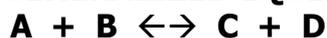


EQUILIBRIUM & K_{eq} NOTES

REVERSIBLE REACTION: a reaction where the reactants form the products, then the products re-form the reactants

* can proceed in _____

* represented by _____

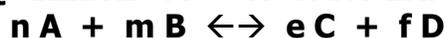
GENERALIZED EQUILIBRIUM RXN:

• $A + B \rightarrow C + D$ _____ reaction

• $C + D \rightarrow A + B$ _____ reaction

CHEMICAL EQUILIBRIUM:

- occurs when _____
- concentration _____

EQUILIBRIUM CONSTANT EXPRESSION (K_{eq})

lowercase letters (n, m, e, f) represent _____

CAPITAL LETTERS (A, B, C, D) represent _____

$$K_{eq} = \frac{[] []}{[] []}$$

* [] means "_____ of"

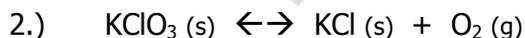
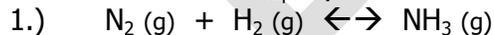
$$K_{eq} = \frac{[\text{side}]}{[\text{side}]}$$

EXTRA K_{eq} NOTE:

- Do NOT include (s) or (l) in K_{eq} expressions – (aq) and (g) only!

**EQUILIBRIUM CONSTANT WORKSHEET**

Part 1 – Write the K_{eq} expressions for the reactions below. NOTE: Equations are not balanced.



Use the K_{eq} expressions written above to determine the value of K in each of the following sets of conditions.

- 1.) $[N_2] = 0.0200 \text{ M}$, $[H_2] = 0.0200 \text{ M}$, $[NH_3] = 0.0100 \text{ M}$
- 2.) $[O_2] = 0.0500 \text{ M}$
- 3.) $[H^{+1}] = 1 \times 10^{-8} \text{ M}$, $[OH^{-1}] = 1 \times 10^{-6} \text{ M}$
- 4.) $[CO] = 2.0 \text{ M}$, $[O_2] = 1.5 \text{ M}$, $[CO_2] = 3.0 \text{ M}$
- 5.) $[Li^{+1}] = 0.2 \text{ M}$, $[CO_3^{-2}] = 0.1 \text{ M}$

LE CHATELIER'S PRINCIPLE NOTES

~ When a system at equilibrium is stressed, the equilibrium will shift in the direction that will relieve the stress.

- "stress" on equilibrium = _____

~ Changes in PRESSURE

** only affect _____ **

RULE: If the pressure goes up (increases), equilibrium will shift towards the side of the equation with the LOWER number of moles of gas.

* How do you figure out the number of moles of gas?*

EXAMPLE 1: $N_2(g) + 3 H_2(g) \leftrightarrow 2 NH_3(g)$

If the pressure on this system increases, the shift in equilibrium will be towards the _____ side because _____

EXAMPLE 2: $H_2(g) + I_2(g) \leftrightarrow 2 HI(g)$

If the pressure on this system decreases, the shift in equilibrium will be towards the _____ side because _____

~ Changes in CONCENTRATION

RULE: If the concentration of a substance on one side of the equation goes up (increases), the equilibrium will shift towards the other side.

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

If $[N_2]$ increases, equilibrium shift will be towards _____ side.

If $[NH_3]$ increases, equilibrium shift will be towards _____ side.

RULE: If the concentration of a substance on one side of the equation goes down (decreases), the equilibrium will shift towards that side.

EXAMPLE 4: $N_2(g) + 3 H_2(g) \leftrightarrow 2 NH_3(g)$

If $[H_2]$ decreases, equilibrium shift will be towards _____ side.

If $[NH_3]$ is removed, equilibrium shift will be towards _____ side.

RULE: If the concentration of a substance is increased, the other substances on that side of the equation will decrease. The substances on the other side of the equation will increase.

EXAMPLE 5: $4 \text{HCl (g)} + \text{O}_2 \text{(g)} \leftrightarrow 2 \text{H}_2\text{O (g)} + 2 \text{Cl}_2 \text{(g)}$
 If $[\text{O}_2]$ decreases, equilibrium shift will be towards _____ side.

$[\text{HCl}]$ _____

$[\text{H}_2\text{O}]$ _____

$[\text{Cl}_2]$ _____

If $[\text{H}_2\text{O}]$ increases, equilibrium shift will be towards _____ side.

$[\text{HCl}]$ _____

$[\text{O}_2]$ _____

$[\text{Cl}_2]$ _____

~ Changes in TEMPERATURE

RULE: The word "heat" or a number of J, kJ, or cal should be treated as another product or reactant. Follow same rules as with concentration.

EXAMPLE 6: $2 \text{H}_2\text{O (g)} \leftrightarrow 2 \text{H}_2 \text{(g)} + \text{O}_2 \text{(g)} + \frac{16 \text{ kcal}}{\text{heat}}$

If the temperature is increased, equilibrium shift will be towards _____ side.

~ Changes in K_{eq} VALUE

RULE: Only changes in temperature affect the K_{eq} value. Changes in pressure and/or concentration do NOT affect the K_{eq} value for a reaction.

If heat is added to start a reaction...

- it is located on the _____ side of the equation.
- it is an _____ reaction.
- If the temperature increases, the value of K_{eq} will _____

If heat is given off by a reaction...

- it is located on the _____ side of the equation.
- it is an _____ reaction.
- If the temperature increases, the value of K_{eq} will _____

LE CHATELIER'S PRINCIPLE WORKSHEET

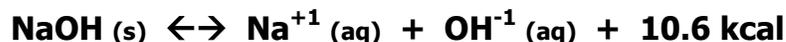
Complete the following chart by writing "left", "right", or "none" for equilibrium shift. Write "increases", "decreases", or "remains the same" for the concentration of reactants and products, and for the value of K.



	<u>Stress</u>	<u>Equilibrium Shift</u>	<u>[N₂]</u>	<u>[H₂]</u>	<u>[NH₃]</u>	<u>K</u>
1	add N ₂	right	---	decreases	increases	same
2	add H ₂			---		
3	add NH ₃				---	
4	remove N ₂		---			
5	remove H ₂			---		
6	remove NH ₃				---	
7	increase temp.					
8	decrease temp.					
9	increase pressure					
10	decrease pressure					



	<u>Stress</u>	<u>Equilibrium Shift</u>	<u>[H₂]</u>	<u>[I₂]</u>	<u>[HI]</u>	<u>K</u>
1	add H ₂	right	---	decreases	increases	same
2	add I ₂			---		
3	add HI				---	
4	remove H ₂		---			
5	remove I ₂			---		
6	remove HI				---	
7	increase temp.					
8	decrease temp.					
9	increase pressure					
10	decrease pressure					



	<u>Stress</u>	<u>Equilibrium Shift</u>	<u>Amount of NaOH (s)</u>	<u>[Na⁺¹]</u>	<u>[OH⁻¹]</u>	<u>K</u>
1	add NaOH		---			
2	add NaCl (adds Na ⁺¹)			---		
3	add KOH (adds OH ⁻¹)				---	
4	add H ⁺¹ (removes OH ⁻¹)				---	
5	increase temp.					
6	decrease temp.					
7	increase pressure					
8	decrease pressure					

UNIT 13 REVIEW WORKSHEET

- Given the equilibrium equation at 25°C: $\text{A}_2 \text{ (g)} + \text{B}_2 \text{ (g)} \leftrightarrow 2 \text{ AB (g)}$
If, *at equilibrium*, the concentrations are as follows: $[\text{A}_2] = 3.45 \text{ M}$, $[\text{B}_2] = 5.67 \text{ M}$, and $[\text{AB}] = 0.67 \text{ M}$
(A) Write the K_{eq} expression for the reaction.
(B) Find the value of the equilibrium constant at 25°C.
- Given the equilibrium equation: $\text{X}_2 \text{ (g)} + 3 \text{ Y}_2 \text{ (g)} \leftrightarrow 2 \text{ XY}_3 \text{ (g)}$ at a temperature of 50°C, it is found that when equilibrium is reached that:
 $[\text{X}_2] = 0.37 \text{ M}$, $[\text{Y}_2] = 0.53 \text{ M}$ and $[\text{XY}_3] = 0.090 \text{ M}$
(A) Write the equilibrium constant expression (K_{eq}).
(B) Calculate the value of K_{eq} at 50°C.
- Predict which way these equilibrium systems will shift when the total pressure is increased.
(A) $\text{N}_2 \text{ (g)} + \text{O}_2 \text{ (g)} \leftrightarrow 2 \text{ NO (g)}$
(B) $2 \text{ SO}_2 \text{ (g)} + \text{O}_2 \text{ (g)} \leftrightarrow 2 \text{ SO}_3 \text{ (g)}$
(C) $4 \text{ NH}_3 \text{ (g)} + 5 \text{ O}_2 \text{ (g)} \leftrightarrow 4 \text{ NO (g)} + 6 \text{ H}_2\text{O (g)}$
- Hydrogen peroxide decomposes according to the following equation:
 $187 \text{ kJ} + \text{H}_2\text{O}_2 \text{ (l)} \leftrightarrow \text{H}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$
Predict the direction of equilibrium shift by each of these changes:
(A) Increase the $[\text{H}_2]$
(B) Decrease the $[\text{O}_2]$
(C) Decrease the total pressure
(D) Increase the temperature

5. Consider the following equilibrium and answer the questions when these changes are made.



- ~ CH₄ gas is added (A) direction of equilibrium shift?
(B) [H₂S]?
(C) [CS₂?]
(D) [H₂?]
- ~ CS₂ gas is removed (A) direction of equilibrium shift?
(B) [CH₄?]
(C) [H₂S]?
(D) [H₂?]
- ~ H₂ gas is added (A) direction of equilibrium shift?
(B) [CH₄?]
(C) [H₂S]?
(D) [CS₂?]
- ~ The temperature is increased (A) direction of equilibrium shift?
(B) [CH₄?]
(C) [H₂S]?
(D) [CS₂?]
(E) [H₂?]