

- 15.61a) Adding  $O_2$  will shift the equilibrium to the right
- b) Heating the reaction will shift the equilibrium to the left
- c) Doubling the volume will shift the equilibrium to the left
- d) Adding a catalyst will not shift the equilibrium
- e) Increasing the total pressure by adding a noble gas will not shift the equilibrium
- f) Removing  $SO_3$  will shift the equilibrium to the right.

- 15.62a) Increase      b) Decrease      c) Decrease      d) Decrease
- e) No Change      f) Decrease

15.63 (realize this question refers to the value of  $K_p$  and not the amounts of reactants or products)

- a) No effect      b) No effect      c) No effect
- d) Increase  $K_p$       e) No effect

15.64a) The reaction is endothermic if heating causes an increase in the fraction of products.

b) There are more moles of product gas if increasing the volume causes an increase in the fraction of products.

15.65

a) Because there are dissimilar numbers of gas reactant gas particles and product gas particles, a change in volume will effect the fraction of products in the equilibrium mixture.

$$\begin{aligned} \text{b) } \Delta H_{\text{rxn}} &= \sum \Delta H_{\text{f}}(\text{products}) - \sum \Delta H_{\text{f}}(\text{reactants}) \\ \Delta H_{\text{rxn}} &= (\Delta H_{\text{f}}(\text{NO}_2) + \Delta H_{\text{f}}(\text{N}_2\text{O})) - 3\Delta H_{\text{f}}(\text{NO}) \\ \Delta H_{\text{rxn}} &= (33.84\text{kJ} + 81.6\text{kJ}) - 3(90.37\text{kJ}) \\ \Delta H_{\text{rxn}} &= -155.7\text{kJ} \end{aligned}$$

c) As determined in part a, this reaction is exothermic. This means that a an increase in temperature will cause the value of  $K_c$  to decrease.

15.67 Because the decomposition of ozone involves 2 moles of reactant and 3 moles of product, an increasing in pressure would favor reactants.