WORKSHEET: CHEMICAL EQUILIBRIUM REVIEW

*1. Chemical equilibrium → two processes (forward and reverse) occurring at the same rate.

*2. Reaction rates can be increased by:
1) Adding a catalyst
2) Increasing the temperature
3) Decreasing the particle size

*3. Le Chatelier's Principle → when a stress is placed on a system, the system will act to relieve the stress and re-achieve equilibrium.

*4. Changing the volume of a system will result in the opposite change of pressure.
i.e. Decrease volume, increase pressure.
Increase volume, decrease pressure

*5. a) $N_{2(g)} + 3H_{2(g)} \overset{10\%}{\rightleftharpoons} 2NH_{3(g)}$ $K = \frac{[NH_{3(g)}]^2}{[N_{2(g)}][H_{2(g)}]^3}$

b) $2H_{2(g)} + O_{2(g)} \overset{>99\%}{\rightleftharpoons} 2H_2O_{(g)}$ $K = \frac{[H_2O_{(g)}]^2}{[H_{2(g)}]^2[O_{2(g)}]}$

c) $CO_{(g)} + H_2O_{(g)} \overset{67\%}{\rightleftharpoons} CO_{2(g)} + H_{2(g)}$ $K = \frac{[CO_{2(g)}][H_{2(g)}]}{[CO_{(g)}][H_2O_{(g)}]}$

*6. $4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)} + 2Cl_{2(g)} + 113\text{ kJ}$

a) increase temperature — SHIFT LEFT
b) decrease pressure — SHIFT LEFT
c) increase $[O_{2(g)}]$ — SHIFT RIGHT
d) add a catalyst — NO CHANGE

*7. $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$ K = 5.6

0.66 mol V = 1.0 L

? 0.66 mol/L

$$K = \frac{[N_2O_{4(g)}]}{[NO_{2(g)}]^2}$$

$$[NO_{2(g)}] = \sqrt{5.6[0.66]}$$

$$[NO_{2(g)}] = 1.9 \text{ mol/L}$$

*8. $8H_2S_{(g)} \rightleftharpoons 8H_{2(g)} + S_{8(g)}$ K = ?

0.18 mol 0.014 mol 0.035 mol V = 1.0 L

0.18 mol/L 0.014 mol/L 0.035 mol/L

$$K = \frac{[H_{2(g)}]^8[S_{8(g)}]}{[H_2S_{(g)}]^8}$$

$$K = \frac{[0.014]^8[0.035]}{[0.18]^8}$$

$$K = 4.7 \times 10^{-11}$$

*9. $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$ K = 0.905

? 1.20 mol/L 1.20 mol/L

$$K = \frac{[H_{2(g)}][I_{2(g)}]}{[HI_{(g)}]^2}$$

$$[HI_{(g)}]^2 = \frac{[H_{2(g)}][I_{2(g)}]}{K}$$

$$[HI_{(g)}] = \sqrt{\frac{[1.20][1.20]}{0.905}}$$

$$[HI_{(g)}] = 1.26 \text{ mol/L}$$

*10. $S_{8(g)} + 8O_{2(g)} \rightleftharpoons 8SO_{2(g)}$

init. 384g 205g

eqm. 380g

Find max. product

If S_8 is L.R.:

$$384g\ S_8 \times \frac{1\ mol\ S_8}{256.48g\ S_8} \times \frac{8\ mol\ SO_2}{1\ mol\ S_8} \times \frac{64.06g\ SO_2}{1\ mol\ SO_2} = 767.28g\ SO_2$$

If O_2 is L.R.

$$205g\ O_2 \times \frac{1\ mol\ O_2}{32.00g\ O_2} \times \frac{8\ mol\ SO_2}{8\ mol\ O_2} \times \frac{64.06g\ SO_2}{1\ mol\ SO_2} = 410.38g\ SO_2$$

∴ O_2 is L.R.

$$\%\ rxn = \frac{exp}{theor.} \times 100\%$$

$$\%\ rxn = \frac{380g}{410.38g} \times 100\%$$

% rxn = 92.6%

$S_{8(g)} + 8O_{2(g)} \overset{92.6\%}{\rightleftharpoons} 8SO_{2(g)}$

*11. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

	N_2	H_2	NH_3
init.	12.70g	6.24g	
eqm.			3.77g

Find max. product.

If N_2 is L.R.:

$$12.70g\ N_2 \times \frac{1\ mol\ N_2}{28.02g\ N_2} \times \frac{2\ mol\ NH_3}{1\ mol\ N_2} \times \frac{17.04\ g\ NH_3}{1\ mol\ NH_3} = \boxed{15.45g\ NH_3}$$

If H_2 is L.R.:

$$6.24g\ H_2 \times \frac{1mol\ H_2}{2.02g\ H_2} \times \frac{2\ mol\ NH_3}{3\ mol\ H_2} \times \frac{17.04\ g\ NH_3}{1\ mol\ NH_3} = 35.09g\ NH_3$$

∴ N_2 is L.R.

$$\%\ rxn = \frac{exp.}{theor.} \times 100\%$$

$$\%\ rxn = \frac{3.77g}{15.45g} \times 100\%$$

$$\boxed{\%\ rxn = 24.4\%}$$

$$\boxed{N_{2(g)} + 3H_{2(g)} \overset{24.4\%}{\rightleftharpoons} 2NH_{3(g)}}$$