Le Chatelier's Principle

Balance the following equations. Write heat as a reactant or product, based on if the reaction is endothermic or exothermic. Predict which way equilibrium will shift, left or right.

One

Consider the following exothermic reaction:

 $H_2(g) + F_2(g) \Leftrightarrow HF(g).$

- a) Which way will equilibrium shift if you add more hydrogen to the system?
- b) Which way will equilibrium shift if you add more hydrofluoric acid to the system?
- c) Which way will equilibrium shift if you decrease the amount of fluorine in the system?
- d) Which way will equilibrium shift if you increase the temperature?
- e) Which way will equilibrium shift if you decrease the volume of the container?

Two

Consider the following exothermic reaction: $NaCl(aq) + Mg(NO_3)_2(aq) \Leftrightarrow NaNO_3(aq) + MgCl_2(aq)$

- a) Which way will equilibrium shift if you add more NaCl to the system?
- b) Which way will equilibrium shift if you add more magnesium nitrate to the system?
- c) Which way will equilibrium shift if you decrease the amount of magnesium chloride in the system?
- d) Which way will equilibrium shift if you decrease the temperature?
- e) Which way will equilibrium shift if you decrease the amount of sodium nitrate in the system?

Three

Consider the following endothermic reaction:

 $SbCl_{5}(g) \Leftrightarrow SbCl_{3}(g) + Cl_{2}(g).$

- a) Which way will equilibrium shift if you decrease the SbCl₅ in the system?
- b) Which way will equilibrium shift if you add more chlorine to the system?
- c) Which way will equilibrium shift if you decrease the temperature of the system?
- d) Which way will equilibrium shift if you increase the volume of the container?
- e) Which way will equilibrium shift if you decrease the amount of SbCl₃?

Four

Consider the following endothermic reaction:

- $SO_2(g) + NO_2(g) \Leftrightarrow SO_3(g) + NO(g).$
- a) Which way will equilibrium shift if you decrease the SO₃ in the system?
- b) Which way will equilibrium shift if you add more NO to the system?
- c) Which way will equilibrium shift if you decrease the temperature of the system?
- d) Which way will equilibrium shift if you increase the volume of the container?
- e) Which way will equilibrium shift if you decrease the amount of SO₂?

Five

Consider the following exothermic reaction:

 $I_2(g)$ + $Na_2S_2O_3(aq) \Leftrightarrow NaI(aq)$ + $Na_2S_4O_6(aq)$.

- a) Which way will equilibrium shift if you decrease the NaI in the system?
- b) Which way will equilibrium shift if you add more I_2 to the system?
- c) Which way will equilibrium shift if you increase the temperature of the system?
- d) Which way will equilibrium shift if you decrease the amount of $Na_2S_2O_3$ in the system?
- e) Which way will equilibrium shift if you decrease the amount of $Na_2S_4O_6$?

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1 $^{4\text{HCl}_{(g)}} + O_{2(g)} \rightleftarrows ^{2} 2H_2O_{(l)} + 2Cl_{2(g)} + 113 \text{ kJ}$

Which action will drive the reaction to the right?

- A heating the equilibrium mixture
- B adding water to the system
- C decreasing the oxygen concentration
- D increasing the system's pressure
- 2 In which of the following reactions involving gases would the forward reaction be favored by an increase in pressure?
 - $A + B \rightleftharpoons AB$
 - **B** $A + B \rightleftharpoons C + D$
 - $C = 2A + B \rightleftharpoons C + 2D$
 - $\mathbf{D} \quad \mathbf{AC} \rightleftharpoons \mathbf{A} + \mathbf{C}$

3 $NH_4CI(s) + heat \implies NH_3(g) + HCI(g)$

What kind of change will shift the reaction above to the right to form more products?

- A a decrease in total pressure
- B an increase in the concentration of HCl
- C an increase in the pressure of NH3
- D a decrease in temperature
- 4 When a reaction is at equilibrium and more reactant is added, which of the following changes is the immediate result?
 - A The reverse reaction rate remains the same.
 - B The forward reaction rate increases.
 - C The reverse reaction rate decreases.
 - D The forward reaction rate remains the same.
- **5** In a sealed bottle that is half full of water, equilibrium will be attained when water molecules
 - A cease to evaporate.
 - B begin to condense.
 - C are equal in number for both the liquid and the gas phase.
 - D evaporate and condense at equal rates.

6 $NO_2(g) + CO(g) \rightleftharpoons NO(g) + CO_2(g)$

- The reaction shown above occurs inside a closed flask. What action will shift the reaction to the left?
- A pumping CO gas into the closed flask
- **B** raising the total pressure inside the flask
- C increasing the NO concentration in the flask
- D venting some CO₂ gas from the flask

Which of the following changes will cause an increase in the rate of the above reaction?

- A increasing the concentration of Br₂
- B decreasing the concentration of C₆H₆
- C increasing the concentration of HBr
- D decreasing the temperature

2

$$2CO + O_2 \rightarrow 2CO_2$$

If the above reaction takes place inside a

sealed reaction chamber, then which of these procedures will cause a decrease in the rate of reaction?

- A raising the temperature of the reaction chamber
- B increasing the volume inside the reaction chamber
- C removing the CO₂ as it is formed
- D adding more CO to the reaction chamber
- **9** A catalyst can speed up the rate of a given chemical reaction by
 - A increasing the equilibrium constant in favor of products.
 - B lowering the activation energy required for the reaction to occur.
 - C raising the temperature at which the reaction occurs.
 - D increasing the pressure of reactants, thus favoring products.
- **10** Which reaction diagram shows the effect of using the appropriate catalyst in a chemical reaction?

A

Progress of Reaction

 $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$