

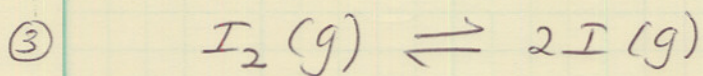
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INTRODUCTION TO NATURAL SCIENCE
CHEMISTRY HOMEWORK - SPRING - WEEK 4

Chapter 16

① (a) $K_c = \frac{[\text{H}_2\text{O}]_{\text{eq}}^2 [\text{O}_2]_{\text{eq}}}{[\text{H}_2\text{O}_2]_{\text{eq}}^2}$ (c) $K_c = \frac{[\text{CO}]_{\text{eq}}^2}{[\text{CO}_2]_{\text{eq}}}$

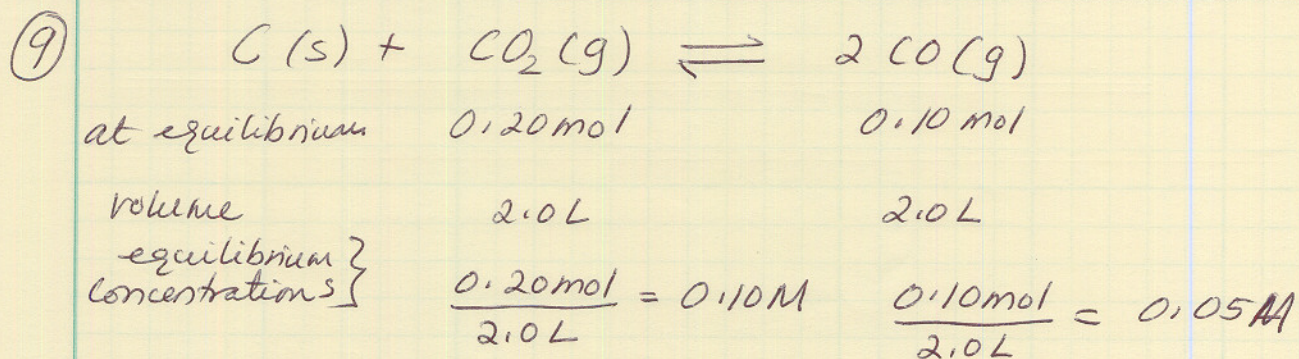
(b) $K_c = \frac{[\text{CO}_2]_{\text{eq}}}{[\text{CO}]_{\text{eq}} [\text{O}_2]_{\text{eq}}^{1/2}}$ (d) $K_c = \frac{[\text{CO}_2]_{\text{eq}}}{[\text{CO}]_{\text{eq}}}$



$$Q = \frac{[\text{I}]^2}{[\text{I}_2]} = \frac{(2.0 \times 10^{-8} \text{ M})^2}{(0.020 \text{ M})} = 2.0 \times 10^{-14} \text{ M} < K$$

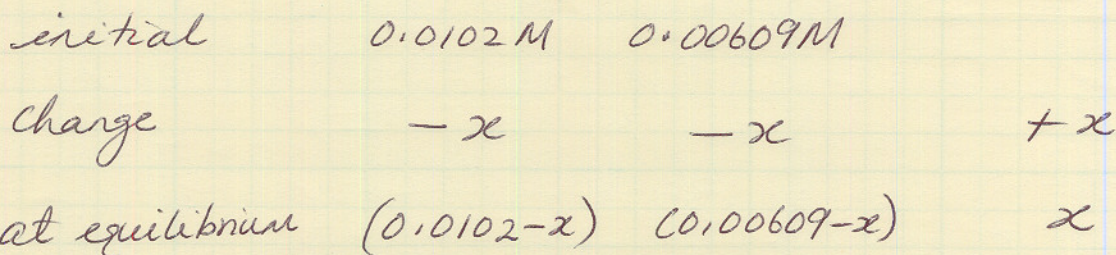
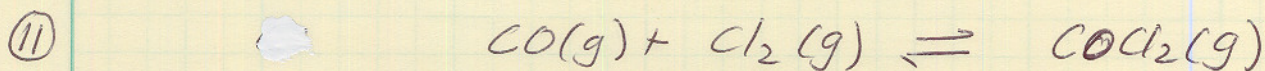
The reaction is not at equilibrium. It will proceed forward to reach equilibrium.

⑦ $K = \frac{[\text{PCl}_3]_{\text{eq}} [\text{Cl}_2]_{\text{eq}}}{[\text{PCl}_5]_{\text{eq}}} = \frac{(1.3 \times 10^{-2} \text{ M})(3.9 \times 10^{-3} \text{ M})}{(4.2 \times 10^{-5} \text{ M})}$
 $= \underline{\underline{1.21 \text{ M}}}$



$$K = \frac{[CO]_{eq}^2}{[CO_2]_{eq}} = \frac{(0.05 \text{ M})^2}{(0.10 \text{ M})} = \underline{\underline{2.5 \times 10^{-2} \text{ M}}}$$

Parts (b) and (c) are done at the end.



$$[COCl_2]_{eq} = x = 0.00301 \text{ M}$$

$$\therefore [CO]_{eq} = 0.0102 - x = 7.19 \times 10^{-3} \text{ M}$$

$$[Cl_2]_{eq} = 0.00609 - x = 3.08 \times 10^{-3} \text{ M}$$

$$K = \frac{[COCl_2]_{eq}}{[CO]_{eq} [Cl_2]_{eq}} = \frac{0.00301 \text{ M}}{(7.19 \times 10^{-3} \text{ M})(3.08 \times 10^{-3} \text{ M})}$$

$$= \underline{\underline{1.36 \times 10^2 \text{ M}^{-1}}}$$

(15)



initial

$$\frac{0.105 \text{ mol}}{12.3 \text{ L}} = 8.54 \times 10^{-3} \text{ M} \quad 0$$

change

$$-x \quad +2x$$

at equilibrium

$$(8.54 \times 10^{-3} - x) \quad +2x$$

$$K = \frac{[I]_{eq}^2}{[I_2]_{eq}} = \frac{(2x)^2}{(8.54 \times 10^{-3} - x)} = 3.76 \times 10^{-3}$$

$$\frac{4x^2}{8.54 \times 10^{-3} - x} = 3.76 \times 10^{-3}$$

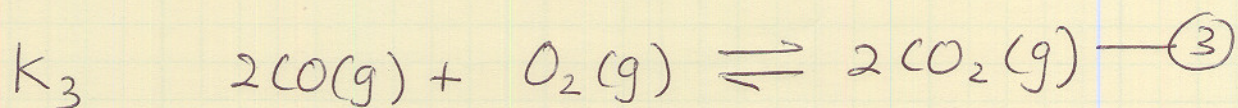
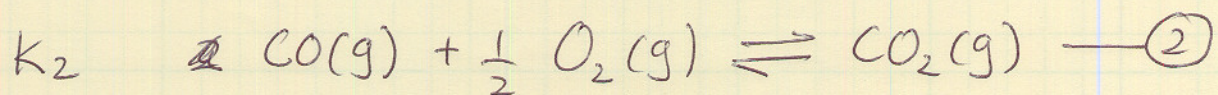
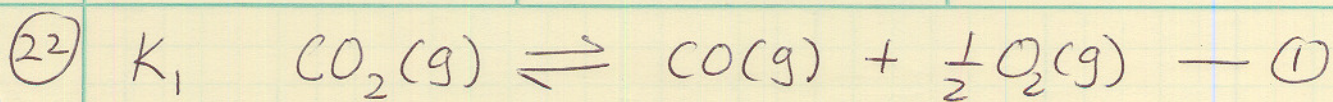
$$4x^2 + 3.76 \times 10^{-3}x - 3.21 \times 10^{-5} = 0$$

$$x = \frac{-3.76 \times 10^{-3} \pm \sqrt{(3.76 \times 10^{-3})^2 + 4(4)(3.21 \times 10^{-5})}}{2(4)}$$

$$x = 2.40 \times 10^{-3}$$

$$[I_2]_{eq} = 8.54 \times 10^{-3} - x = \underline{\underline{6.14 \times 10^{-3} \text{ M}}}$$

$$[I]_{eq} = 2x = \underline{\underline{4.80 \times 10^{-3} \text{ M}}}$$



Rn (2) is the reverse of Rn (1)

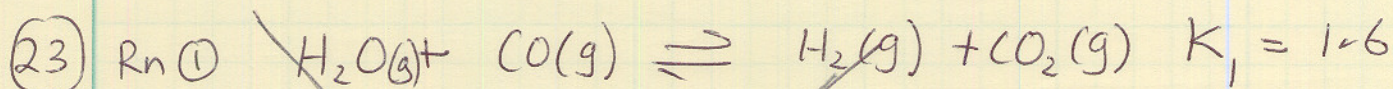
$$\Rightarrow K_2 = K_1^{-1}$$

Rn (3) is $2 \times$ Rn (2)

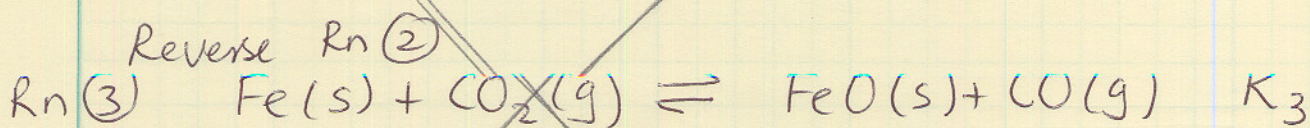
$$\Rightarrow K_3 = K_2^2 = (K_1^{-1})^2 = K_1^{-2}$$

$$= (6.66 \times 10^{-12})^{-2}$$

$$K_3 = \underline{\underline{2.25 \times 10^{22}}}$$



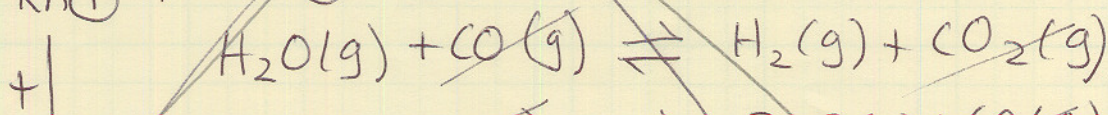
Reverse Rn (2)

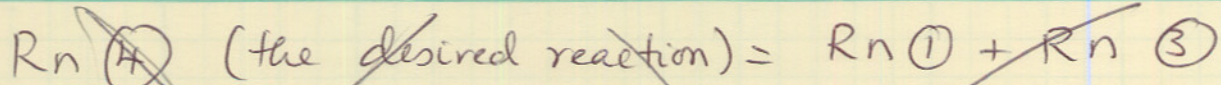


$$K_3 = K_2^{-1}$$

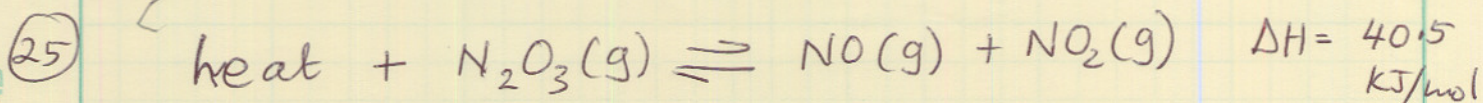
$$= \underline{\underline{1.49}}$$

Rn (1) + Rn (3) \Rightarrow

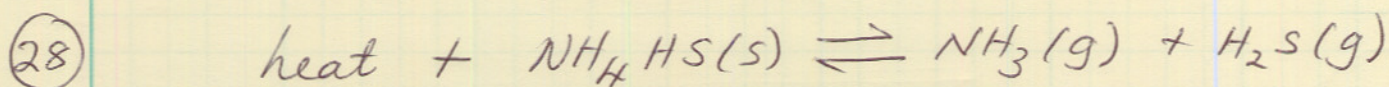




~~$$\begin{aligned} \therefore K_4 &= K_1 \cdot K_3 \\ &= (1.6)(1.49) = \underline{\underline{2.4}} \end{aligned}$$~~



- (a) shift to the right (adding a reactant)
 (b) shift to the left (adding a product)
 (c) effectively decrease the pressure \Rightarrow effectively increase number of species \Rightarrow shift to the right
 (d) shift to the left (removed a "reactant")



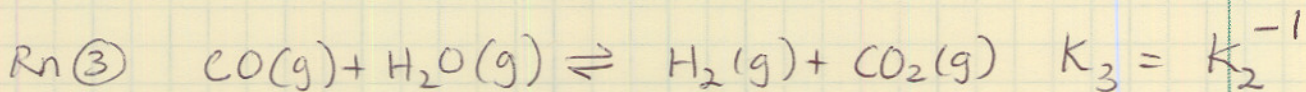
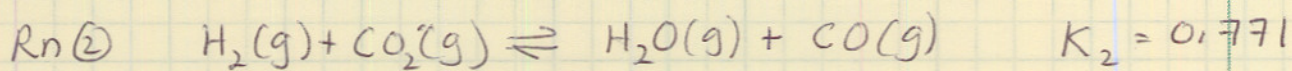
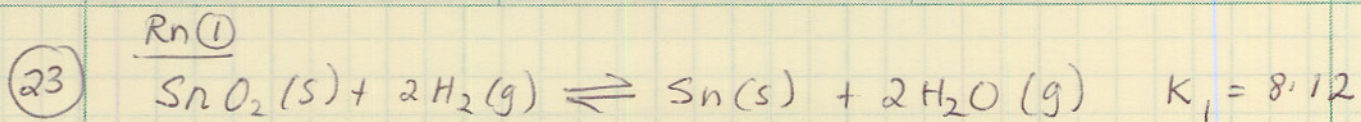
increase temp - equilibrium shifts to the right (added a "reactant")

add more NH_4HS - equilibrium will not change since NH_4HS is a solid and does not appear in the equilibrium expression.

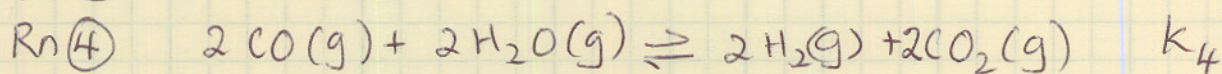
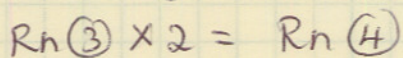
add more NH_3 - equilibrium will shift to the left (added a product)

H_2S is removed - equilibrium will shift to the right (product has been removed)

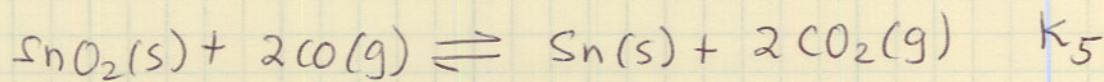
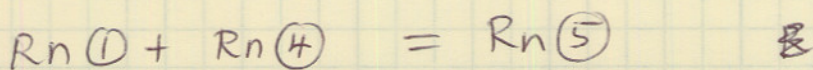
6 #



(because Rn (3) is reverse of Rn (2)) $K_3 = 1.30$



$$K_4 = K_3^2 = 1.68$$



Rn (5) is the desired reaction

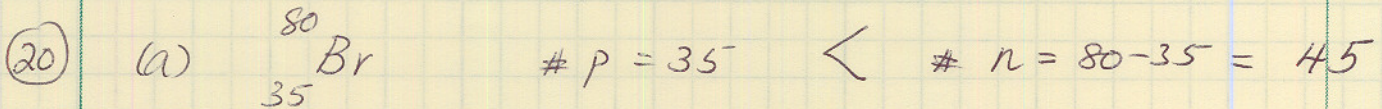
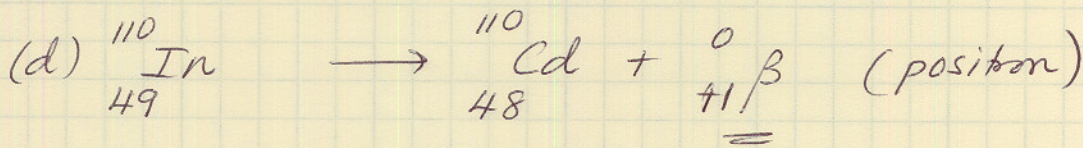
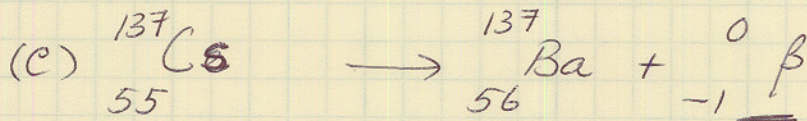
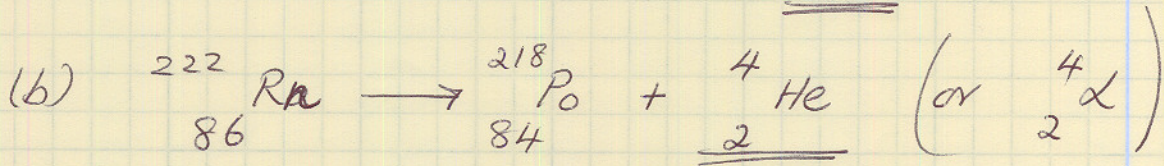
$$K_5 = K_1 \cdot K_4 = (8.12)(1.68) = \underline{\underline{13.66}}$$

$$\text{(9) (b)} \quad [\text{CO}]_{\text{eq}} = \frac{0.10 \text{ mol}}{2 \text{ L}} = 0.05 \text{ M}$$

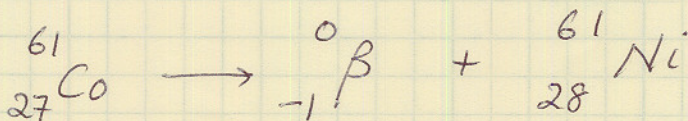
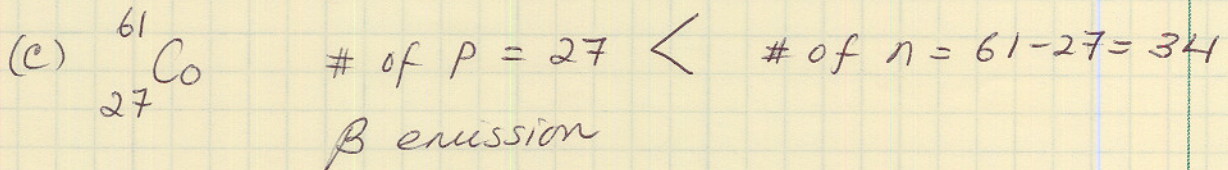
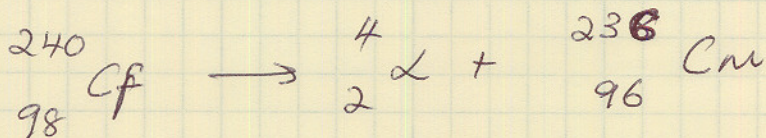
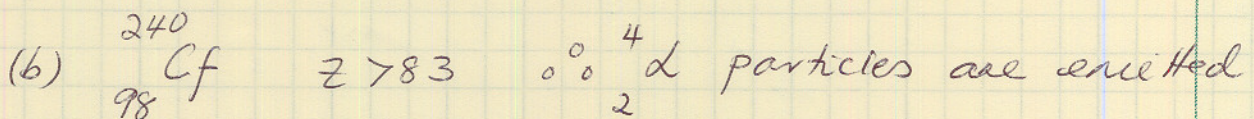
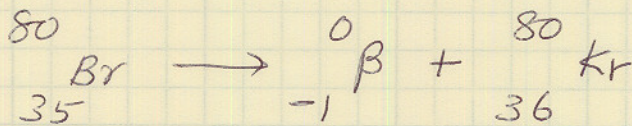
$$[\text{CO}_2]_{\text{eq}} = \frac{0.20 \text{ mol}}{2 \text{ L}} = 0.10 \text{ M}$$

$$K = \frac{[\text{CO}]_{\text{eq}}^2}{[\text{CO}_2]_{\text{eq}}} = \underline{\underline{2.5 \times 10^{-2}}}$$

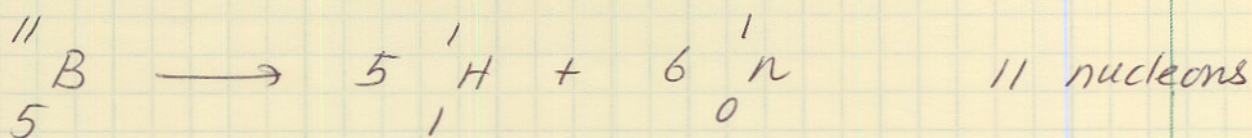
K does not depend on the concentration of (s)

Chapter 23

decay by emitting $\underline{\underline{{}_{-1}^0\beta}}$ particles



9



$$\text{mass of nucleons} = [5(1.00783) + 6(1.00867)] \text{ g/mol}$$

$$= 11.09117 \text{ g/mol}$$

$$\text{mass defect } (\Delta m) = \cancel{11.00931} (11.09117 - 11.00931) \text{ g/mol}$$

$$= 0.08186 \text{ g/mol}$$

$$E_b = (\Delta m) c^2 = \left(\frac{0.08186 \text{ g}}{\text{mol}} \right) \left(2.99 \times 10^8 \text{ m s}^{-1} \right)^2 \left(\frac{\text{kg}}{10^3 \text{ g}} \right)$$

$$= 7.3184 \times 10^{12} \text{ J mol}^{-1} = 7.3184 \times 10^9 \text{ kJ mol}^{-1}$$

$$\text{binding energy per nucleon} = \frac{7.3184 \times 10^9 \text{ kJ mol}^{-1}}{11 \text{ nucleons}}$$

$$= \underline{\underline{6.6531 \times 10^8 \text{ kJ mol}^{-1} \text{ nucleon}^{-1}}}$$