

Exercise 7: Free energy and electrochemistry

1. An example of thermodynamics and kinetics from biochemistry: F_{ab} is the variable part of the antibody molecule and it binds to a substrate, called a hapten. At 25°C , the dissociation constant of an F_{ab} -hapten complex is 3.0×10^{-7} .

a. What is the **standard free energy change** of binding? Is the binding spontaneous or non-spontaneous? Hint: write the chemical equation of binding first.

b. The rate constant of the release of the hapten molecule from the complex is 120 s^{-1} . What is the **rate constant** for the capture of the hapten molecule by F_{ab} ?

2. The overall reaction in the lead storage battery is



a. For the cell reaction, $\Delta H^\circ = -315.9 \text{ kJ}$ and $\Delta S^\circ = 263.5 \text{ J/K}$. Calculate E° at -20.0°C . Assume ΔH° and ΔS° do not depend on temperature.

b. Calculate E at -20.0°C when $[\text{HSO}_4^-] = [\text{H}^+] = 4.5 \text{ M}$.

c. Explain how this result shows that car batteries fail more often in cold weather than in warm weather.