Chemistry 114
Second Hour Exam

Name:_____

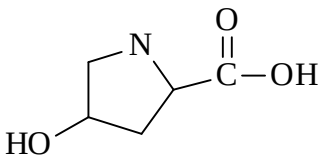
Gas Constants (R): 0.08206 L·atm/K·mol -or- 8.31451 J/K· mol

Please show all work for partial credit

1. (5 points) Identify the functional groups on the following compounds

A. 4-hydroxy-L-proline (an amino acid)

Amine

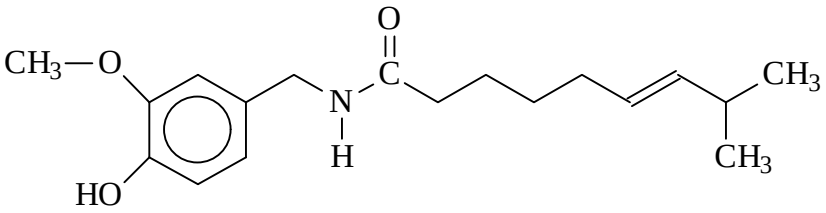


Carboxylic acid

Alcohol

B. Capsaicin (The burning flavor of peppers)

Ether Amide Double bond



Alcohol Aromatic ring

(Note: the NH-C=O is a special group you haven't had called an amide)

2. (5 points) Predict which of the above compounds are soluble in water? Which would be soluble in nonpolar liquids?

4-hydroxy-L-proline water soluble
Capsaicin -non polar - not water soluble

3. (9 points) Name three different intermolecular forces, give their relative strengths, and predict which of these forces would be dominant in the following solids: NaOH, H_2O $CH_3(CH_2)_nCH_3$

Ionic interactions - Strongest - Dominate in NaOH

Polar interactions, of which hydrogen bonding is a special case - Medium strength- dominant in H_2O

London Dispersion forces (Van der Waals) weakest - dominant in $CH_3(CH_2)_nCH_3$

4. (10 points) I have a simple cubic crystal of a substance. If I shine 1.54 Å X-ray radiation at the crystal I can see a reflection at an angle of 25 degrees. What is the distance between atoms in the crystal lattice?

$n\lambda = 2d\sin\theta$

$1.54Å = 2d\sin(25^o)$
$1.54/2 = d\ (.4226$
$d = 1.54/[2(.4226)] = 1.82Å$

5. (9 points) In class we talked about three different types of atomic solids. Name these solids, tell how they are different from each other, and give an example of each.

Molecular - have complete molecules at lattice points
Ionic - Have ins at lattice points
Atomic- Have atoms at lattice points

6. (5 points) What kind of bonding is used to hold a metal lattice together, and how is this different than the bonding used in a diamond crystal?

Metals use delocalized covalent bonding to hold the matrix of atoms together, while directional covalent bonds are used to hold the atoms together in a diamond. In the delocalized covalent bond the electrons are not held tightly between a pair of atoms, so they are free to move throughout the matrix. In the directional covalent bond the electrons must remain between two atoms so they cannot move in the matrix

7. (5 points) What in the heck is an octahedral hole and why is it important in chemistry?

A octahedral hole is a hole that exists between atoms that are packed in a hexagonal array. It is the largest hole and is important in describing the packing of ions because we usually place the smaller cations in these holes

8. (8 points) What types of solids will be formed by the following substances?

a. P_4
molecular

b. C
Atomic -network

c. NaOH
Ionic

D. Ne
Atomic - group 8A

9. (9 points) Define $\Delta H_{fusion,}$ $\Delta H_{vaporization}$, and $\Delta H_{solution}$

$\Delta H_{fusion,}$ - the heat needed to change1 mole of a substance form a solid to a liquid at that substances melting point.
$\Delta H_{vaporization}$ the heat needed to change 1 mole of a substance from a liquid to a gas at that substances boiling point.
$\Delta H_{solution}$ - the heat gained or lost when 1 mole of a solute is dissolved in a solvent

10. (10 points) In lab we had some problems getting correct boiling points. For instance the normal boiling point of hexane is 69° C, yet the class found it had a boiling point of 65.1°C. Assuming the pressure in the lab 680 mm Hg, what is the heat of vaporization of hexane

$$\ln\left(\frac{P_1}{P_2}\right) = \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{680}{760}\right) = \frac{\Delta H}{R}\left(\frac{1}{(69+273)} - \frac{1}{(65.1+273)}\right)$$

$$\ln(.895) = \frac{\Delta H}{R}\left(\frac{1}{342} - \frac{1}{338.1}\right) = \frac{\Delta H}{R}(.002924 - .002958)$$

$$-.111 = \frac{\Delta H}{8.3145}(-3.4x10^{-5})$$

$$\Delta H = .111(8.3145)/3.4x10^{-5} = 393 kJ/mol$$

11. (10 points) I have discovered a new material called zehfusoid. It is a solid at 25^{o}C and 1 atm of pressure, but becomes liquid either when the pressure is raised to 100 atm or when the temperature is raised to 150^{o} C. If the temperature drops to $^{-}$50^{o} C the solid turns to a gas. From this information make a phase diagram for zehfusoid. If your phase diagram has a critical point or a triple point, label these points and tell their significance.

Question was dropped because the phase diagram didn't make sense

12. I am going to mix 20 g of ethanol (CH_3CH_2OH) with 100 mLs of water. The final volume of this solution is 128 mL. What is the...

A. (5 points) Molality of the solution.

m = moles solute/kg solvent

mole solute = 20/[12(2)+6(1)+16)] = .435

kg solvent = .100 (assuming 1g/ml density

m = .435/.100 = .435 m

B. (5 points) Mole fraction of ethanol in the solution.

Mole fraction = mole ethanol/total moles

Moles water = 100/18 = 55.55moles

Mole fraction = .435/(.435+55.55) = .0726

C. (5 points) The mass % ethanol of the solution.

Mass of ethanol/total mass X 100%

= 20/120 x 100 %

= 16.7%

(Note a mass% of 50 corresponds to 100 proof)