Biophysical Chemistry for Life Scientists

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Problem Set 6
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(1) Calculate the electric field (E^*) and the electrostatic potential (Φ) at a distance r from a charge q_B. What is the direction of the electric field? Recall that $F = q_A E^*$ and $U(r) = q_A \Phi(r)$, where q_A is a test charge. **Bold symbols denote vector quantities.**

(2) Calculate the potential energy of interaction between Na^+ and Cl^- separated by a distance of 10 Å (1 nm) (a) in a vacuum; and in (b) in water at 37 °C (dielectric constant $\varepsilon = 74.2$).. Do the calculations in both SI and cgs units.

(3) Calculate the ionic strength of a 0.01 $\underline{m}$ solution of $Fe_2(SO_4)_3$. Estimate the mean activity coefficient of this solute at 37 °C according to Debye-Huckel theory.

(4) Calculate the ionic strength of a solution containing 0.1 $\underline{m}$ NaCl and 0.01 $\underline{m}$ $MgCl_2$.

(5) From Coulomb's Law and the reversible work required to move two oppositely charged ions from infinite separation to a distance r apart, obtain an expression for the free energy of interaction between a pair of ions in solution. Also, obtain an expression for the electrostatic entropy and enthalpy, i.e., the entropy and enthalpy of interaction.