

Le Chatelier's Principle

Le Chatelier's Principle was devised by French Chemist Henri Le Chatelier (1850-1936). **It states that when a system is at equilibrium and it is subjected to a stress, it will shift its equilibrium point to relieve the stress.** The way a system responds to certain stresses is outlined below:



I. Addition or Removal of Reactant or Product

- If a reactant is added, the reaction shifts to the right & increases the concentration of the products.
- If a product is added, the reaction shifts to the left & increases the concentration of the reactants.
- If a reactant is removed, the reaction shifts to the left & decreases the concentration of the products.
- If a product is removed, the reaction shifts to the right & decreases the concentration of the reactants.

The equilibrium value(K) remains the same whenever a reactant or product is added or removed from the system.

II. Temperature Changes

- In an endothermic reaction, an increase in temperature shifts right and increases the concentration of the products.
- In an exothermic reaction, an increase in temperature shifts left and increases the concentration of the reactants.
- In an endothermic reaction, a decrease in temperature shifts left and decreases the concentration of the products.
- In an exothermic reaction, a decrease in temperature shifts right and decreases the concentration of the reactants.
- Changes in temperature do affect the equilibrium constant.

III. Pressure Changes

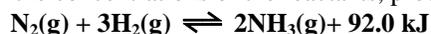
Changes in pressure only affect **gaseous** substances.

- An increase in pressure will shift the equilibrium to where there are fewer moles of gas and increase the concentrations of the molecules on that side of the equation.
- A decrease in pressure will shift the equilibrium to where there are more moles of a gas and increase the concentrations of the molecules on that side of the equation.
- A decrease in the volume of a container will also cause an increase in pressure (and vice versa) because pressure and volume have an inverse relationship.
- **Even though a change in pressure or volume may cause a shift right or left. There is a change in the equilibrium position due to the work done on the system but the equilibrium constant does not change. It is a constant at a certain temperature.**
- **The addition of an inert gas increases the total pressure but has no effect on the concentrations or partial pressures of the reactants.**

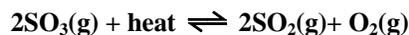
IV. Catalysts

Catalysts only speed up a reaction and do not affect the concentration of the reactants or products or the equilibrium value.

Homework: Complete the following charts by writing LEFT, RIGHT or NONE for the equilibrium shift and INCREASES, DECREASES or STAYS THE SAME for the concentrations of the reactants, products and equilibrium value(K).



Stress	Equilibrium				
	Shift	[N ₂]	[H ₂]	[NH ₃]	K
1. Add N ₂		-----			
2. Add H ₂			-----		
3. Add NH ₃				-----	
4. Remove N ₂		-----			
5. Remove H ₂			-----		
6. Remove NH ₃				-----	
7. Increase Temperature					
8. Decrease Temperature					
9. Increase Pressure					
10. Decrease Pressure					



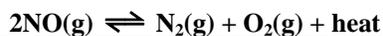
Stress	Equilibrium Shift	[SO ₃]	[SO ₂]	[O ₂]	K
11. Add SO ₃		-----			
12. Add O ₂				-----	
13. Add SO ₂			-----		
14. Remove SO ₃		-----			
15. Remove O ₂				-----	
16. Remove SO ₂			-----		
17. Add He					
18. Decrease Temperature					
19. Increase Pressure					
20. Decrease Pressure					



Stress	Equilibrium Shift	Amount of AgCl	[Ag ⁺]	[Cl ⁻]	K
21. Add AgCl		-----			
22. Add AgNO ₃			-----		
23. Add HCl				-----	
24. Increase Temperature					
25. Decrease Temperature					
26. Increase Pressure					
27. Decrease Pressure					



Stress	Equilibrium Shift	[PCl ₅]	[PCl ₃]	[Cl ₂]	K
28. Add Cl ₂				-----	
29. Add PCl ₃			-----		
30. Add PCl ₅		-----			
31. Increase Temperature					
32. Decrease Temperature					
33. Increase Pressure					
34. Add Ne					



Stress	Equilibrium Shift	[NO]	[N ₂]	[O ₂]	K
35. Remove NO		-----			
36. Remove N ₂			-----		
37. Remove O ₂				-----	
38. Decrease Temperature					
39. Increase Temperature					
40. Decrease Pressure					
41. Increase Pressure					

42. Define Le Chatelier's Principle.

43. What is(are) the only stress(es) that can affect the equilibrium value(K)?

44. How do catalysts affect the concentrations of reactants and products?