

1. Calculate the surface tension of a liquid if the capillary rise in a tube of radius $100\ \mu\text{m}$ is $0.1\ \text{m}$ and the density is $0.8\ \text{gm/cm}^3$.
2. Myoglobin is a skeletal protein that binds oxygen. The standard free energy for the reaction
 $\text{Myoglobin} + \text{O}_2 \rightarrow \text{Oxymyoglobin}$
Is $\Delta G^\circ = -30.0\ \text{kJ/mol}$ at $298\ \text{K}$ and $\text{pH}\ 7$. The standard state of O_2 is the dilute solution molarity scale; therefore the concentration of O_2 must be in units of molarity (M). What is the ratio (oxymyoglobin)/(total myoglobin) in an aqueous solution at equilibrium with a partial pressure of oxygen $P(\text{O}_2) = 30\ \text{Torr}$? Assume ideal behavior of O_2 gas and that Henry's law holds for O_2 dissolved in water ($K(\text{O}_2) = 43 \times 10^3\ \text{atm}$).
3. According to the chemiosmotic theory, an electrochemical proton gradient is used to synthesize ATP in mitochondria. The enzyme that does this is located on the inside of the mitochondrial membrane. The oxidation of carbohydrates and fats is used to pump protons outside the mitochondrial membrane until the steady state membrane potential is $-140\ \text{mV}$ and the pH gradient is $\Delta\text{pH} = 1.5$ units. Inside the mitochondrion, $\text{pH} = 7.0$, $[\text{ATP}] = 1\ \text{mM}$, $[\text{P}_i] = 2.5\ \text{mM}$, $[\text{ADP}] = 1\ \text{mM}$, and $T = 310\ \text{K}$ and the standard free energy change is ($\Delta G^\circ = 31\ \text{kJ/mol}$).
 - A. How much free energy is required to synthesize ATP inside the mitochondria?
 - B. How much free energy is made available by moving one mole of protons from the outside to the inside? Is this enough to drive ATP synthesis?
 - C. How many protons must be translocated per ATP synthesized?
4. How many photons of light strike a molecule on average if the wavelength of the radiation is $500\ \text{nm}$ and the total energy per unit area is $1\ \text{nanoJoule/mm}^2$ and the concentration of molecules is $1\ \text{mM}$ in a $1\ \text{mm}$ cuvette?
5.
 - A. What is the temperature at the surface of a burner on a stove if the maximum emission wavelength is $4240\ \text{nm}$?
 - B. The limit of visible detection is ca. $780\ \text{nm}$. How much radiant energy is emitted at $780\ \text{nm}$ compared to that emitted at the peak of the blackbody emission spectrum?