CHEM106 Midterm Exam
You must show all equations and all work to receive any credit

1. At body temperature, an enzyme lowers the activation energy for a certain reaction from 80 kJ/mole to 40 kJ/mole. Determine how many times faster the catalyzed reaction occurs.

2. Use fundamental kinetic principles to clearly explain why an enzyme-catalyzed reaction would occur faster than a reaction that was not catalyzed by an enzyme. Include diagrams to clearly support your answer.

3. On the same graph, draw a Lineweaver-Burk double reciprocal plot for an enzyme-catalyzed reaction for two situations: when there is no inhibitor present and when there is a competitive inhibitor present. Clearly label all key aspects of this diagram. Comment on whether V_{max} or K_M are each the same or are different (if so, in what way) for these two situations.

4. An enzyme catalyzed reaction with a specific substrate has a Michaelis constant of 0.75 mM. At what substrate concentration would you expect that 25% of all enzyme active sites would be occupied with substrate molecules?

5. The amino acid lysine has pKa's of 2.18, 8.95, and 10.53 (the 10.53 pKa is for lysine's side group).

    a. Draw the complete Lewis structures—showing all atoms, bonds, lone electron pairs and full charges--of the two most abundant forms of lysine that would be present at a pH of 10.10. Clearly show which is the more concentrated.

    b. For a pH of 10.10, calculate the ratio of the two most concentrated forms of lysine.

6. Draw the mechanism for the reaction of ethanol (CH_3CH_2OH) with propanoic acid (CH_3CH_2COOH). Show complete Lewis structures—to include all atoms, all bonds, and all charges--for both reactants and expected products. Clearly show the mechanism for the reaction.

7. Predict and clearly explain, using fundamental scientific principles, how cell membrane fluidity is affected by:

    a. An increase in temperature

    b. An increase in the degree of unsaturation of phospholipid fatty acid chains.

    c. A decrease in phospholipid fatty acid chain lengths.

8. As a chemist in a leading pharmaceutical firm, you have been assigned the tasking of measuring the partition coefficient, P, for 4-Pentyl Pyrazole. This substance is one of the drug candidates being considered for Phase I human clinical trials testing. The pharmaceutical industry uses a substance's P value to help predict drug activity and biological effectiveness. From a mixture of 1000.0 mL of water with 100.0 mL of 1-octanol, you determined that the water phase had 1.1×10^{-3} moles of 4-Pentyl Pyrazole and that the 1-octanol phase for this mixture contained 9.1×10^{-4} moles of 4-Pentyl Pyrazole.

    a. Calculate the partition coefficient, P, for 4-Pentyl Pyrazole.

    b. Comment on whether 4-Pentyl Pyrazole is hydrophobic or hydrophilic. Clearly explain why using fundamental scientific principles.

9. Draw the molecular structure for each of the following amino acids in the form that is most abundant at a physiological pH of 7.4. Except for aromatic rings, show all atoms, bonds, lone pairs, and full charges (not partial charges) for these compounds:

    a. Alanine

    b. Glutamic Acid

    c. Cysteine

    d. Serine

    e. Valine