Krug Chemistry – Deep Run Daily Planning Guide

Date of Lesson: Q3 Day 22 – Ea, Keq, and Le Chatelier's Principle

Topic /Big Questions: (Question Stems & Question Creation Chart)

- **What factors determine the speed of a chemical reaction?**
- **What factors affect equilibrium?**
- **How does the amount of activation energy affect a chemical reaction?**
- **What are the similarities and differences between exothermic and endothermic reactions?**
- **What factors affect the equilibrium constant?**

State SOL	Unpacking the Standards (Video explanation shown at 3:18)
CH. 7	CH.7 The student will investigate and understand that thermodynamics explains the relationship between matter and energy. Key ideas include a) heat energy affects matter and interactions of matter; b) heating curves provide information about a substance; c) reactions are endothermic or exothermic; d) energy changes in reactions occur as bonds are broken and formed; e) collision theory predicts the rate of reactions; f) rates of reactions depend on catalysts and activation energy; and **g)** enthalpy and entropy determine the extent of a reaction.

Visible Learning (For the three items with asterisks*, think from a student perspective. Use simple language)

***What am I learning today?** The activation energy is the amount of energy required to break the ionic and covalent bonds of the reactants in order to form new products. A catalyst lowers the activation energy. Endothermic reactions have a large activation energy. Le Chatelier's Principle explains that a chemical reaction will shift forward or reverse in favor of reaching equilibrium. The equilibrium constant is a mathematical expression used to determine the direction a chemical reaction will shift in order to reach equilibrium.

***Why is it important?** Thermodynamics is the branch of science that deals with the relationship of heat and other forms of energy. Chemical systems undergo three main processes that use thermal energy: phase changes, heating/cooling, and chemical reactions. Chemical systems desire to be in a state of equilibrium and will adjust as needed to maintain the lowest energetic state.

***How will I know I've learned it?** I will identify the reactants, activation energy, products, and enthalpy for the forward and reverse reaction on an Energy Diagram. I will calculate the equilibrium constant, given the concentrations of reactants and products. I will understand how the value of Keq determines the direction of a chemical reaction. I will understand how changing the concentration, temperature, or pressure will affect the direction of a chemical reaction.

Differentiation strategies:

Energy Diagram Worksheet

Le Chatelier Worksheet

Equilibrium Constant Worksheet

Accommodations and/or modifications are being met for students with IEP's/504's.

Small group activities; frequent checks for understanding; materials available on Schoology;

Daily Plan/Sequence of Instruction:

Energy Diagram

Students will copy the information teacher writes on the board in their lab notebooks before doing the worksheet.

Teacher will draw a line representing the potential energy of a water molecule. Teacher will explain that this is the reactant side of an energy diagram. Teacher will demonstrate breaking the covalent bonds between the oxygen and hydrogen atoms. Teacher will ask if breaking the bonds was endothermic or exothermic. Teacher will explain that chemical reactions occur when the ionic and covalent bonds of the reactants beak apart in order to rearrange and create new products. This process requires energy and is ENDOTHERMIC (+ΔH). Teacher will draw an upward line from potential energy of reactants representing the increase in activation energy required to break the bonds.

Teacher will explain that the transition state is unstable due to free radicals. As molecules and compounds form, they are more stable and require less energy. Consequently, bonds forming is EXOTHERMIC because energy is transferred back into the surroundings. The energy diagram curves back downward. If the potential energy of the products is larger than the potential energy of the reactants, the overall reaction is ENDOTHERMIC. If it is smaller, then the overall reaction is EXOTHERMIC. Teacher will explain that the difference between the products and reactants is called ENTHALPY.

Students will complete the **Energy Diagram Worksheet** to check for understanding.

Le Chatelier Principle

Students will copy the information teacher writes on the board in their lab notebooks before doing the worksheet.

Teacher will explain how carbon dioxide poisoning occurs and write the chemical reaction on the board. See WHAT IS CARBON MONOXIDE POISONING? (https://courses.lumenlearning.com/cheminter/chapter/equilibrium-constant/)

$$\mathrm{Hb(CO)_4}(aq) + 4\mathrm{O_2}(g) \rightleftharpoons \mathrm{Hb(O_2)_4}(aq) + 4\mathrm{CO}(g)$$

Teacher will ask students to predict the direction of the reaction if oxygen is added or removed and if carbon monoxide is added or removed.

Teacher will write the following reaction on the board: **Heat + CH_4 (g) + 2 H_2S (g) ↔ CS_2 (g) + 4 H_2 (g)**. Teacher will ask students to predict the direction of equilibrium based on a change in concentration of reactants, a change in concentration of products, an increase in temperature, and an increase in pressure. Teacher will explain that the value of the Equilibrium constant only changes with temperature. Teacher will demonstrate how an increase in products raises the Keq. (It helps to use 1000/1 for favoring products, 1/1 for equilibrium, and 1/1000 for favoring reactants.) Students will record the results in their lab notebooks.

Students will complete the **Le Chatelier Worksheet** to check for understanding.

Equilibrium Constant

Teacher will explain procedure for setting up Keq equation. Teacher will explain that concentration of reactants and products is measure in moles/liter (molarity). Student groups will each be assigned a different reaction from the **Equilibrium Constant Worksheet**. Groups will use white boards to write the Keq equation, show its value based on given concentrations, and predict the direction of equilibrium shift. Then they will share their results with the class for a CER discussion.

Assessments (List all formative/summative assessments used to check for understanding during this lesson. Summative assessments may occur during a different class period.):

Energy Diagram Worksheet – (summative)

Le Chatelier Worksheet – (summative)

Equilibrium Constant Worksheet – (summative)

After assessing today's lesson are you and your students comfortable moving forward with your next objective?

Yes – students participated, recorded observations in lab notebooks, and understand energy diagrams, Le Chatelier's Principle, and Keq

No, remediation required to proceed – if students do not participate, teacher will contact parents and guardians; if students are absent, they can copy notes from a classmate; tutoring is offered during One Lunch

Teacher Reflection: Assign the **Unit 10 Thermodynamics PowerPoint** and **SOL Book Lesson 12 Causes of Chemical Reactions** for homework. Also recommend that students read information about **NON-REVERSIBLE** reactions at https://courses.lumenlearning.com/cheminter/chapter/nonreversible-reactions/.