Le Chatelier’s Principle

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**Le Châtelier's Principle - a Summary (see textbook)**

"If a dynamic equilibrium is subjected to a stress it *readjusts* so as to minimize the effect of that stress and return to a new equilibrium position!"

 A + B $⇌$ C + D The equilibrium will shift to the RIGHT/PRODUCTS if you: add A, add B, remove C or remove D. (K is unaffected)

A + B $⇌$ C + D The equilibrium will shift to the LEFT/REACTANTS if you: remove A, remove B, add C or add D. (K is unaffected)

A + heat $⇌$ B The equilibrium will shift to the RIGHT/PRODUCTS if you: add heat (increase the Tsystem). (K increases, endothermic reaction ∆ H > 0 kJ). Heat energy is added to the reaction, not the reactants or the products.

A + heat $⇌$ B The equilibrium will shift to the LEFT/REACTANTS if you: remove heat energy from the equilibrium (decrease Tsystem). (K will decrease, endothermic reaction ∆H > 0 kJ)

A $⇌$ B + heat The equilibrium will shift to the LEFT/REACTANTS if you: add heat (increase the system temperature). (K will decrease, exothermic reaction ∆ H < 0kJ)

A $⇌$ B + heat The equilibrium will shift to the RIGHT/PRODUCTS if you: remove heat energy from the equilibrium (decrease the Tsystem). (K will increase, exothermic reaction ∆H < 0kJ)

A(g) $⇌$ 2 B(g) The equilibrium will shift to the RIGHT/PRODUCTS (the side with more mol of gas molecules) if you decrease Psystem /increase system volume. (K is unaffected)

A(g) $⇌$ 2 B(g) The equilibrium will shift to the LEFT/REACTANTS (the side with fewer mol of gas molecules) if you increase Psystem by decreasing the system volume. (K is unaffected)

A(g) $⇌$ B(g) The equilibrium will be quite unaffected by any change in the system pressure. The numbers of moles of gas in the system can neither be increased or decreased in response to a change in Psystem . (K is unaffected)

Increasing the total system pressure on a gaseous equilibrium by adding an inert gas has absolutely no effect on that equilibrium. Although the total system pressure increases the partial pressures of the equilibrium components (the P's in the Kp expression) do not change! (K is unaffected) Catalysts have no effect on the *position* of *equilibrium* they only cause the system to reach equilibrium more rapidly, or to respond to a stress on the equilibrium more rapidly. (K is unaffected) Note: only a **temperature change** can lead to a **change in the value of** K for that system.

**Equilibrium – Le Châtelier’s Principle questions**

1. Predict the direction in which the equilibrium: 2 NH3(g) $⇌$ N2(g) + 3 H2(g) will be shifted by the following changes:

 (a) addition of NH3(g) (e) addition of He(g)(inert).

 (b) addition of N2(g) (f) addition a catalyst

 (c) removal of H2(g) (g) removal of NH3(g)

 (d) decreasing temperature (reaction is endothermic as written)

2. In which direction is the system; H2(g) + I2(g) $ ⇌$ 2HI(g) - shifted by the removal of hydrogen?

 (a) Name **two** other stresses that would have the same effect!

 (b) If this reaction is endothermic in the forward direction what fourth stress would result in a shift in the same direction?

 (c) The graphs below represent the equilibrium starting from all HI or a 50:50 H2/I2 mix.



 What is essentially the same for these equilibria? What is different?

 (d) What stresses on this system would have **no effect** on the position of equilibrium?

3. Would addition of Fe(s) to the equilibrium 2 Fe2O3(s) + 3 C(s) $⇌$ 4 Fe(s) + 3 CO2 (g) cause it to be shifted to the left, to the right or would it have no effect at all? Explain your answer.

4. What effect(s) would be predicted as the result of

 (a) increasing the pressure on Br2(g) + 3 F2(g) $⇌$ 2 BrF3(g) by decreasing its volume?

 (b) decreasing the pressure of Xe(g) + F2(g) $⇌$ XeF2(g) by increasing its volume?

 (c) increasing the temperature of 2 NO(g) + O2(g) $⇌$ 2 NO2 (g) + heat energy?

5. Which of the change(s) below will cause the value of the K for an equilibrium to change?

 (a) Change in total system volume. ( e) Change in reactant amounts.

 (b) Change in product amounts. ( f) Change in system temperature.

 (c) Change in system pressure after an inert gas is added.

 (d) A catalyst is added to the system.