LeChatelier's Principle Worksheet

***Describe the changes that occur after each stress is applied to the equilibrium. ***

$$N_{2\,(g)} + 3H_{2\,(g)} \rightleftarrows 2NH_{3\,(g)} + \text{heat}$$

Stress	$[N_2]$	$[H_2]$	$[NH_3]$	Shifts Right or Left	Shifts to favor the Reactants or Products
1. $[N_2]$ is increased					
2. $[H_2]$ is increased					
3. $[NH_3]$ is increased					
4. Temp is increased					
5. $[N_2]$ is decreased					
6. $[H_2]$ is decreased					
7. $[NH_3]$ is decreased					
8. Temp is decreased					
9. A catalyst is added					

$$CaCO_{3\,(s)} + \text{heat} \rightleftarrows CaO_{\,(s)} + CO_{2\,(g)}$$

Note: Adding solids or liquids and removing solids or liquids does not shift the equilibrium. This is because you cannot change the concentration of a pure liquid or solid as they are 100% pure. It is only a concentration change that will change the # of collisions and hence shift the equilibrium.

Stress	$[CO_2]$	Shifts Right or Left	Shifts to favor the Reactants or Products
1. $CaCO_3$ is added			
2. CaO is added			
3. CO_2 is added			
4. Temp is decreased			
5. A catalyst is added			
6. $[CO_2]$ is decreased			
7. Temp is increased			
8. CaO is removed			

***Choose the best answer to the following questions and briefly explain why each is correct. ***

1. Ammonia is produced commercially by the Haber reaction:

   $N_2(g) + 3\ H_2(g) \leftrightarrow 2\ NH_3(g) + heat$

   The formation of ammonia is favored by
   (A) an increase in pressure
   (B) a decrease in pressure
   (C) removal of $N_2(g)$
   (D) removal of $H_2(g)$

2. Given the reaction at equilibrium:

   $2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g) + heat$

   Which change will shift the equilibrium to the right?
   (A) increasing the temperature
   (B) increasing the pressure
   (C) decreasing the amount of $SO_2(g)$
   (D) decreasing the amount of $O_2(g)$

3. Which system at equilibrium will be *least* affected by a change in pressure?
   (A) $3\ H_2(g) + N_2(g) \leftrightarrow 2\ NH_3(g)$
   (B) $2\ S(s) + 3\ O_2(g) \leftrightarrow 2\ SO_3(g)$
   (C) $AgCl(s) \leftrightarrow Ag^+(aq) + Cl^-(aq)$
   (D) $2\ HgO(s) \leftrightarrow 2\ Hg(\ell) + O_2(g)$

4. Given the closed system at equilibrium:

   $CO_2(g) \leftrightarrow CO_2(aq)$

   As the pressure on the system increases, the solubility of the $CO_2(g)$
   (A) decreases (C) remains the same
   (B) increases

5. Given the equilibrium reaction:

   $2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g) +$ Heat

   When the pressure on the system in increased, the concentration of the SO_3 will
   (A) decrease (C) remain the same
   (B) increase

6. Given the reaction at equilibrium:

   $N_2(g) + O_2(g) = 2\ NO(g)$

   If the temperature remains constant and the pressure increases, the number of moles of $NO(g)$ will
   (A) decrease (C) remain the same
   (B) increase

7. Given the reaction at equilibrium:

   $2\ A(g) + 3\ B(g) \leftrightarrow A_2B_3(g) + heat$

   Which change will not affect the equilibrium concentrations of $A(g)$, $B(g)$, and $A_2B_3(g)$?
   (A) adding more $A(g)$
   (B) adding a catalyst
   (C) increasing the temperature
   (D) increasing the pressure

8. The addition of a catalyst to a system at equilibrium will increase the rate of
   (A) the forward reaction, only
   (B) the reverse reaction, only
   (C) both the forward and reverse reactions
   (D) neither the forward nor reverse reaction

9. Given the reaction at equilibrium:

   $N_2(g) + O_2(g) + energy \leftrightarrow 2\ NO(g)$

   Which change will result in a *decrease* in the amount of $NO(g)$ formed?
   (A) decreasing the pressure
   (B) decreasing the concentration of $N_2(g)$
   (C) increasing the concentration of $O_2(g)$
   (D) increasing the temperature

LeChatelier's Principle Worksheet

***Describe the changes that occur after each stress is applied to the equilibrium. ***

$$N_{2\,(g)} + 3H_{2\,(g)} \rightleftarrows 2NH_{3\,(g)} + \text{heat}$$

Stress	$[N_2]$	$[H_2]$	$[NH_3]$	Shifts Right or Left	Shifts to favor the Reactants or Products
1. $[N_2]$ is increased	↓	↓	↑	right	products (Foe.)
2. $[H_2]$ is increased	↓	↓	↑	right	products (Foe.)
3. $[NH_3]$ is increased	↑	↑	↓	left	reactants (Rev.)
4. Temp is increased	↑	↑	↓	left	reactants (Rev.)
5. $[N_2]$ is decreased	↑	↑	↓	left	reactants (rev.)
6. $[H_2]$ is decreased	↑	↑	↓	left	reactants (Rev.)
7. $[NH_3]$ is decreased	↓	↓	↑	right	products (Foe.)
8. Temp is decreased	↑	↑	↓	left	reactants (rev.)
9. A catalyst is added	—	—	—	no shift	—

$$CaCO_{3\,(s)} + \text{heat} \rightleftarrows CaO_{(s)} + CO_{2\,(g)}$$

Note: Adding solids or liquids and removing solids or liquids does not shift the equilibrium. This is because you cannot change the concentration of a pure liquid or solid as they are 100% pure. It is only a concentration change that will change the # of collisions and hence shift the equilibrium.

Stress	$[CO_2]$	Shifts Right or Left	Shifts to favor the Reactants or Products
1. $CaCO_3$ is added	—	—	— its a solid.
2. CaO is added	—	—	— its a solid.
3. CO_2 is added	↓	left	reactants
4. Temp is decreased	↓	left	reactants
5. A catalyst is added	—	—	— no effect.
6. $[CO_2]$ is decreased	↑	Right	products.
7. Temp is increased	↑	right	products.
8. CaO is removed	—	—	— its a solid.

***Choose the best answer to the following questions and briefly explain why each is correct. ***

1. Ammonia is produced commercially by the Haber reaction:

$$N_2(g) + 3\,H_2(g) \leftrightarrow 2\,NH_3(g) + \text{heat}$$

The formation of ammonia is favored by
(A) an increase in pressure fewer moles
(B) a decrease in pressure greater moles
(C) removal of $N_2(g)$ ←
(D) removal of $H_2(g)$ ←

A

2. Given the reaction at equilibrium:

$$2\,SO_2(g) + O_2(g) \leftrightarrow 2\,SO_3(g) + \text{heat}$$

Which change will shift the equilibrium to the right?
(A) increasing the temperature ← endo.
(B) increasing the pressure less moles →
(C) decreasing the amount of $SO_2(g)$ Rev←
(D) decreasing the amount of $O_2(g)$ Rev←

B

3. Which system at equilibrium will be *least* affected by a change in pressure?
(A) $3\,H_2(g) + N_2(g) \leftrightarrow 2\,NH_3(g)$
(B) $2\,S(s) + 3\,O_2(g) \leftrightarrow 2\,SO_3(g)$
(C) $AgCl(s) \leftrightarrow Ag^+(aq) + Cl^-(aq)$ – no gases.
(D) $2\,HgO(s) \leftrightarrow 2\,Hg(\ell) + O_2(g)$

C

4. Given the closed system at equilibrium:

$$CO_2(g) \leftrightarrow CO_2(aq)$$

→ shift forward. dissolved. few moles

As the pressure on the system increases, the solubility of the $CO_2(g)$
(A) decreases (C) remains the same
(B) increases

B

5. Given the equilibrium reaction:

$$2\,SO_2(g) + O_2(g) \leftrightarrow 2\,SO_3(g) + \text{Heat}$$

(3 → 2) shift R. → make this. fewer moles.

When the pressure on the system in increased, the concentration of the SO_3 will
(A) decrease (C) remain the same
(B) increase

B

6. Given the reaction at equilibrium:

$$N_2(g) + O_2(g) = 2\,NO(g)$$

If the temperature remains constant and the pressure increases, the number of moles of $NO(g)$ will – fewer moles.
(A) decrease (C) remain the same
(B) increase # moles gas are equal

C

7. Given the reaction at equilibrium:

$$2\,A(g) + 3\,B(g) \leftrightarrow A_2B_3(g) + \text{heat}$$

Which change will not affect the equilibrium concentrations of $A(g)$, $B(g)$, and $A_2B_3(g)$?
(A) adding more $A(g)$
(B) adding a catalyst — increases rate forward + reverse equally.
(C) increasing the temperature
(D) increasing the pressure

B

8. The addition of a catalyst to a system at equilibrium will increase the rate of
(A) the forward reaction, only
(B) the reverse reaction, only
(C) both the forward and reverse reactions Lowers activation energy.
(D) neither the forward nor reverse reaction

C

9. Given the reaction at equilibrium:

$$N_2(g) + O_2(g) + \text{energy} \leftrightarrow 2\,NO(g)$$

Which change will result in a *decrease* in the amount of $NO(g)$ formed? — shift left.
(A) decreasing the pressure moles of gas are equal.
(B) decreasing the concentration of $N_2(g)$
(C) increasing the concentration of $O_2(g)$ shifts right.
(D) increasing the temperature shifts endo (Right)

B