Honors Chemistry

Answers to Chapter 13 Study Questions

1. True: b), c) and d)

2. a) Reaction = 2 x reverse of original reaction. So $K_2 = (1/K_1)^2 = (1/0.447)^2 = 5.00$.

 b) $K = \frac{[N_2O_4]}{[NO_2]^2}$ c) $5.0 = \frac{[N_2O_4]}{[0.30]^2}$; $[N_2O_4] = 5.0 \text{ x } (0.30)^2 = 5.0 \text{ x } 0.090 =$ 0.45 mol/L

3. a) $K = [H_2S]/[H_2]$; no effect

 b) $K = [NH_3]^2/[N_2] \text{ x } [H_2]^3$; more product made. Increasing the pressure increases the concentration; counteract this by shifting to the side with fewer moles

 c) $K = [HBr]^2/[H_2]$; more reactant made

4. $$Q = \frac{[NH_3]^2}{[N_2]x[H_2]^3} = \frac{(100)^2}{(30)x(500)^3} = \frac{1\,x\,10^4}{(3\,x\,10^1)x(1.2\,x\,10^8)} = 2.7 \text{ x } 10^{-6} \Rightarrow Q < K$$

 Not at equilibrium and more product will be formed (to make Q larger).

5. a) *i*) more reactant made (since more product added)
 ii) more product made (since some product is removed)
 iii) more product made (the concentration is decreased so increase concentration)
 iv) more product made (endothermic reactions use up heat)
 v) more reactant made (to decrease pressure, shift to side with fewer moles)

 b) Increase yield: *ii*, *iii* & i*v* (increase product)

 c) *K* will increase since increasing the temperature makes more product.

6.

	[NO] (M)	$[H_2]$ (M)	$[N_2]$ (M)	$[H_2O]$ (M)
original	0.100	0.050	0	0.100
change	- 0.030	- 0.030	+0.015	+ 0.030
equilibrium	0.070	0.020	0.015	0.130

 a) $[H_2] = 0.020$ M, $[N_2] = 0.015$ M, $[H_2O] =$ 0.130 M

 b) $$K = \frac{[N_2] \times [H_2O]^2}{[NO]^2 \times [H_2]^2}$$

 c) $$K = \frac{(0.015) \times (0.130)^2}{(0.0700)^2 \times (0.020)^2} = \frac{(0.015)(0.0169)}{(0.0049)(0.00040)} = \frac{2.5\,x\,10^{-4}}{2.0\,x\,10^{-6}} = 1.3 \text{ x } 10^2 = 130$$

 d) Since *K* is greater than 1, the concentration of products is greater than the concentration of reactants; however since *K* is not extremely large, some reactants will remain at equilibrium.

7. $K = \dfrac{[NO]^2}{[N_2][O_2]}$;

	$[N_2]$ (M)	$[O_2]$ (M)	[NO] (M)
original	0	0	0.50
change	$+x$	$+x$	$-2x$
equilibrium	x	x	$0.50-2x$

$$K = 1.0 \text{ x } 10^{-5} = \frac{(0.50-2x)^2}{x^2} = \left(\frac{(0.50-2x)}{x}\right)^2; \quad \frac{(0.50-2x)}{x} = \sqrt{1.0\times10^{-5}} = 3.16 \text{ x } 10^{-3}$$

$0.50 - 2x = (3.16 \text{ x } 10^{-3})x$; $0.50 = 2.00316\,x$; $x = 0.50/2.00316 = 0.2496$ M

$[N_2] = 0.25$ M; $[O_2] = 0.25$ M; $[NO] = 0.500 - 2(0.2496) = 8 \text{ x } 10^{-4}$ M

8. a) $K_1 = \dfrac{[B]}{[A]}$; $K_2 = \dfrac{[C]}{[B]}$; $K = \dfrac{[C]}{[A]} = \dfrac{[B]}{[A]}\dfrac{[C]}{[B]}$; $K = K_1 \times K_2$

b) When a chemical equation is equal to the sum of two other chemical equations, then the equilibrium constant for the reaction is equal to the product of the equilibrium constants of the other two equations.