A few Midterm practice problems…

1. Find the pH, $[H_3O^+]$, $[OH^-]$, and pOH for a:
   a. 0 .050M KOH solution.
   b. 0.030M HCl solution.
2. A Lineweaver-Burk plot gave a slope of 0.0561 and a y-intercept of 0.387.
   a. Calculate V_{max} for this reaction
   b. Calculate K_M for this reaction.
   c. If the enzyme concentration used was 10^{-6}M, use your calculated V_{max} to determine the enzyme turnover number.
3. Identify the hybridization and bond angles for each carbon, oxygen, and nitrogen atom in the following molecules
   a. Tyrosine at physiological pH.
   b. Acetylcholine
   c. Norepinephrine
4. An enzyme catalyzes reaction rates by lowering a reaction's activation energy. Calculate by what factor the reaction rate increases for an enzyme-catalyzed reaction with an activation energy of 20 kJ/mol compared with the rate when no catalyst is present and the activation energy is 100 kJ/mol.
5. The pKa's for aspartic acid are 2.09, 3.86 (side chain), and 9.82.
   a. For a pH of 3.0 draw the Lewis structures of the two most concentrated forms of aspartic acid. Show all atoms, bonds, charges, and lone pairs.
   b. For a pH of 3.0, determine the relative fractions of the two most concentrated forms.
   c. Explain the difference in the overall charges for an aspartic acid ion when it is in the stomach at a pH=1.5 vs being in a cell at a physiological pH of 7.4. Fully support your answer.
6. Alkaloids are N-containing organic compounds that occur in nature. Research by students in the chemistry labs at Winthrop is currently demonstrating a new synthetic route to make nicotine (which is an alkaloid) through a pathway that has never been done before.
   a. To extract nicotine from ground tobacco into an aqueous solution, predict whether it would be preferable to use an acidic or basic aqueous solution. Use Henderson-Hasselbalch, solubility, and your knowledge of nitrogen-containing compounds to develop and to support your prediction.
   b. Once nicotine has been extracted into an aqueous solution, predict how the pH should be adjusted to get the nicotine to partition into the organic layer of the organic solvent added to

the solution. Fully explain and support your prediction.

7. Compare the log P's for 1-butanol, 1-decanol, glycerol, water, and pentane.

8. Indinavir is a potent inhibitor of the HIV-1 protease, and is used in the treatment of AIDS. It has a log P value of 2.7. 5.00 mL of 1-octanol was vigorously mixed with 200.0 mL of water and 1 mmole of Indinavir was added during mixing. Calculate the number of mmoles of Indinavir that partition to each of the two phases in the mixture.

9. The rate constant for the decomposition of HI at 573K is 2.91×10^{-6}M/sec. The rate constant for this reaction at 673K is 8.38×10^{-4}M/sec.

    a. Determine the activation energy for this reaction in units of kJ/mole.

    b. For a temperature of 573K, use your answer for the activation energy to predict the fraction of collisions with sufficient energy to react.

    c. For a temperature of 573K, determine the collision frequency factor.

10. Draw the mechanism and clearly show what occurs when ethanol reacts with propanoic acid (CH_3CH_2COOH). Draw the structures of all reactants and products.

11. Phosphoric acid has pKa's of 1.97, 6.82, and 12.5.

    a. Draw the complete Lewis structures for the two most concentrated forms at a physiological pH of 7.4.

    b. Calculate the exact relative amounts of these two forms at a pH of 7.4.

    c. Draw the mechanism for the reactions that occur among phosphate, ethanolamine, and glycerol to form a part of a phospholipid structure often found in cell membranes.

12. Drugs A, B, and C have ED50's of 3 nM, 6 μM, and 0.001 mM respectively. Substance A has twice the efficacy of B and one-third the efficacy of C. Draw a dose response diagram that clearly shows the relative potencies and efficacies of these substances on a given target.