# AP CHEMISTRY

## TOPIC 6: EQUILIBRIUM, REVIEW, PART III ( EXTRA PRACTICE ) Day 74:

- Le Chatelier's Principle.

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EACH of these situations **BEGIN** at Equilibrium and then a change is applied to the WHOLE system.

Answer the question accordingly:

I. The system is an endothermic reaction - the temperature is increased on the system at equilibrium. What is happening to the equilibrium constant, K? Try to explain why.

***Answer:***

(endo) E ⟶
Shift away from the addition !!!

$\frac{[\text{ products }]\uparrow}{[\text{ reactants }]\downarrow}$

When the temperature changes - K (equilibrium concentration) changes. When energy is ADDED, the reaction adjusts by shifting AWAY FROM the addition. In this case, the products increase while the reactants are decreased. This causes the K value to increase (its value).

II. The system's temperature is decreased, as a result the equilibrium constant, K, is increased. Is the system endothermic or exothermic? Try to explain why.

***Answer:***

⟶ E (exo)
Shift toward the removal !!!

$\frac{[\text{ products }]\uparrow}{[\text{ reactants }]\downarrow}$

When the temperature is decreased – energy is REMOVED from the system. The system's equilibrium constant increased as a result of the removal of energy (this caused the products' concentration(s) (or pressure(s)) to increase.) The reaction is exothermic since the shift went toward the removal of energy (on the product side).

III. The system has a $\Delta H = -482\ kJ$, what happens the equilibrium constant, K, when the temperature is increased. Try to explain why.

***Answer:***

⟵ E (exo)
Shift away from the addition !!!

$\frac{[\text{ products }]\downarrow}{[\text{ reactants }]\uparrow}$

The system is EXOTHERMIC (negative delta "H" value). When the temperature is increased – heat is ADDED to the system – the system will shift AWAY from the addition. As a result of the shift, the concentration(s) of the PRODUCTS is(are) reduced – causing K to be reduced.

IV. The gas system (all are gases) has a balanced equation of $2A + 2B \leftrightarrow 3C$, which direction will the reaction shift as a result of the system's volume being reduced from 3 liters to 2.5 liters. Try to explain why.

***Answer:***

⟶
Shift to the RIGHT

When a system at equilibrium (with gases) has its volume reduced – the pressure of the system is increased. The system is "not happy" with the change in pressure. The system accommodates the change in pressure by trying to get the pressure back to the original pressure (to achieve the original $K_p$). The system does this by REDUCING the total number of particles in the system that is responsible for the collisions with the walls of the container. When the volume is decreased, the system wants to decrease the "number of molecules" in the system. This is achieved by shifting the reaction to the right (in this case).

V. The system's temperature is increased, as a result the equilibrium constant, K, is decreased. Is the system endothermic or exothermic? Try to explain why.

***Answer:***

⟵ E (exo)
Shift away the addition !!!

$\frac{[\text{ products }]\downarrow}{[\text{ reactants }]\uparrow}$

The system will shift AWAY from the addition. When the temperature of the system was increased – energy (heat) was ADDED to the system. As a result of the shift, the concentration(s) (or pressure(s)) were DECREASED. The system is EXOTHERMIC (energy is a product).

VI. The system has a $\Delta H = +2770\ kJ$, what happened to the temperature when the equilibrium constant, K, was increased? Try to explain why.

***Answer:***

| |
|---|
| (endo) E ⟶<br>Shift away from the addition !!! |

$$\frac{[\ \text{products}\ ]\uparrow}{[\ \text{reactants}\ ]\downarrow}$$

The system is ENDOTHERMIC (positive delta "H" value). When the temperature is increased – heat is ADDED to the system – the system will shift AWAY from the addition. As a result of the shift, the concentration(s) of the PRODUCTS is(are) increased – causing K to be increased.

VII. The equilibrium constant, K, is equal to $2.38 \times 10^{-5}$. If Q = 0.000129 how will the reaction shift (if at all)? Try to explain why.

***Answer:***

| |
|---|
| Q > K<br>⟵<br>Shift to the Left |

$$\frac{[\ \text{products}\ ]\downarrow}{[\ \text{reactants}\ ]\uparrow}$$

The system is NOT at equilibrium, Q does not equal K. since the value of Q is higher than the equilibrium constant, K, the concentrations (or pressures) of the products are too high and need to be decreased. In order for the products to decrease, the reactants need to be formed from the products. The shift will cause the reactants to be formed from the products UNTIL equilibrium has been established (allowing for the products to be decreased) or that Q = K.

VIII. The system is at equilibrium and some gaseous product is taken out of the system. How will the reaction shift (if at all)? Try to explain why.

***Answer:***

| |
|---|
| ⟶<br>Shift toward the REMOVAL |

When a system at equilibrium has "something" removed from the system the rates of the forward reaction is longer the same as the rate of the reverse reaction. In other words, Q is no longer equal to K. The system will adjust to place the system back into equilibrium. The reaction will form more "stuff" from the side (of the reaction) where the stuff was removed.