Read Chapter 14 (at least Sections 14.1, 14.2, and 14.3) and Chapter 3, answer the following problems, and indicate with whom you worked: ____________.


2. In Naegeli, Redepenning, & Anson, *Journal of Physical Chemistry*, 1986, 90, 6227 (see class website), redox-active molecules are embedded in Nafion-coated electrodes and their formal potentials are measured.
   a. Based on Figure 2, answer the following:
      i. Why are the potentials called formal potentials and not standard potentials?
      ii. Explain why the formal potential for the reduction of the redox-active molecules in solution at a bare electrode becomes slightly more negative as the concentration of LiCl is increased?
      iii. When a Nafion-coated electrode is used, explain the cause of the LiCl concentration dependence to the formal potentials? (Assume that the Nafion was presoaked in an aqueous electrolyte containing a high concentration of LiCl in a large beaker.)
   b. Based on Figure 4, where the ordinate axis should be labeled “fraction of protonated molecules,” answer the following:
      i. What is the approximate pKₐ of [Ru^{II}(NH₃)₅(pz-H⁺)]³⁺, where pz is pyrazine and pz-H is protonated pz?
      ii. Why does [Ru^{II}(NH₃)₅(pz-H⁺)]³⁺ not deprotonate when it is incorporated into Nafion and the pH is varied? (Assume that the Nafion was presoaked in an aqueous electrolyte containing a high concentration of HCl in a large beaker.)
      iii. If the pH of the solution changed to 11 using NaOH, and the beaker is large, will [Ru^{II}(NH₃)₅(pz-H⁺)]³⁺ in Nafion deprotonate? Explain why or why not?

3. At steady-state, a human neuron has the following approximate distribution of ions across its cell membrane:

<table>
<thead>
<tr>
<th></th>
<th>Inside (mM)</th>
<th>Outside (mM)</th>
<th>Relative permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>K⁺</td>
<td>100</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Na⁺</td>
<td>10</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>10</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

Based on this information, answer the following:
   a. What is the resting potential of the membrane at physiological temperature (i.e. 98.6 °F)?
   b. When a nerve is stimulated by an action potential, voltage-sensitive sodium channels open up (wide) and the cell depolarizes to roughly +40 mV. However, due to charge neutrality, the concentrations of Na⁺ inside and outside of the cell change very little, and the small flux of sodium simply charges the membrane like a capacitor. What is the relative permeability of Na⁺ that caused this depolarization?
   c. This depolarization causes the Na⁺ channels (from part b) to close and another channel to open. If this results in a membrane potential that is slightly more negative than the resting potential (from part a), could the chloride and/or potassium channel have opened up (wide)? Explain your answer.