ve Exothermic reaction spontaneous process.  1/2N2(g)+O2(g) →2NO(g) ∆𝐻f = +33.2 KJmol-1  ∆𝐻 = +𝑣𝑒 endothermic reaction spontaneous process.  That is tendency to acquire minimum energy or maximum stability is the one of the criteria of spontaneity.  b) entropy factor and spontaneity ∆𝑆 = +𝑣𝑒 for spontaneous process.  SO3(g)→ 𝑆𝑂2(g) + 1/2O2(g) ∆𝑆 = +𝑣𝑒  H2O(g)→ H2O(s) ∆S=-ve Here it is Non spontaneous process in isolated system  Evaporation group hang the chart to predict spontaneity in non-isolated system.  ∆𝑆total=∆𝑆system + ∆𝑆surroundings > 0  Freezing of water H2O(g)→ H2O(s) ∆S=-ve  Indicating the process is non-spontaneous at above 273K but at below 273K, the increase of entropy of surrounding is more than decrease of entropy of the system. Such that total entropy is positive. Hence spontaneous. |
| **Meta cognitive knowledge**  The student can acquire the awareness of knowledge, thinking and learning strategies in enthalpy change during phase transformations, entropy and spontaneity. | |
| **Follow up activities**  Define standard enthalpy of atomization (∆𝐻°a) | Assign to three groups.  Fusion group present their findings in the chart.  Standard enthalpy of atomization is the enthalpy change on breaking one mole of bonds completely to obtain atoms in the gas phase in their standard states. H2(g) → 2H(g) ∆𝐻°a = 435 KJmol-1 |