

**Chemistry – 4311**  
**December 7, 2013**

**Final Exam**

Name \_\_\_\_\_

Key

(10) 1. Matching (use a letter only once)

30000 equals b.

The enthalpy H is defined as d.

According to the first law of thermodynamics, the change in the internal energy  $\Delta U$  equals g.

The P-V work for a constant pressure process is defined as c.

If the only work is P-V work, the heat for heating a substance at constant V is j.

$$N_A = 6.02 \times 10^{23}$$

$$1 \text{ atm} = 101.325 \text{ kPa} = 760 \text{ torr}$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$F = 96,500 \text{ C/mole}$$

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$(R \text{ 298 K})/F = 0.0257 \text{ V}$$

$$R = 8.314 \text{ J/mol-K} = 1.987 \text{ cal/mol-K} = 0.08206 \text{ L-atm/mol-K} \quad k_B = 1.381 \times 10^{-23} \text{ J/K}$$

(15) 2. A gas mixture contains 2 moles of  $\text{CO}_2$ , 5 moles of Ar, and 3 moles of  $\text{CH}_4$  in a 1 liter container at 298K

a. What is the mole fraction of  $\text{CH}_4$ ?

$$5 \quad \frac{3}{10} = 0.3$$

b. What is the pressure of the gas mixture?

$$5 \quad PV = nRT \quad P = \frac{10 \times 0.08206 \times 298}{1} = 245 \text{ atm}$$

c. What is the partial pressure of  $\text{CH}_4$ ?

$$5 \quad 245 \times 0.3 = 73 \text{ atm}$$

a.  $H = U - PV$

b.  $3 \times 10^4$

c.  $-P_{\text{ex}}\Delta V$

d.  $H = U + PV$

e.  $\int C_V dT/T$

f.  $3 \times 10^{-4}$

g.  $q + w$

h.  $-nRT \ln(V_2/V_1)$

i.  $(P_2 - P_1)\Delta V$

j.  $\int C_V dT$

(15) 3. One mole of an ideal gas at 300 K and a pressure of 5.0 atm expands isothermally and reversibly to a final pressure of 1.00 atm.

(a) Calculate the final volume  $V_2$ .

$$5 \quad PV = nRT \quad V = \frac{1 \times 0.08206 \times 300}{1} = 24.6 \text{ L}$$

(b) Calculate  $w$  in L-atm.

$$10 \quad w = -nRT \ln V_2/V_1 = -nRT \ln P_1/P_2 \\ = -1 \times 0.08206 \times 300 \times \ln 5/1 \\ = -39.6 \text{ L-atm}$$

(10) 4. Matching (use a letter only once)

The Gibbs free energy is defined as c.

At constant T & P,  $\Delta G$  is j for a spontaneous process.

Raoult's law is f.

At equilibrium and constant T & P,  $\Delta G_r$  equals e.

For spontaneous flow of matter from phase  $\alpha$  to  $\beta$  the a of phase  $\alpha$  is greater than that of phase  $\beta$ .

i. entropy

j. negative

a. chemical potential

b.  $-RT \ln K$

c.  $G = H - TS$

d.  $\mu_i = \mu_i^\circ + RT \ln P_i$

e. zero

f.  $P_i = x_i P_i^*$

g. positive

h.  $G = H - TS + PV$

(15) 5. Ethanol ( $C_2H_5OH$ ) and methanol ( $CH_3OH$ ) form a nearly ideal solution. The vapor pressure of pure ethanol is 44.5 torr, and that of methanol is 88.7 torr, at  $20^\circ C$ . Consider a solution containing 2 moles of ethanol and 3 moles of methanol.

(a) Calculate the pressure of methanol in the vapor.

$$10 \quad P_{Me} = x_{Me} P_{Me}^* \quad P_{Me} = \frac{3}{5} \times 88.7 = 53.2 \text{ torr}$$

(b) Calculate the mole fraction of methanol in the vapor.

$$5 \quad P_{Et} = \frac{2}{5} \times 44.5 = 17.8 \text{ torr}$$

$$x_{Me} = \frac{53.2}{53.2 + 17.8} = 0.75$$

