Name_______________ CHEM320

Exam 1

Oct. 15, 2009

Answer each of the following questions making sure to pay attention to labeling the correct units and significant figures. For numerical answers place your final answer in a box. This is the answer that I will grade; if there is no box, I will assume that you don't have a final answer.

1. (5) A laboratory sample of 9.50 mass % sodium hydroxide was analyzed and found to have a density of 1.1034 g cm $^{-3}$. A clean, dry Erlenmeyer flask of mass 35.653 g was used to determine the mass of a sample of this solution. The sample was placed in the Erlenmeyer and the total mass was found to be 96.546 g. What is the corresponding molarity, $\underline{M}$, of this solution?

2. (15) Define each of the following terms using either words or equations:
   a) isolated system

   b) closed system

   c) diathermic wall

   d) constant pressure heat capacity

   e) enthalpy

3. (20) Using the maxwell boltzman distribution, derive an expression for <c>, the average speed of a gas particle in a sample of gas.

4. (10) Using partial derivatives, prove that for a closed system P is a state function if the system is described by the van der Waals equation of state.

5. (14) Calculate the $\Delta_f H^\circ$ for $CaC_2(s)$ at 25 °C using the following information:

	$\Delta_{rxn}H^\circ$
$CaC_2(s) + 2\ H_2O \rightarrow Ca(OH)_2(s) + C_2H_2(g)$	–127.9
$Ca(s) + \frac{1}{2}\ O_2(g) \rightarrow CaO(s)$	–635.1
$CaO(s) + H_2O \rightarrow Ca(OH)_2(s)$	–65.2

$\Delta_c H^\circ$ ($C_{graphite}$) = –393.51 kJ mol^{-1} and
$\Delta_c H^\circ$ ($C_2H_2(g)$) = –1299.58 kJ mol^{-1} and

6. (8) Sketch a correctly labeled plot of Z vs. p for the following 3 gasses (put all three on the same plot so that you can show the correct relationship between each of the gasses. a) an ideal gas b) NH_3 c) CO_2

7. (16) For each of the following processes predict whether the given thermodynamic function would be positive, negative or zero.

a) the reversible, isothermal expansion of an ideal gas: ΔU =
q =
w =
ΔT =

b) the reversible, adiabatic compression of an ideal gas: ΔU =
q =
w =
ΔH =

8. (12) For a sample of the gas sulfur dioxide at SATP determine the rms speed, the average speed, the most probable speed and the mean free path of the gas molecules in this gas sample. The collision cross section of this gas is $\sigma = 0.58\ nm^2$

1 bar = 1 x 10^5 Pa

1 L = 1 dm^3

R = 8.314 J/K mol

R = 0.082056 L atm/K mol

1nm = 1 x 10^{-9} m

760 torr = 1 atm

1 L = 1 x 10^{-3} m^3

R = 0.08314 L bar/ K mol

$k_B = 1.3807 \times 10^{-23}$ J K^{-1}

$N_A = 6.022 \times 10^{23}$ mol^{-1}

$$f(v) = 4\pi\left(\frac{M}{2\pi RT}\right)^{\frac{3}{2}} v^2 e^{-\left(Mv^2/2RT\right)}$$

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$$\int_0^\infty x^2 e^{-ax^2} dx = \frac{1}{4a}\sqrt{\frac{\pi}{a}}$$

$$\int_0^\infty x^3 e^{-ax^2} dx = \frac{1}{2a^2}$$

$$\int_0^\infty x^4 e^{-ax^2} dx = \frac{3}{8a^2}\sqrt{\frac{\pi}{a}}$$