Median - 92
100 score - 7

Chemistry – 4311
October 26, 2016

Exam #2 **Name** Key

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

At constant T & P, O C is negative for a spontaneous process.

dS of the system is defined as S.

$\Delta S_{universe}$ is f for all spontaneous processes.

The Gibbs energy is defined as l.

The molar free energy difference between the exterior and interior regions of a membrane for ion X is j.

For equilibrium between two phases their i are equal.

The chemical potential is the partial molar O.C

Raoult's Law is m.

The relationship between the activity and mole fraction is b.

Vapor pressure changes versus temperature according to n.

a. dU/T

b. $a_i = \gamma_i x_i$

c. ΔG

d. $G = H + PV$

e. $P = \Delta H_{vap}/(RT)$

f. positive

g. $a_i = \gamma_i / x_i$

h. entropy

i. chemical potentials

j. $\Delta\bar{G} = RT\ln\{[X]_{ex}/[X]_{in}\}$

k. negative

l. $G = H - TS$

m. $P_1 = x_1 P_1^*$

n. $\ln P = -\Delta H_{vap}/(RT) + C$

o. Gibbs free energy

p. entropies

q. ΔH

r. $\Delta\bar{G} = \{[X]_{ex}/[X]_{in}\}$

s. dq_{rev}/T

t. $P_1 = x_1 K_1$

$k_B = 1.381 \times 10^{-23}$ J/K

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

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

R= 8.314 J/mol-K

R= 1.987 cal/mol-K

R= 0.08206 L-atm/mol-K

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

1 atm = 101.325 kPa

(10) 2. Match the correct expression for ΔS:

ΔS of mixing a.

ΔS for a phase transition b.

ΔS for heating a pure substance c.

ΔS for for a change from state 1 to state 2, based upon probability e.

ΔS for a reversible, isothermal gas expansion f

a. $-R(n_A \ln x_A + n_B \ln x_B)$

b. $\Delta H/T$

c. $\int C_p dT/T$

d. $\Delta G/T$

e. $k_B \ln(W_2/W_1)$

f. $nR\ln(V_2/V_1)$

g. $\int C_p dT$

(4) 3. Enter positive or negative for the following:

(a) The entropy change of protein unfolding is positive

(b) The enthalpy change of protein unfolding is positive.

(16) 4. One mole of liquid water is vaporized at its boiling point 100 °C, at constant temperature and pressure. Assume the process is at equilibrium. ΔH_{vap} = 40.7 kJ/mol. What are q, ΔS, and ΔG for this process?

(5) $q_p = \Delta H_{vap}$

(5) $\Delta G_{T,P} = 0$ at equilibrium

$\Delta G = \Delta H - T\Delta S = 0$

$\Delta S = \frac{\Delta H_{vap}}{T}$

$= \frac{40.7 \times 10^3 \text{ J/mol}}{373 \text{ K}}$

(6) $= 109.1 \text{ J/K-mol}$

(10) 5. The vapor pressure of isopropyl alcohol is 40 torr at 297 K and 760 torr at 356 K. What is ΔH_{vap} in kJ/mol for isopropyl alcohol?

$$\ln \frac{P_2}{P_1} = -\frac{\Delta H_{vap}}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

$$\ln \frac{760}{40} = -\frac{\Delta H_{vap}}{8.314}\left[\frac{1}{356} - \frac{1}{297}\right] = 43,870 \text{ J}$$

$= 43.87 \text{ kJ}$

(10) 6. For RNA (double-strand) →RNA (single-strand) ΔH° is 40 kJ mol^{-1}/base-pair and ΔS° is 104 J-mol^{-1}-K^{-1}/base-pair.
(a) Is this an exothermic or endothermic process?

+2 endothermic

(b) What is ΔG° at 298 K?

+4 $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 40\ kJ - 298 \times 0.104\ kJ$
$= 9\ kJ/mol$

(c) What is the minimum temperature at which the process is spontaneous?

+4 $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ $\quad T = \frac{40}{0.104}$
$0 = 40 - T \times 0.104$ $\quad = 385\ K$

(20) 7. Ethanol (C_2H_5OH) and methanol (CH_3OH) form nearly ideal solutions. The vapor pressure of pure ethanol is 44.5 torr, and that of methanol is 88.7 torr, at 20 °C.
(a) Calculate the mole fractions of methanol and ethanol in a solution obtained by mixing 3 moles of methanol and 2 moles of ethanol.

+4 $X_M = 3/5 = 0.6$ $\quad X_E = 2/5 = 0.4$

(b)Calculate the partial pressures of methanol and ethanol, and the total vapor pressure of the solution.

+8 $P_M = 0.6 \times 88.7 = 53.2$ torr
$P_E = 0.4 \times 44.5 = 17.8$ torr
71 torr

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

+8 $X_M = \frac{53.2}{71} = 0.75$

(10) 8. The expression for osmotic pressure is $\pi V = n_2RT$. The osmotic pressure at 25 °C of a solution of ρ-lactoglobulin containing 13.46 g protein per liter of solution was found to be 9.6×10^{-3} atm. What is the resulting molecular weight of the protein?

$\pi V = n_2RT = \frac{W_2}{M_2}RT$

$9.6 \times 10^{-3} \times 1L = \frac{13.469}{M_2} \times 0.08206 \times 298$

$M_2 = 34,286$ grams