

# Equilibrium Worksheet

① (a)  $k_{eq} = \frac{[NO_2]^4 [O_2]}{[N_2O_5]^2}$

(b)  $k_{eq} = \frac{[SO_3]^2}{[SO_2]^2 [O_2]}$

(c)  $k_{eq} = \frac{[SO_3]}{[SO_2][O_2]^{1/2}}$

(d)  $k_{eq} = \frac{[P_4O_{10}]}{[P_4][O_2]^5}$

② (a)  $k_{eq} = \frac{[NO]^2}{[N_2][O_2]}$  (b) mol/L

③ original  $k_{eq} = \frac{[NO_2]^2}{[N_2O_4]} = 0.212$

(a)  $k_{eq} = \frac{[N_2O_4]}{[NO_2]^2} = \frac{1}{0.212} = \underline{4.717}$

(b)  $k_{eq} = \frac{[N_2O_4]^{1/2}}{[NO_2]} = \sqrt{\frac{[N_2O_4]}{[NO_2]^2}} = \sqrt{4.717} = \underline{2.172}$

④  $k_{eq} = \frac{[CH_3OH]}{[H_2]^2 [CO]} = \frac{[.1]}{[.1]^2 [.1]} = 100$

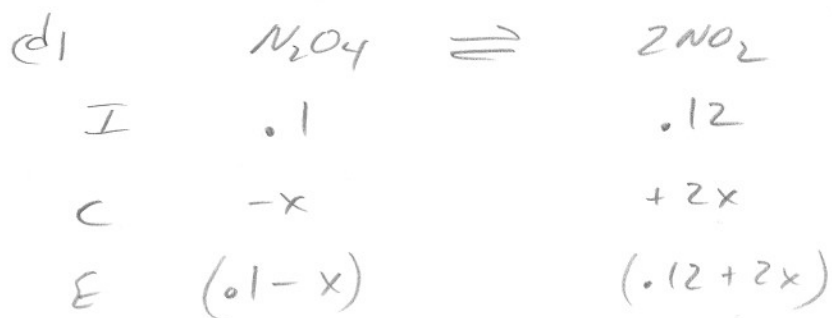
∴ the system is not at equilibrium

⑤  $k_{eq} = \frac{[SO_3]^2}{[SO_2]^2 [O_2]} = \frac{(0.1)^2}{(0.01)^2 (0.2)} = \underline{500}$

$$(6) (a) K_{eq} = \frac{[NO_2]^2}{[N_2O_4]} = \frac{(0.12)^2}{(0.1)} = 0.144$$

(b) The system is not at equilibrium

(c)  $[NO_2]$  must increase



$$K_{eq} = \frac{[NO_2]^2}{[N_2O_4]}$$

$$0.212 = \frac{(0.12+2x)^2}{(0.1-x)}$$

$$0.212(0.1-x) = (0.12+2x)^2$$

$$0.0212 - 0.212x = 0.0144 + 0.48x + 4x^2$$

$$0 = 4x^2 + 0.692x - 0.0068$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-0.692 \pm \sqrt{(0.692)^2 - 4(4)(-0.0068)}}{2(4)}$$

$$= \frac{-0.692 \pm 0.7666}{8} = -0.082, 0.009$$

(more than what we started with)

$$[N_2O_4] = 0.1 - 0.009 = \underline{0.09} \text{ mol/L} \quad [NO_2] = 0.12 + 2(0.009) = \underline{0.14} \text{ mol/L}$$

$$\textcircled{7} \quad (a) \quad k_{eq} = \frac{[CO_2]}{[O_2]}$$

$$(b) \quad k_{eq} = [CO_2]$$

$$(c) \quad k_{eq} = [CO_2][H_2O]$$

$$(d) \quad k_{eq} = \frac{[CO_2]}{[CO]}$$

$$(e) \quad k_{eq} = \frac{[H_2]^4}{[H_2O]^4}$$