Thermodynamics Quiz

Solutions

1.) First Law: There exists a property in the universe, called energy, which can not be changed no matter what processes occur. Energy can not be created nor destroyed

Second Law: There exists a property in the universe, called entropy, which can only change in one direction no matter what processes occur in the universe

0th Law: A universal absolute temperature scale exists and it has a minimum value of absolute zero

2.) A 1st order transition can be observed by a discontinuity in the plot of H vs. T at the transition temperature

A 2nd order transition can be observed by a discontinuity in the plot of C_p vs. T at the transition temperature

3.) A polymer can be melted (say by using a DSC) to generate a melting endotherm by plotting Q vs. T. The area under the endotherm curve (relative to a baseline) is equivalent to the ΔH_f. The ratio of the measured ΔH_f to ΔH_f° (for a 100% crystalline structure) gives the percent crystallinity

4.) $C_v = \frac{3}{2}R$ $C_p = C_v + R = \frac{5}{2}R$

More heat is required to raise the temperature of a substance one degree at constant pressure than at constant volume. This higher value of C_p is the result of work done in a constant pressure process $\left(w = \int_{V_1}^{V_2} PdV\right)$ that is not present in a constant volume process

5.) $S = S(T,P)$ $dS = MdT + NdP = \left(\frac{\partial S}{\partial T}\right)_P dT + \left(\frac{\partial S}{\partial P}\right)_T dP$

From Maxwell's Equations we know, $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$ and $\left(\frac{\partial S}{\partial T}\right)_P = \frac{C_p}{T}$

by definition $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ So $\left(\frac{\partial S}{\partial P}\right)_T = -V\alpha$

So $dS = \frac{C_p}{T}dT - V\alpha \, dP$