pH Homework
Biol / Chem 400 Biochemistry

Name _____

1. Which is a stronger acid, one with a pKa=9 or an acid with a pKa of 4.76?
EXPLAIN WHY. (1 point)

2. What is the pH of a solution containing 75 mM of HPO_4^{2-} and 80 mM $H_2PO_4^-$? The total volume of the buffer is 500 ml. (1 point)

3. A buffer, pKa 8.5, was being used at a concentration of 5 mm to maintain a protein solution at pH 8.9. The solution was stored exposed to air at 4oC and the pH kept on dropping (…it was pH=8.2 after 2 days).

Explain why the pH continued to drop WITH word AND with appropriate chemical equations. In addition to using chemical notation, please also give the chemical names for the compounds you draw. (3 points)

WHY? _____

4. Draw the following peptide: (SER-PRO-ASP-HIS-GLY). Indicate the amino and carboxyl terminal and the peptide bond. Determine the net charge of the peptide at pH 2, 7 and 12. (3 points)

5. Draw the titration curve for: (2 points)

a. Acetic Acid Acid
b. Malic acid (this is a diprotic acid).

6. In order to purify a certain protein you require 0.6 liters of a 0.010 M acetate buffer at pH 5.2. You have both the acid and base forms. How many grams of each do you need? The pKa for acetic acid is 4.76. Determine the mass of each from the structure. (4 points)

7 (4 points) An enzyme-catalyzed reaction was carried out in 50 ml of a 0.15M phosphate buffer, pH 7.5. As a result of the reaction, 0.025 mole/liter of H^+ was produced.

a) Write the acid / base equation for this reaction. Include both structure and names for each component of the reaction.
b) What was the ratio of conjugate acid to conjugate base at the start of the reaction?
c) What are the concentrations of each form of phosphate at the start of the reaction?
d) What was the pH at the end of the reaction?

8. You are an emergency room physician and you have just admitted a patient, **Jeff Gordon. a 24** year old who was brought to the emergency room around 9:00 after **loosing another race to Jimmy Johnson**. Jeff was found in the garage disoriented and had trouble speaking. At the hospital Jeff begins to suffer from nausea and vomiting. He is also hyperventilating. **Steve, Jeff's friend** reveals that Jeff has been depressed lately after loosing so many races and shows you an empty bottle of aspirin found in Jeff's racecar. The aspirin bottle, when full, would have contained 250 tablets. Jeff admits he took the tablets around 7:00 that evening. You draw blood from him and the following analysis is shown below

	Jeff G 2 hrs after aspirin ingestion	Jeff G 10 hrs after ingestion	Normal values
$_PCO_2$	26 mm Hg	19 mm Hg	35 - 45 mm Hg
HCO_3^-	18 mM	21 mM	22 - 26 mM
$_PO_2$	113 mm Hg	143 mm Hg	75 - 100 mm Hg
pH	7.44	7.55	7.35 - 7.45
[Blood salicylate]	57 mg/dl	117 mg/dl	

In the emergency room Jeff is given a stomach lavage with saline and 2 doses of activated charcoal to adsorb the aspirin. Eight hours later he is still experiencing nausea and vomiting and her respiratory rate increased, and further treatment was required. You carry out a gastric lavage (if you don't know what a lavage is, look it up) with a sodium bicarbonate solution pH 8.5. Jeff's blood pH begins to drop around 24 hours after the ingestion and finally returns to normal at 60 hours.

a. Aspirin or acetylsalicylic acid is converted to salicylic acid and acetic acid by the acids and esterases in the stomach. **(1 point)**
   - Draw the structure of acetylsalicylic acid and acetic acid and write the balanced equation for this transformation.
   - Write the protonization equation for salicylic acid and indicate which form will be water soluble.

b. Since Jeff has been brought into the hospital only two hours after the overdose, you suspect that his stomach might contain undissolved aspirin that is continuing to be absorbed. The fact that Jeff's is still experiencing nausea and vomiting 10 hours after the ingestion confirms your suspicion and you decide to use a gastric lavage at pH 8.5 to effectively remove the undissolved aspiring. This treatment solubilizes the aspirin so that it can easily be removed from the stomach. **(3 points)**
   - Calculate the percent of protonated and unprotonated forms of salicylic acid at the pH of the stomach, which is usually around 2.0. and compare that to the percent of protonated and unprotonated forms of salicylic acid at the pH of the lavage.
   - Why does the lavage result in increased solubility of the drug? (Assume that the pK values for the carboxylic group in the salicylic acid and the acetylsalicylic acid are the same pKa=3).

c. The changes in Jeff's blood pH are principally due to the H_2CO_3/HCO_3^- buffering system. **(4 points)**
   - Describe how this buffer system functions to maintain blood pH. Include relevant equations.
   - How do salicylates act on the nervous system (you will have to do some research to determine this one)?
   - Explain how the salicylate-induced changes leads to the symptoms seen in our patient.

d. Use the Henderson-Hasselbalch equation to determine the ration of HCO_3^- to H_2CO_3 in the patient's blood 10 hours post ingestion. The pKa of the first dissociable proton of H_2CO_3 is 6.4. **(4 points)**
   - How does this compare to the ratio found in normal blood?
   - Can the H_2CO_3/HCO_3^- system serve as an effective buffer in this patient?