Instituto Politécnico de Tomar

Frequency of CHEMICAL THERMODYNAMICS – January 8, 2014

R = 8.314 $J.K^{-1}.mol^{-1}$ = 0.082 atm $L.mol^{-1}.K^{-1}$; 1 atm = 101325 Pa = 760 mmHg

Maximum time: 2H30m

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1. Two moles of oxygen (considered as an ideal gas) are compressed adiabatically with application of constant exterior pressure of 10 atm, since the initial temperature of 26.85° C and 1 atm, until a final equilibrium state. Considering Cp = 7/2 R:

1.1. Calculate the final temperature of the gas.

1.2. Calculate the work, *w*, heat, *Q*, internal energy change, ΔU and enthalpy change, ΔH (If you do not solved the preceding paragraph consider the final temperature equal to 1071 K).

2. The reaction of nitrogen monoxide oxidation is important in the process of formation of smoke pollutants

$$NO(g) + ½\ O_2(g) \rightarrow NO_2(g)$$

Calculate for this reaction:

2.1. The standard enthalpy of reaction, ΔH^o_r at 298 K.

2.2. The enthalpy of reaction at 200 K.

Compound	ΔH^o_f at 298 K / $kJ.mol^{-1}$	C_p / $J.mol^{-1}.K^{-1}$
NO(g)	90.29	30.3
O_2(g)	-----	30.0
NO_2(g)	33.10	39.4

3. Entropy is the fundamental property associated with the 2nd law of Thermodynamics

3.1. State the second Law.

3.2. Calculate the entropy change when 1 mol of water vapor is heated from 200 °C until 400 ºC at 1 atm. The molar heat capacity of water is given by the equation: C_p/ $J.K^{-1}.mol^{-1} = 30.51 + 1.03\times10^{-2}\ T$

4. Using the Trouton rule (ΔS_{vap} = 85 $J.K^{-1}.mol^{-1}$ at the normal boiling temperature) calculate the vapor pressure of dipropylic ether at 33° C, knowing that the normal boiling temperature is 89.5° C.

5. It was found that a solution of benzene and toluene at 293 K showed a total vapor pressure of 46 mmHg. At that temperature, vapor pressures of pure benzene and toluene are equal to 74.7 mmHg and 22.3 mmHg.

5.1. Determine the mole fraction of benzene in solution and in the vapor phase in equilibrium with it.

5.2. Calculate the ΔG_{mist} assuming the ideality in liquid phase.

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