Name: _____ **Date:** _____

Gibbs Free Energy Practice Problems

*°C = (°F – 32) *5/9* *°F = °C * 9/5 + 32* *K = °C + 273*

---

1. Calculate the Gibbs free energy change (ΔG) for the following chemical reaction:

   ATP ⟶ ADP + P_i

   The reaction occurs at 68 °F, the change in heat (ΔH) = 19,070 cal, and the change in entropy (ΔS) = 90 cal/K.

   68 °F = 293 K, therefore the equation is set up in the following way:
   ΔG = ΔH – TΔS
   ΔG = 19,070 cal – (293 K) (90 cal/K)
   ΔG = –7300 cal = –7.3 kcal

2. Calculate the Gibbs free energy change (ΔG) for the following chemical reaction:

   glutamate + NH_3 ⟶ glutamine + H_2O

   The reaction occurs at 68 °F, the change in heat (ΔH) = 4103 cal, and the change in entropy (ΔS) = 2.4 cal/K.

   68 °F = 293 K, therefore the equation is set up in the following way:
   ΔG = ΔH – TΔS
   ΔG = 4103 cal – 293 K (2.4 cal/ K)
   ΔG = 3399.8 cal = 3.4 kcal

3. Would either of the reactions above occur spontaneously? If so, which one(s) and why?

   The reaction with ATP in #1. The change in Gibbs free energy (ΔG) is negative for exothermic reactions and can only be negative for spontaneous reactions. However, the activation energy required would still cause this reaction to occur slowly.

4. Are either of the above reactions endergonic? If so, which one(s) and why?

   The reaction with glutamate and NH_3 in #2. The change in ΔG (free energy) is positive, meaning free energy is absorbed, making this reaction endergonic.

Name: _____ **Date: _____**

Gibbs Free Energy Practice Problems

5. How does the Gibbs free energy in each of the two reactions change if the temperature were raised to normal body temperature (98.6 °F)?

   98.6 °F = 310 K. Changing the equations accordingly looks like this:

   #1
   $\Delta G = \Delta H - T\Delta S$
   $\Delta G = 19{,}070\ cal - (310\ K)\ (90\ cal/K)$
   $\Delta G = -8830\ cal = -8.83\ kcal$

   #2
   $\Delta G = \Delta H - T\Delta S$
   $\Delta G = 4103\ cal - 310\ K\ (2.4\ cal/\ K)$
   $\Delta G = 3359\ cal = 3.359\ kcal$

6. Does an increase in reaction temperature make each of these reactions more or less likely to occur spontaneously? Explain your answer.

   #1
   This reaction now becomes more exothermic and is likely to occur faster/more spontaneously. Although activation energy remains a hurdle, the entropy of the products is dramatically higher, making this reaction more thermodynamically favorable.

   #2
   This reaction now becomes less endothermic and requires less energy input to occur. While this is more thermodynamically favorable, the free energy change is still positive, meaning this reaction will still not occur spontaneously.