Bio98A Worksheet #1

Problem #1 - What is the pH of each of the following solutions? Use table 2.4, below, for K_a and pK_a values.

a). 0.04 M HCl
b). 0.04 M NaH_2PO_4
c). 0.1 M H_2CO_3 and 0.6 M $NaHCO_3$
d). 0.1 M H_2CO_3 and 0.08 M NaOH
e). 0.45 M $NaHCO_3$ and 0.35 M HCl

Problem #2 - Determine the H+ and OH- concentration in cow's milk. The pH of cow's milk is typically 6.5.

Problem #3 - Sketch a titration curve for tyrosine. What is the isoelectric point of tyrosine? Use table 3.2 for pK_a values.

Problem #4 – How many moles of NaOH would you need to add to 800 ml of a 0.4 M H_2CO_3 solution in order to bring the pH of the solution to 10.5?

Problem #5
a) What is the pH of a 0.6 M solution of benzoic acid (*Ka* 6.5 x 10-4)?
b) What is the pH of a solution containing 0.03M benzoic acid (p*Ka* 3.19) and 0.02M Na benzoate?

Problem #6
Sally, your 199 supervisor, asks for a pH 7.5 buffer. You already have 0.5M KH_2PO_4. What concentration of K_2HPO_4 do you need? (p*K*a = 6.86)

Problem #7 **True or False**

a) One of the reasons water is a polar molecule is because it is V-shaped (rather than linear).
b) Buffers are aqueous systems that tend to resist changes in pH when small amounts of H+ and OH- are added.
c) The [H+] is 1M in a solution at pH 4.0.
d) Adding a strong base to a weak acid solution will shift HA molecules to the A- form.
e) A single water molecule can act as a hydrogen bond donor in as many as four hydrogen bonds at the same time.
f) An acid that dissociates to the extent of 92% in water would be termed a strong acid.
g) Lactic acid (pKa 3.9) is a stronger acid than phosphoric acid (pKa 2.1).
h) The pKa is the pH at which a weak acid's protons are 50% titrated.
i) The oxygen atom in water has a partial positive charge.
j) Hydrogen bonds are relatively weak compared to covalent bonds.

TABLE 2.4 Dissociation constants and pK_a values of weak acids in aqueous solutions at 25°C

Acid	K_a(M)	pK_a
HCOOH (Formic acid)	1.77×10^{-4}	3.8
CH_3COOH (Acetic acid)	1.76×10^{-5}	4.8
$CH_3CHOHCOOH$ (Lactic acid)	1.37×10^{-4}	3.9
H_3PO_4 (Phosphoric acid)	7.52×10^{-3}	2.2
$H_2PO_4^{\ominus}$ (Dihydrogen phosphate ion)	6.23×10^{-8}	7.2
$HPO_4^{2\ominus}$ (Monohydrogen phosphate ion)	2.20×10^{-13}	12.7
H_2CO_3 (Carbonic acid)	4.30×10^{-7}	6.4
$HCO_3^{\ominus}$ (Bicarbonate ion)	5.61×10^{-11}	10.2
$NH_4^{\oplus}$ (Ammonium ion)	5.62×10^{-10}	9.2
$CH_3NH_3^{\oplus}$ (Methylammonium ion)	2.70×10^{-11}	10.7

Table 2-4 Principles of Biochemistry, 4/e

TABLE 3.2 pK_a values of acidic and basic constituents of free amino acids at 25°C

Amino acid	p*K*a value		
	Carboxyl group	Amino group	Side chain
Glycine	2.4	9.8	
Alanine	2.4	9.9	
Valine	2.3	9.7	
Leucine	2.3	9.7	
Isoleucine	2.3	9.8	
Methionine	2.1	9.3	
Proline	2.0	10.6	
Phenylalanine	2.2	9.3	
Tryptophan	2.5	9.4	
Serine	2.2	9.2	
Threonine	2.1	9.1	
Cysteine	1.9	10.7	8.4
Tyrosine	2.2	9.2	10.5
Asparagine	2.1	8.7	
Glutamine	2.2	9.1	
Aspartic acid	2.0	9.9	3.9
Glutamic acid	2.1	9.5	4.1
Lysine	2.2	9.1	10.5
Arginine	1.8	9.0	12.5
Histidine	1.8	9.3	6.0

Table 3-2 Principles of Biochemistry, 4/e