Practice Questions Section 3.3

Le Châtelier's Principle - Volume & Pressure

1. The pressure on each of the following systems is increased by decreasing the volume of the container. Explain whether each system would shift in the forward direction, the reverse direction, or stay the same.

   a. $2\ SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\ SO_{3\,(g)}$

   b. $H_{2\,(g)} + I_{2\,(g)} \rightleftharpoons 2\ HI_{(g)}$

   c. $CaCO_{3\,(s)} \rightleftharpoons CaO_{(s)} + CO_{2\,(g)}$

   d. $AgCl_{(s)} \rightleftharpoons Ag^{1+}_{(aq)} + Cl^{1-}_{(aq)}$

2. List three ways that the following equilibrium reaction could be forced to shift to the right:

   $2\ NO_{2\,(g)} \rightleftharpoons 2\ NO_{(g)} + O_{2\,(g)}$

3. Given the following equilibrium reaction:

   $2\ C_{(s)} + O_{2\,(g)} \rightleftharpoons 2\ CO_{(g)}$

   What will be the effect of the following disturbances to the system:

   a. adding CO (at constant volume and temperature)

   b. addition of O_2 (at constant volume and temperature)

   c. addition of solid carbon (at constant temperature)

   d. decreasing the volume of the container

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Le Châtelier's Principle - Volume & Pressure Answers

1. The pressure on each of the following systems is increased by decreasing the volume of the container. Explain whether each system would shift in the forward direction, the reverse direction, or stay the same.

   a. $2\ SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\ SO_{3\,(g)}$ — forward reaction is favored; there are fewer moles of gas on the product side.

   b. $H_{2\,(g)} + I_{2\,(g)} \rightleftharpoons 2\ HI_{(g)}$ — No change - same number of moles on each side

   c. $CaCO_{3\,(s)} \rightleftharpoons CaO_{(s)} + CO_{2\,(g)}$ — reverse reaction is favored; there are no moles of gas on the reactants side vs. one mole of gas on the product side.

   d. $AgCl_{(s)} \rightleftharpoons Ag^{1+}_{(aq)} + Cl^{1-}_{(aq)}$ — No change - no gases present

2. List three ways that the following equilibrium reaction could be forced to shift to the right:

   $2\ NO_{2\,(g)} \rightleftharpoons 2\ NO_{(g)} + O_{2\,(g)}$

   Solution:

   - add more $NO_{2\,(g)}$
   - remove $NO_{(g)}$ or $O_{2\,(g)}$
   - decrease the pressure
   - increase the volume

3. Given the following equilibrium reaction:

   $2\ C_{(s)} + O_{2\,(g)} \rightleftharpoons 2\ CO_{(g)}$

   What will be the effect of the following disturbances to the system:

   a. adding CO (at constant volume and temperature) — reverse reaction is favored. Adding a substance on one side of the equation forces the reaction to the other side of the equation.

   b. addition of O_2 (at constant volume and temperature) — The forward reaction is favored to use up the additional O_2

   c. addition of solid carbon (at constant temperature) — No effect. Adding more of a solid does not change it's concentration. The reaction may go on longer, but equilibrium is not affected.

   d. decreasing the volume of the container — Count moles of GAS on both sides of the equation. There is 1 mole of gas on the reactant side, and 2 moles on the product side. Decreasing volume will favor the side with the fewest moles of gas - the reverse reaction will be favored.