Chemistry 366
Thermodynamics
Midterm Exam
March 4, 2008

Name _____

Full credit will be given to correct answers only when ALL the necessary steps are shown. DO NOT GUESS THE ANSWER.

This is a closed book exam, and you are responsible to be sure that your exam has no missing pages 5 pages).

If you consider that there is not enough information to solve a problem, you have to specify the missing information and describe the problem solving procedure.

But surely this is an old tale you tell, they say;
But surly this is a new tale you tell, other say.
Tell it once again, they say;
Or, do not tell it yet again, others say.
But I have heard all this before, say some;
Or, but this is not how it was before, say the rest

Naqshbandi recital, from The Way of the Sufi, by Idries Shah

Once you start the exam, you have up to 1 hours to solve it.

Honor Statement

I have neither give nor received aid in this examination.

Full signature _____

PROBLEM 1 (25 POINTS)

Calculate the pressure exerted by benzene for a molar volume 1.42 L at 790 K using the Redlich-Kwong equation of state:

$P = \frac{RT}{V_m - b} - \frac{a}{\sqrt{T}} \frac{1}{V_m (V_m + b)} = \frac{nRT}{V - nb} - \frac{n^2 a}{\sqrt{T}} \frac{1}{V(V + nb)}$. The Redlich-Kwong parameters a and b for benzene are 452.0 bar $dm^6\ mol^{-2}\ K^{1/2}$ and 0.08271 $dm^3\ mol^{-1}$, respectively. Is the attractive or repulsive portion of the potential dominant under these conditions?

PROBLEM 2 (25 POINTS)

1 mol of an ideal gas, for which $C_{V,m} = 3/2R$, initially at 20.0°C and 1.00×10^6 Pa undergoes a two-stage transformation. For each of the stages described in the following list, calculate the final pressure, as well as q, w, ΔU, and ΔH. Also calculate q, w, ΔU, and ΔH for the complete process.

a) The gas is expanded isothermally and reversibly until the volume doubles.

b) Beginning at the end of the first stage, the temperature is raised to 80.0°C at constant volume.

PROBLEM 3 (25 POINTS)

Use the relation $C_{P,m} - C_{V,m} = T\left(\frac{\partial V_m}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_P$, the cyclic rule, and the van der Waals equation of state to derive an equation for $C_{P,m} - C_{V,m}$ in terms of V_m and the gas constants R, a, and b.

PROBLEM 4 (25 POINTS)

Calculate the standard enthalpy of formation of $FeS_2(s)$ at 300°C from the following data at 25°C. Assume that the heat capacities are independent of temperature. You are also given that for the reaction $2FeS_2(s) + 11/2O_2(g) \rightarrow Fe_2O_3(s) + 4\,SO_2(g)$, $\Delta H^\circ_{reaction} = -1655\ kJ\ mol^{-1}$.

Substance	$Fe(s)$	$FeS_2(s)$	$Fe_2O_3(s)$	S(rhombic)	$SO_2(g)$
ΔH°_f (kJ mol^{-1})			–824.2		–296.81
$C_{p,m}/R$	3.02	7.48		2.72	