LIET 152 1st Exam 2011. 10. 08 Department : ID : Name :

1. A solution contains 1.521 g of maleic acid (*MM* = 116.07 g/mol) dissolved in 85.0 mL of acetone (*MM* = 58.08 g/mol, ρ= 0.818 g/mL). Calculate the molality, mole fraction, and mass percent of maleic acid in the solution. (6 points)

2. Match each solute to its most appropriate solvent. (4 points)

solute: I_2 NaCl Au paraffin

solvent: Hg CCl_4 *n*-octane water

3. The freezing point of an aqueous solution containing pantothenic acid (*MM* = 205.3 g/mol) is - 0.65 °C. Calculate the osmotic pressure of this solution at 18 °C, at which the solution density is 1.015 g/mL. (K_f = 1.858 °C·kg/mol, R = 0.08206 L·atm/mol·K, 0 °C = 273 K) (10 points)

4. Benzene has a normal freezing point of 5.50 °C and a density of 0.88 g/mL. When 1.28 g of naphthalene (*MM* = 128 g/mol) is dissolved in 125 mL of benzene, the freezing point of the solution is 5.03 °C.
(a) Determine the molal freezing point constant (K_f) for this solvent. (5 points)

(b) When 0.125 g of an unknown compound is dissolved in 25.0 mL of benzene, the solution freezes at 5.24 °C. Determine the molar mass of the unknown. (5 points)

5. The table lists the parts per million by mass of the principal ions in sea water:

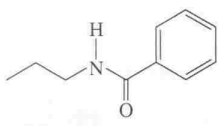
Ion	Cl^-	Na^+	Mg^{2+}	SO_4^{2-}
10^2 ppm	194	108	12.9	9.04
MM (g/mol)	35.455	22.990	24.32	96.06
Ion	Ca^{2+}	K	Br^-	
10^2 ppm	4.11	3.92	0.67	
MM (g/mol)	40.078	39.098	79.904	

Assuming that each ion acts independently of all the others and that seawater has a density of 1.026 g/mol, calculate the freezing point (K_f = 1.858 °C kg/mol) and osmotic pressure of seawater. (10 points)

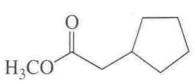
6. Fill in the missing entries. (each 2 point)

name	structure	name	structure
hydroxyl	—Ö—H	aldehyde	
sulfhydryl		carboxyl	
amine		phosphate	

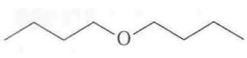
7. Draw the structure of precursors of the following condensation products. (each 3 points)
(a)



(b)



(c)



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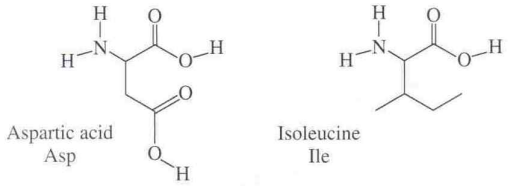
8. Draw the structures of all possible products resulting from condensation reactions between aspartic acid and isoleucine. (5 points)



9. Suppose that a polypeptide is constructed with alanine ($C_3H_7NO_2$) as the only monomer.

(a) What is the empirical formular (MM = 71 g/mol) of this polypeptide? (3 points)

(b) If the polypeptide has a molar mass of 1.20×10^3 g/mol, how many repeat units of alanine does it contain? (3 points)

10. One possible source of acid rain is the reaction between NO_2, a pollutant from automobile exhausts, and water:

$$3\ NO_2\ (g) + H_2O\ (l) \rightarrow 2\ HNO_3\ (g) + NO\ (g)$$

	NO_2	H_2O	HNO_3	NO
ΔG° (kJ/mol)	-73.5	87.6	51.3	-237.1
ΔH° (kJ/mol)	-133.9	91.3	33.2	-285.83
S° (J/mol·K)	266.9	210.8	240.1	69.95

(a) Is this thermodynamically feasible under standard conditions at 298 K. (2 points)

(b) Find the minimum temperature under standard conditions at which the reaction is thermodynamically feasible. (3 points)

(c) Is this thermodynamically feasible at 298 K with each product gas present at $p = 1.00 \times 10^{-6}$ bar. (R = 0.008314 kJ/mol·K) (5 points)

11. Find ΔS for the system, surroundings, and overall when 25.0 g of liquid H_2O (MM = 18.02 g/mol, ΔH_{vap} = 40.79 kJ/mol) is evaporated at 100. °C, if the heat required is provided by a hot plate whose temperature is 315 °C. (5 points)

12. One reaction that generates pollutants in the internal combustion engine is the oxidation of nitrogen by oxygen:

$$N_2\ (g) + O_2\ (g) \rightarrow 2\ NO\ (g)$$
$$\Delta H^\circ = 182.6\ \text{kJ/mol} \qquad \Delta S^\circ = 24.83\ \text{J/mol·K}$$

(a) Is the reaction spontaneous at 298 K. (2 points)

(b) Estimate the temperature above which it becomes spontaneous at standard pressure. (3 points)

13. What is the efficiency of the metabolic conversion of 1 mol of palmitic acid to 130 mol of ATP? (2 points)

$$ADP + H_3PO_4 \rightarrow ATP + H_2O \qquad \Delta G^\circ = +30.6\ \text{kJ}$$
$$C_{15}H_{31}CO_2H + 23\ O_2 \rightarrow 16\ CO_2 + 16\ H_2O \qquad \Delta G^\circ = -9790\ \text{kJ}$$

Compute the number of grams of palmitic acid (MM = 256.42 g/mol) that would have to be metabolized to provide the heat to warm a swimmer from whose skin 75 g of water evaporates. (3 points)

14. Here are the thermodynamic data for the fusion of NH_3:

$$NH_3\ (s) \rightarrow NH_3\ (l)$$
$$\Delta H^\circ = 5.65\ \text{kJ/mol} \qquad \Delta S^\circ = 28.9\ \text{J/mol·K}$$

(a) Calculate ΔG° for the melting of 1.00 mol of NH_3 at 298 K. (2 points)

(b) Calculate the freezing point of NH_3. (3 points)