Worksheet: Le Chatelier's Principle Name_____

If a system at equilibrium is subjected to a stress, the equilibrium is displaced in the direction that relieves the stress.

- A stress is defined as any change which could affect the rate of either or both the forward and/or reverse reaction.
- When, because of an applied stress, the forward reaction is faster than the reverse reaction, the system is said to shift to the (right, left). As a result, the [products] will (increase, decrease) and the [reactants] will (increase, decrease).
- When, because of an applied stress, the reverse reaction is faster than the forward reaction, the system is said to shift to the (right, left). As a result, the [products] will (increase, decrease) and the [reactants] will (increase, decrease).

In simpler terms: If anything is added to a system at $\rightleftharpoons$, *the system will try to consume whatever was added. If anything is removed from a system at equilibrium, the system will try to replace whatever was removed. So, the reaction is favored away from what is (added, removed) and toward what is (added, removed).*

1. In the following reaction, will the [H_2] increase or decrease when equilibrium is reestablished after these stresses are applied?

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g) + 22\ kJ$$

$NH_3(g)$ is added	↑	*$N_2(g)$ is removed*	↑
pressure is increased	↓	*temperature is increased*	↓

2. Note reaction: $2\,NO\,(g) + H_2\,(g) \rightleftharpoons N_2O\,(g) + H_2O\,(g) + 36\ kJ$

   In which direction, left or right, will the equilibrium shift if the following changes are made?

NO is added	→	the system is cooled	→
H_2 is removed	←	pressure is increased	→
N_2O is added	←	H_2 is removed	←

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3. In this reaction: $CO_2\ (g) + H_2\ (g) + \text{heat} \rightleftharpoons CO\ (g) + H_2O\ (g)$

a. Is heat absorbed or released by the forward reaction?

absorbed

b. In which direction will the equilibrium shift if these changes are made?

CO is added	←	temperature is increased	→
CO_2 is added	→	system is cooled	←
H_2 is removed	←	pressure is increased	X nothing
catalyst is added	X no shift = no effect		same # n gas each side no shift

4. In this reaction: $2\ NO\ (g) + H_2\ (g) \rightleftharpoons N_2O\ (g) + H_2O\ (g) + \text{heat}$

3n gas 2n gas

What will happen to the $[H_2O]$ when equilibrium is reestablished after these stresses are applied?

temperature is increased	← ↓
a catalyst is added	X no shift
pressure is decreased	← ↓
NO is added	→ ↑
N_2O is removed	→ ↑

5. How would an increase in pressure affect the $[H_2]$ in the following reactions?

3n 2n

$2\ H_2\ (g) + O_2\ (g) \rightleftharpoons 2\ H_2O\ (g)$ → ↓

4n gas ∅ n gas

$4\ H_2\ (g) + Fe_3O_4\ (s) \rightleftharpoons 3\ Fe\ (s) + 4\ H_2O\ (l)$ → ↓

$H_2\ (g) + Cl_2\ (g) \rightleftharpoons 2\ HCl\ (g)$ no effect no shift

2n gas 2n gas