CONCEPT: LE CHATELIER'S PRINCIPLE

Le Chatelier's Principle states if a reaction's equilibrium is disrupted it will shift in order to re-establish equilibrium.

Reactants & Products

- Adding Reactants or Removing Products

  Reaction will shift to the _____.

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

- Removing Reactants or Adding Products

  Reaction will shift to the _____.

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

Pressure & Volume

- Decreasing Pressure or Increasing Volume

  Reaction will shift to side with _____ moles of gas.

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

- Increasing Pressure or Decreasing Volume

  Reaction will shift to side with _____ moles of gas.

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

Temperature

−ΔH (exothermic) heat as a product

+ΔH (endothermic) heat as a reactant

- Increasing Temperature

  Reaction will shift _____ heat.

  _____ _____

  2 A(g) + B (s) + heat ⇌ **3 C (g) + D (s)**

- Decreasing Temperature

  Reaction will shift _____ heat.

  _____ _____

  2 A(g) + B (s) + heat ⇌ **3 C (g) + D (s)**

Inert Gas (Noble Gas)

- Adding under constant volume

  There will be _____ in the equilibrium position

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

- Adding under constant pressure

  Reaction will shift to side with _____ moles of gas.

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

Liquids, Solids & Catalysts

- Addition

  There will be _____ in the equilibrium position

  _____ _____

  2 A(g) + B (s) ⇌ **3 C (g) + D (s)**

PRACTICE: LE CHATELIER'S PRINCIPLE

EXAMPLE 1: The following data was collected for the following reaction at equilibrium.

$$A\,(s) + 2\,B\,(g) \rightleftharpoons 3\,C\,(g) + D\,(g)$$

At 55°C, K is 4.7×10^{-7} and at 100°C K is 1.9×10^{-2}. Which of the following statements is true?

a) The reaction is exothermic.

b) The reaction is endothermic.

c) The enthalpy change, ΔH, is equal to zero.

d) Not enough information is given.

EXAMPLE 2: In which of these gas-phase equilibria is the yield of products increased by increasing the total pressure on the reaction mixture?

a) $CO\,(g) + H_2O\,(g) \rightleftharpoons CO_2\,(g) + H_2\,(g)$

b) $2\,NO\,(g) + Cl_2\,(g) \rightleftharpoons 2\,NOCl\,(g)$

c) $2\,SO_3\,(g) \rightleftharpoons 2\,SO_2\,(g) + O_2\,(g)$

d) $PCl_5\,(g) \rightleftharpoons PCl_3\,(g) + Cl_2\,(g)$

e) $2\,H_2O_2\,(g) \rightleftharpoons 2\,H_2O\,(g) + O_2\,(g)$

PRACTICE: The reaction $2\,NaHCO_3\,(s) \rightleftharpoons Na_2CO_3\,(s) + H_2O\,(g) + CO_2\,(g)$ is endothermic. What would you do in order to maximize the yield of $Na_2CO_3\,(s)$?

a) Lower the temperature and increase the volume of the container.

b) Raise the temperature and add $CO_2(g)$ and $H_2O(g)$.

c) Lower the temperature and decrease the volume of the container.

d) Add $CO_2(g)$ and $H_2O(g)$ and increase the volume of the container.

e) Increase the volume of the container and raise the temperature.