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**I. Definition of Le Châtelier’s Principle**

Le Châtelier’s Principle states that if \_\_\_\_\_\_\_ is applied to a system at \_\_\_\_\_\_\_\_\_\_\_\_\_, the system shifts in the direction that relieves that \_\_\_\_\_\_\_.

**II. Changes in concentration**

**Example: CO(g) + 3H2(g) 🡪 CH4(g) + H2O(g)**

|  |  |
| --- | --- |
| **Equilibrium shifts to the right** | **Equilibrium shifts to the left** |
| 1. Add a reactant  **CO(g) + 3H2(g)** ⥂ **CH4(g) + H2O(g)** | 3. Remove a reactant  **CO(g) + 3H2(g)** ⥃ **CH4(g) + H2O(g)** |
| 2. Remove a product  **CO(g) + 3H2(g)** ⥂ **CH4(g) + H2O(g)** | 4. Add a product  **CO(g) + 3H2(g)** ⥃ **CH4(g) + H2O(g)** |

**III. Changes in volume and pressure**

**Example: CO(g) + 3H2(g) 🡪 CH4(g) + H2O(g)**

1. If pressure is increased, the equilibrium will shift to the side with \_\_\_\_\_\_\_\_\_ moles of gas.
   1. In the reaction above, the equilibrium would shift to the \_\_\_\_\_\_\_\_.
2. If pressure is decreased, the equilibrium will shift to the side with \_\_\_\_\_\_\_\_\_ moles of gas.
3. In the reaction above, the equilibrium would shift to the \_\_\_\_\_\_\_\_.
4. If pressure increases, volume \_\_\_\_\_\_\_\_\_\_\_\_. If pressure decreases, volume \_\_\_\_\_\_\_\_\_\_\_\_.
5. If the number of moles of gas is \_\_\_\_\_\_\_\_ on both sides of the equation, changes in volume and pressure have no effect on the equilibrium.

**IV. Changes in temperature**

|  |  |
| --- | --- |
| **Exothermic Reaction** | **Endothermic Reaction** |
| 1. Increase T: equilibrium shifts to the left  **CO(g) + 3H2(g)** ⥃ **CH4(g) + H2O(g) + heat** | 3. Increase T: equilibrium shifts to right  **heat + N2O4(g)** ⥂ **2NO2(g)** |
| 2. Lower T: equilibrium shifts to the right  **CO(g) + 3H2(g)** ⥂ **CH4(g) + H2O(g) + heat** | 4. Lower T: equilibrium shifts to left  **heat + N2O4(g)** ⥃ **2NO2(g)** |

**V. Effect of adding a catalyst**

Adding a catalyst \_\_\_\_\_\_\_\_\_\_ the rate of a chemical reaction but does so equally in both directions. Therefore, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ does **not** shift.