Free Energy Worksheet

1. With certain assumptions, the ***change*** in the enthalpy ΔH may be defined as "the heat absorbed by a system under conditions of constant pressure." (That is, if $\Delta H > 0$, heat is *absorbed* and enthalpy *increases*; if $\Delta H < 0$, heat is *given off* and enthalpy *decreases*.) Let's see how ΔH is related to the internal energy U of a system.

a) Write down the equation that expresses the first law of thermodynamics in the following form:

$Q =$

b) In this discussion, will assume that the only work being done on the system is mechanical work, or "PdV" work. Then (under conditions of constant pressure), $W = P\Delta V$; rewrite the equation for Q in terms of ΔU, P and ΔV.

$Q =$ *constant pressure*

c) We should now have arrived at the expression $Q = \Delta U + P\Delta V$, which holds for constant-pressure conditions. This equation says that ***heat absorbed*** under constant pressure does two things: (1) increases the ***internal energy (E)*** of the system, and (2) allows the system to do mechanical work ***on the surroundings***.

Using the definition that ΔH is *equal* to heat absorbed under constant pressure, write the equation from (b) in terms of ΔH, instead of Q:

$\Delta H =$ *constant pressure*

So now we can see that when the enthalpy of a system ***changes*** by an amount ΔH (under conditions of constant pressure), there are actually ***two*** separate contributions to this change: (1) the change in the *internal energy* of the system (ΔU), and (2) the work done ***by*** the system ***on*** the surroundings ($P\Delta V$). An increase in internal energy, ***or*** positive work being done ***by*** the system, will both result in an increase in the enthalpy H of the system.

2. It would be useful to be able to predict whether a process can occur. We will try to find some property of the system that would allow us to make such a prediction. In order to do this, we will have to make use of the second law of thermodynamics.