GLY 560 -- Thermodynamics and Isotopes in Geology **Name _____**

Thermodynamics and Isotopes in Geology, Problem 5

Change of graphite into diamond at 25ºC.

Let's use the equation we discussed in class to calculate the pressure at which graphite transforms into diamond at 25ºC. Diamond is the high pressure form of carbon, as many of you already know.

Step 1:
In the space below, write a balanced reaction that shows the transformation of graphite into diamond:

Step 2:

form	formula	ΔH^o KJ/mol	ΔG^o KJ/mol	S^o J/mol/K	V^o cm^3/mol
graphite	C	0	0	5.740	5.298
diamond	C	1.895	2.900	2.377	3.417

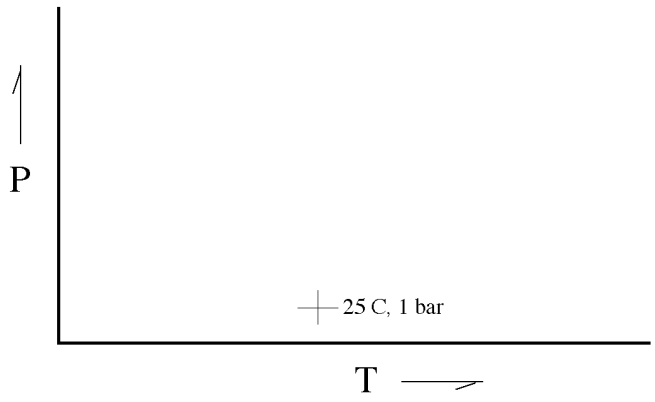
At 25ºC and 1 bar, which form of carbon is stable? _____

Why is this so? _____

What happens to the *molar volume* when graphite transforms to diamond? _____

What happens to the *entropy* when graphite transforms to diamond? _____

Therefore, show on the graph below the "directions" to the graphite / diamond equilibrium line (from 25ºC, 1 bar) and sketch in an approximate reaction boundary:



Step 3:

Using the Gibbs Free Energies listed, calculate the ΔG_{rxn}. Express your final answer in J/mole.

Using the molar volumes listed, calculate the ΔV^{o}_{rxn}. Express your answer first in cm^3 and then your final answer in J/bar.

Step 4:

Using the equation discussed in class, calculate the pressure (at 25ºC) where graphite transforms to (is in equilibrium with) diamond. List your final answer in both bars and kilobars.

Step 5:

Calculate the ΔS^{o}_{rxn}. Express your answer in J/mole/K.

Use ΔS^{o}_{rxn} and ΔV^{o}_{rxn} (calculated in Step 3) to determine the slope of the graphite / diamond transformation using the *Clapeyron Equation*.

How much higher would the equilibrium pressure be at 500ºC? Show your calculation below:

Plot the graphite / diamond transformation boundary on the graph to the right. As noted, the pressure at the bottom of average continental crust (35 km thick) is about 10 kilobars.

Given your answers in Steps 4 and 5, is diamond ever stable in the Earth's crust? ____