ChE 3173 **EXAM III** **December 6, 1983**

I. (30 points)

The hydrate of sodium carbonate decomposes according to the following equation:

$$Na_2CO_3 \cdot H_2O\ (S) \rightleftarrows Na_2CO_3\ (S) + H_2O\ (g)$$

If the sodium carbonate hydrate is enclosed in a container and heated, a pressure of pure water above the solid results. This pressure has been measured and correlated as:

$$\log_{10} P = 7.944 - 3000/T$$

where: P is in atmospheres
T is in K

Derive an expression for the Gibb's Free Energy of reaction as a function of temperature assuming the fugacity coefficient of water vapor is one.

II. (40 points)

Three isomers of pentane exist, normal (P), iso (I), and neo (N). All three isomers may be obtained by catalytic isomerization. The reactions may be represented:

$$P \rightleftarrows I$$

$$P \rightleftarrows N$$

$$I \rightleftarrows N$$

a) How many independent reactions are there?

b) For the reaction $P \rightleftarrows I$, $K_a = 7.676$ and for $P \rightleftarrows N$, $K_a = 2.165$. If the reactions take place in the gas phase and φ's are all one, what is the mole fraction of each species at equilibrium if we start with one mole of pure P?

c) What is the value of K for $I \rightleftarrows N$ under the same conditions?

III. (30 points)

Calculate K for the disassociation of water vapor at 2500 K.

$$H_2O\ (g) \rightleftarrows H_2\ (g) + \tfrac{1}{2}\ O_2\ (g)$$