1. Answer the following questions about the ionization of trichloracetic acid.
   a. At 25.0° C , what is the standard Gibbs Free energy for the ionization of trichloroacetic acid given the
   ΔH° is 6.3 kJ/mol and the ΔS° is 8.4 J/mol-K. Is the ionization product or reactant favored?

$HA + H_2O \rightleftharpoons A^- + H_3O^+$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \quad \Delta G^\circ = 6.3\,kJ - 298K(0.0084\,kJ/K)$

$\Delta G^\circ = 3.8\,kJ$

reactant favored @ eq.

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

K < 1 is reactant favored

   b. What is the pKa of trichloracetic acid?

$pKa = -\log(Ka)$

$pKa = -\log(0.22)$

$pKa = 0.68$

$\Delta G^\circ = -RT\ln Ka \qquad -\Delta G^\circ/RT$

$Ka = e^{-3,800\,J/8.314\frac{J}{mol\cdot K}\cdot 298K} \qquad Ka = e$

$Ka = 0.22$

reactant favored

   c. Is trichloracetic acid weaker or stronger than acetic acid ($Ka = 1.8 \times 10^{-5}$)

pKa acetic 4.7

trichloracetic acid b/c Ka is larger in magnitude.

2. It is determined for chemical reaction that ΔH° is 185 kJ/mol and ΔS° is 1.8 J/mol-K. Answer the following questions

a. Is the reaction endo or exothermic at 25.0 °C?

endothermic $\Delta H > 0$

b. What is the ΔG° for the reaction? Is the reaction spontaneous at 25.0°C?

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G^\circ = 185\,kJ - \left[(298\,K)\left(0.0018\frac{kJ}{K}\right)\right] =$$

non-spon. @ 25.0°C $\Delta G = +184\,kJ$

c. At what temperature does the reaction become spontaneous? Is this temperature practical for lab? (you can assume enthalpy and entropy changes do not vary significantly with temperature)

$\Delta G^\circ = \emptyset$

$$\emptyset = \Delta H - T\Delta S$$

$$\frac{-\Delta H}{-\Delta S} = \frac{-T\Delta S}{-\Delta S}$$

$$T = \frac{\Delta H}{\Delta S}$$

$$T = \frac{185\,kJ}{0.0018\,kJ/K}$$

$T = 1.03 \times 10^5 K$