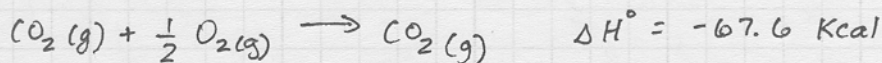
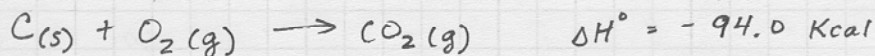


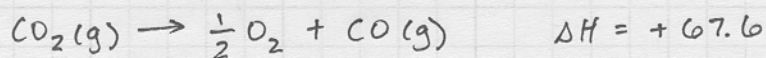
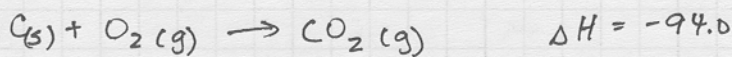
Chapter 3

(3-2) Calculate the standard enthalpy of formation

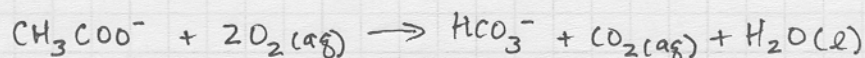
ΔH_f° for $\text{CO}_2(\text{g})$, given:



rewriting



(3-5) Find ΔG° given:



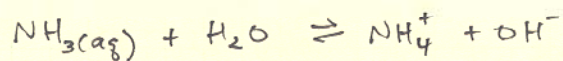
$$\Delta G^\circ = \left(\sum Y_i G_{fi}^\circ \right)_{\text{products}} - \left(\sum Y_i G_{fi}^\circ \right)_{\text{reactants}}$$

	ΔG_f°
CH_3COO^-	-89.0 Kcal/mol
$\text{O}_2(\text{aq})$	+3.39 + 3.93
HCO_3^-	-140.31
$\text{CO}_2(\text{aq})$	-92.31
$\text{H}_2\text{O}(\text{l})$	-56.69

$$\Delta G^\circ = \left[(-140.3) + (-92.31) + (-56.69) \right] - \left[2(3.93) + (-89.0) \right]$$

$$\Delta G^\circ = \underline{\underline{-208.16 \text{ Kcal}}}$$

(3-6) Given:



find:

(a) K at 25°C

(b) If pH=9, $[\text{NH}_3] = 10^{-5} \text{ M}$ $[\text{NH}_4^+] = 10^{-6} \text{ M}$,

Is reaction at equilibrium?

We know, at equilibrium

$$\Delta G^\circ = -RT \ln K$$

OR

$$K = \exp\left(\frac{-\Delta G^\circ}{RT}\right)$$

$$\Delta G^\circ = \left[(-19) + (-37.6)\right] - \left[(-6.37) + (-56.7)\right]$$

$$\Delta G^\circ = 6.47 \text{ Kcal/mol}$$

$$K = \exp\left(\frac{-6.47 \text{ Kcal/mol} \left(\frac{1000 \text{ cal}}{\text{Kcal}}\right)}{\left(1.987 \frac{\text{cal}}{\text{mol K}}\right) (298 \text{ K})}\right)$$

$$\underline{K = 1.8 \times 10^{-5}}$$

(b) $\Delta G = \Delta G^\circ + RT \ln Q$

$$\Delta G = 6.47 \times 10^3 \text{ cal} + \left(1.98 \frac{\text{cal}}{\text{K}}\right) (298 \text{ K}) \ln \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{H}_2\text{O}][\text{NH}_3]}$$

$$[\text{NH}_4^+] = 10^{-6}$$

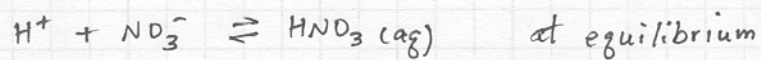
$$[\text{NH}_3] = 10^{-5}$$

$$[\text{OH}^-] = \frac{(14 - \text{pH})}{10} = \frac{(14 - 9)}{10} = 10^{-5}$$

$$\Delta G = 6.5 \times 10^3 + 590 \ln \frac{(10^{-6})(10^{-5})}{(1)(10^{-5})}$$

$\Delta G = -1651 \text{ Kcal} < 0 \Rightarrow$ reaction proceeds as written
reaction is not at equilibrium

(3-7) Given:



What % C_{T, NO_3} is present as HNO_3 at $\text{pH} = 1$?

First, find K

$$K = \exp\left(\frac{-\Delta G^\circ}{RT}\right)$$

$$\Delta G^\circ = (-26.41) - [(-26.43) + (0)]$$

$$\Delta G^\circ = 0.02 \text{ Kcal}$$

$$K = \exp\left(\frac{-0.02 \times 10^3 \text{ cal}}{(1.98)(298)}\right) = 0.97$$

$$K = \frac{[\text{HNO}_3]}{[\text{H}^+][\text{NO}_3^-]} \quad \text{OR} \quad \frac{[\text{HNO}_3]}{[\text{NO}_3^-]} = K [\text{H}^+]$$
$$= (0.97)(10^{-1})$$
$$= 0.097$$

$$[\text{HNO}_3] = 0.097 [\text{NO}_3^-]$$

$$[\text{NO}_3^-] = \frac{[\text{HNO}_3]}{0.097}$$

$$\% \text{ as HNO}_3 = \frac{[\text{HNO}_3]}{[\text{HNO}_3] + [\text{NO}_3^-]} \times (100)$$

$$= \frac{[\text{HNO}_3]}{[\text{HNO}_3] + \frac{[\text{HNO}_3]}{0.097}} \times 100 = \frac{1}{1 + \frac{1}{0.097}} \times 100$$

$$\% \text{ as HNO}_3 = 8.8\%$$