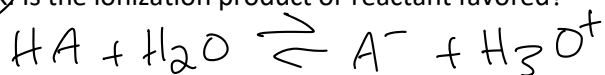


1. Answer the following questions about the ionization of trichloroacetic acid.

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?



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

b. What is the pKa of trichloroacetic acid?

$$pKa = -\log(0.22)$$

$$pKa = 0.68$$

$$pKa = -\log(Ka)$$

$$\Delta G^\circ = 3.8 \text{ kJ}$$

reactant favored @
eg.

$$\Delta G^\circ = -RT \ln(Ka) \quad -\Delta G^\circ / RT$$

$$Ka = e^{-3,800 \text{ J} / (8.314 \text{ J/mol-K} \cdot 298 \text{ K})} \quad Ka = e$$

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

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

K < 1 is reactant favored

reactant favored

pKa acetic
4.7

trichloroacetic 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?

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

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

non-spont. @ 25.0 °C $\Delta G = +184 \text{ kJ}$

- 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)

$$\Delta G^\circ = 0$$

$$0 = \Delta H - T\Delta S$$

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

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

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

$$T = 1.03 \times 10^5 \text{ K}$$