

## Biochemistry II

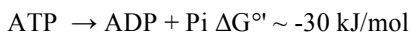
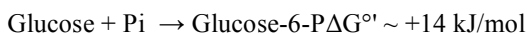
### Thermodynamics Homework

Name \_\_\_\_\_

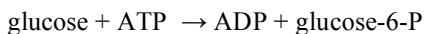
10 pts each – Due 18 January 2008

1. The change in Gibbs free energy,  $\Delta G'$ , for a chemical reaction has 2 components: enthalpy and entropy. Which of the following statements is correct? INDICATE why each of the other answers are incorrect.
- A) Reactions will occur spontaneously if the enthalpy is positive (energy is absorbed during the reaction).
- B) Reactions will occur spontaneously if the enthalpy is negative (heat is released during the reaction).
- C) A negative  $\Delta G'$  indicates that the reaction could occur spontaneously. CORRECT
- D) A negative  $\Delta G'$  indicates that the reaction will not occur spontaneously.
2. When the reaction  $X \rightarrow Y$  reaches equilibrium, the ratio of Y to X is 10 (i.e., there is 10 times more Y than X and  $K_{eq}=10$ ). The standard free energy change,  $\Delta G^\circ$ , for the reaction  $X \rightarrow Y$  is: (Show your work)
- A) +12 kJ/mol   B) -12 kJ/mol   xxx   C) 0 kJ/mol   D) +6 kJ/mol   E) -6 kJ/mol   xxxx

Consider the free energy changes for the following reactions:



3. What is the  $\Delta G^\circ$  for the following coupled reaction: (Show your work)



- A) -44 kJ/mol   B) -16 kJ/mol   C) -30 kJ/mol   D) +16 kJ/mol

4. At standard conditions, the reaction ( $\text{glucose} + \text{ATP} \rightleftharpoons \text{ADP} + \text{glucose-6-P}$ ) will: ALSO - INDICATE why each of the other answers are incorrect.
- A) proceed to the left
- B) proceed to the right
- C) not proceed because the system is at equilibrium
- D) Because  $\Delta G^\circ = 0$ , no information about the net reaction can be predicted from the information given

5. The free energy change ( $\Delta G'$ ) for the oxidation of the sugar molecules in a sheet of paper into  $\text{CO}_2$  and  $\text{H}_2\text{O}$  is large and negative (the =  $\Delta G_o' - 2833 \text{ kJ/mol}$ ). Explain why paper is stable at room temperature in the presence of oxygen ( $\text{O}_2$ ) because:
6. The cleavage of the phosphate group of phosphoenolpyruvate by simple hydrolysis to form pyruvate has a large negative  $\Delta G$  ( $\Delta G_o'$  for hydrolysis is  $-61.9 \text{ kJ/mol}$ ). However in the reaction by which pyruvate is formed from phosphoenolpyruvate in a cell during glycolysis, the standard free energy change ( $\Delta G_o'$ ) is only  $-31.4 \text{ kJ/mol}$ . Explain why this reaction occurs in a cell.
7. The  $\Delta G^{\circ'}$  for the hydrolysis of  $\text{ATP}$  to  $\text{ADP} + \text{P}_i$  is approximately  $-31 \text{ kJ/mole}$ .
- Calculate the equilibrium constant for this reaction ( $R = 8.314 \text{ J/}^\circ\text{mole}$ ) at the cellular temperature of  $37^\circ\text{C}$ .
  - If the cellular concentrations of  $\text{ATP}$ ,  $\text{ADP}$ , and  $\text{P}_i$  are  $8$ ,  $1$ , and  $8 \text{ mM}$ , respectively, is the above reaction at equilibrium in the cell?