**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**STUDENT ACTIVITY - Le Chatelier’s Principle**

***Introduction***

When opposing forces or issues are balanced, a system is said to be in equilibrium. In biology class you called this “maintaining homeostasis” for living systems or organisms. Placing a stress on any equilibrium system, whether it is chemical, biological, societal, environmental, or personal, causes the equilibrium be disrupted.

Le Chatelier’s Principle allows us to predict the results that follow from “stressing,” or in other words, changing the conditions of a system at chemical equilibrium. This allows scientists to develop techniques to control chemical reactions in natural and industrial settings in order to obtain desired products.

***MODEL #1: Disrupting an Equilibrium***

The graph below represents a sealed system that starts at equilibrium, and is then disrupted when hydrogen gas is injected into the it (increasing H2 concentration).

**H2 (g) + I2 (g) 🡨🡪 2 HI (g)**



According to LeChatelier’s principle, the addition of hydrogen gas disrupts the equilibrium system. The graph shows how the system responds to the disturbance of the added hydrogen gas.

1. What information on the graph indicates that the system was initially at equilibrium?

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2. What information on the graph shows the system was disrupted?

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3. From the graph, what caused the disruption? (HINT: Look at the concentrations for each substance).

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***INFORMATION***

When an equilibrium system is disrupted, it will respond by “shifting” in either the forward or reverse direction. If the disruption causes the forward rate of reaction to be greater than the reverse rate for a little while, the equilibrium is said to have undergone a “**Shift to the Right**,” resulting in a decrease in reactant concentrations, and an increase in product concentrations. This happens because reactants are being used up in the forward direction faster than they are being replaced in the reverse direction. You can figure out which way a reaction has shifted by studying a graph of concentrations vs. time, like the one in Model 1.

4. After the disturbance caused by adding H2, what happens to the concentration of the I2?

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5. After the disturbance caused by adding H2, what happens to the concentration of the HI?

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6. After the disturbance caused by adding H2, what immediately happens to the concentration of H2?

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7. When more H2 was added, which way did the reaction shift?

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8. After the addition of H2, its effect is eventually diminished. How can you tell that equilibrium is re-

 achieved? **Mark on the graph when this happens…**

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9. In terms of collision theory, explain why the concentration of H2 (g) begins to *decrease* immediately

 after more H2 (g) is added to the system.

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***MODEL 2: Ways to “Shift” your Equilibrium!***

**Reactant Disturbance:** Increase (↑) causes the equilibrium to shift to the right (→)

 Decrease (↓) causes the equilibrium to shift to the left (←)

**Product Disturbance:** Increase (↑) causes the equilibrium to shift to the left (←)

 Decrease (↓) causes the equilibrium to shift to the right (→)

**Temperature Disturbance:** A change in temperature corresponds to a change in energy therefore by using the ‘energy’ term in the equation itself, it can be treated like a reactant or product (see above).

**Pressure Disturbance:** An increase (↑) in pressure causes the equilibrium to shift

towards the "smaller number of moles *of gas"* side.

 A decrease (↓) in pressure causes the equilibrium to shift

towards the "larger number of moles *of gas"* side.

*Note:* If the number of moles of gas is the same on both sides, then a change in pressure has no effect in the equilibrium.

The following equation describes a system that is at equilibrium:

2H2 (g) + O2 (g) ↔ 2H2O (g) + energy (heat)

**Key Questions**

10. In this table, apply Le Chatelier's Principle and indicate the direction of the shift in equilibrium if the

 indicated stress is applied to the reaction system. (The first one is completed for you.)



**The following questions are based on the table in Question #10**

11. Describe the direction of the equilibrium shift when the concentration of a reactant is increased.

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12. If an equilibrium shifts to the right, which reaction is happening faster, the forward or the reverse?

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13. What happens to the concentrations of the reactants H2 and O2 when the reaction in Model 2 shifts right?

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14. What happens to the concentration of the product H2O when the reaction in Model 2 shifts to the right?

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15. If an equilibrium shifts to the left, which reaction is happening faster, the forward or the reverse?

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16. What happens to the concentrations of the reactants H2 and O2 when the reaction in Model 2 shifts left?

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17. What happens to the concentration of the product H2O when the reaction in Model 2 shifts to the left?

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18. What is true of the reaction rate of the forward reaction as compared with the rate of the reverse

 reaction, when the equilibrium is re-established?

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19. Fill in the blanks in the chart below, given the reaction to form nitrogen oxide in a container.

N2 (g) + O2 (g) + heat 🡨🡪 2 NO (g)

