CHEM106 Midterm Examination **Name on back only please....**

Please show all equations, all equation rearrangements, all work, and all units to receive any credit
Lewis structures must (except aromatic rings) show all atoms, bonds, lone pairs, and full (not partial) charges

1. Showing the complete Lewis structure for all reactants and products, draw a clearly labeled and complete mechanism for the condensation reaction that occurs between choline and acetic acid.

2. Draw Lewis structures for all reactants and products and show a clearly labeled and complete mechanism for the reaction that occurs between **the side group** of the amino acid serine and a **dihydrogen phosphate ion**.

3. The amino acid cysteine has pKa's of 2.05, 10.25, and 8.00 (side group). Draw the complete Lewis structure for the most concentrated form of cysteine at each of the following pH's.

   a. pH = 1.0

   b. pH = 7.4

   c. pH = 9.0

4. Phosphoric Acid (H_3PO_4) is a triprotic acid that reacts with water as an acid with three K_a equilibrium constants having the following values: $K_{a1} = 7.6 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 2.1 \times 10^{-13}$. [$pK_a = -\log(K_a)$]

   a. Write the chemical equation for the reaction of phosphoric acid with water that K_{a1} refers to.

   b. For a pH=7.4, draw the Lewis structures for the two most concentrated forms of phosphoric acid. Clearly show which of the two forms is present at a greater concentration.

   c. For the two forms drawn in part b, calculate the relative amounts that would be present at a pH = 7.4.

5. Compare the boiling points of CH_3OH, CH_2OHCH_3, and $CH_2OHCH_2CH_3$. Clearly explain the basis for their difference using the specific relevant scientific principle.

6. For a physiological temperature of 37°C, calculate how much faster an enzyme-catalyzed reaction (having an Ea = 20 kJ/mole) would occur compared to the uncatalyzed same reaction having an activation energy of 100 kJ/mole.

7. Diethylamine [$CH_3CH_2NHCH_2CH_3$] has a log P value of 0.57 at 298 K.

   a. Draw the Lewis structure for diethylamine.

   b. Define specifically what P is and calculate the value of P for diethylamine.

   c. Using diethylamine's molecular properties, clearly explain why it has this magnitude of P.

   d. A small quantity of diethylamine was added to a mixture of 50 mL of water and 100 mL of 1-octanol at a temperature of 298 K. The diethylamine concentration in 1-octanol was measured and found to be 82.6 μM. Calculate, in units of molarity, the concentration of diethylamine in the water phase.

   e. A small amount of water was then added to the mixture. Outline the sequence of events that occurs (and why) with this addition of water. Predict how the original diethylamine concentrations in both the 1-octanol and water phases are affected by the addition of water to the mixture.

8. For an enzyme-catalyzed reaction, clearly label and plot--on the same graph--the reaction rate (velocity) as a function of substrate concentration for the cases when an competitive inhibitor is absent and when it is present.

9. For an enzyme-catalyzed reaction, draw a fully labeled double reciprocal plot showing the inverse of the reaction rate (1/velocity) as a function of 1/substrate concentration for the two cases when an competitive inhibitor is absent and when it is present.

10. A Lineweaver-Burk plot gave a slope=0.0387 sec, a y-intercept=0.216 sec/mM, and an x-intercept= -5.58 mM.

    a. Calculate V_{max} for this reaction.

    b. Calculate K_M for this reaction.

    c. Use your calculated K_M to determine the substrate concentration at which 80% of the enzyme active sites will be occupied by substrate molecules.

    d. If the enzyme concentration used was 10^{-6} M, use your calculated V_{max} to determine the enzyme turnover number.

11. Contrast how inflammation processes are interdicted using steroids with how they are slowed using non-steroidal anti-inflammatory drugs (NSAIDS). Comment on the specific adverse side effects associated with NSAIDS.