CHEM106 Section 002 Problem Set 2
Due Thursday, February 18, 2010

Name: Key

Answer all of the following questions and record your answer on the answer sheet. You must show all of your calculations in order for any credit to be given. You must box your final answers on any scratch paper that you include with this Problem Set. If I can't follow your work, you won't receive partial credit.

1. Km = 0.524 μM   Vm = 5.15 nmol/min

2. $[S]_1$ = 16.3 $[S]_2$ = 23.0 $[S]_3$ = 24.9 $[S]_4$ = 31.7

3. Type of inhibition? Uncompetitive (3 Parallel lines; Vm & Km change by σ)

4. 40 mL

5. i) pKa = 3.5   ii) 0.054M   iii) pH = 8.02

6. i) pK_B = 3.5   ii) [B:] = 0.133M   iii) pH = 5.86

7. i) See attached   ii) f (none of the above)

8. Attach a sheet directly after this sheet.

9. 1.85×10^{-5} M aspirin in final 15mL solution

1. The following data were obtained from an enzyme kinetics experiment. Graph the data using a Lineweaver-Burk plot and determine, by inspection of the graph, the values for K_m and V_{max}.

[S] (μM)	[S] (mM)	V (nmol/min)
0.20		1.43
0.26		1.67
0.33		2.08
1.00		3.33

$y = 101.31x + 0.194$

$\frac{1}{V_m} = 0.194$

$V_m = 5.15$ nmol/min
$K_m = 0.524\ \mu M$

2. Use the Michaelis-Menton Equation to calculate the missing values of [S] given below if V_{max} = 5 mmol/min. Plot [S] versus V (NOT the reciprocals!). Draw line parallel to the x-axis at V_{max} and extend your plotted line to show its approach to V_{max}.

[S] (mM)	V (mmol/min)
10	1.2
$[S]_1$ = 16.3	1.7
$[S]_2$ = 23.0	2.1
$[S]_3$ = 24.9	2.2
$[S]_4$ = 31.7	2.5

$V_0 = \frac{V_m [S]}{K_m + [S]}$

when [S] = 10, K_m =

$1.2 = \frac{5(10)}{K_m + 10}$

$1.2 K_m + 12 = 50$

$K_m = 31.7$ mM

3. The effect of an inhibitor on an enzyme was tested and the experiment gave the results below. Plot the data and determine, by inspection of the graph, what type of inhibition is involved.

[S] μM	V (μmol/min) with 0.0 nM Inhibitor	V (μmol/min) with 25 nM Inhibitor	V (μmol/min) with 50 nM Inhibitor
0.4	0.22	0.21	0.20
0.67	0.29	0.26	0.24
1.00	0.32	0.30	0.28
2.00	0.40	0.36	0.32

4. How many ml of a 0.2 M NaOH solution are required to bring the pH of 20 ml of a 0.4 M HCl solution to 7.0?

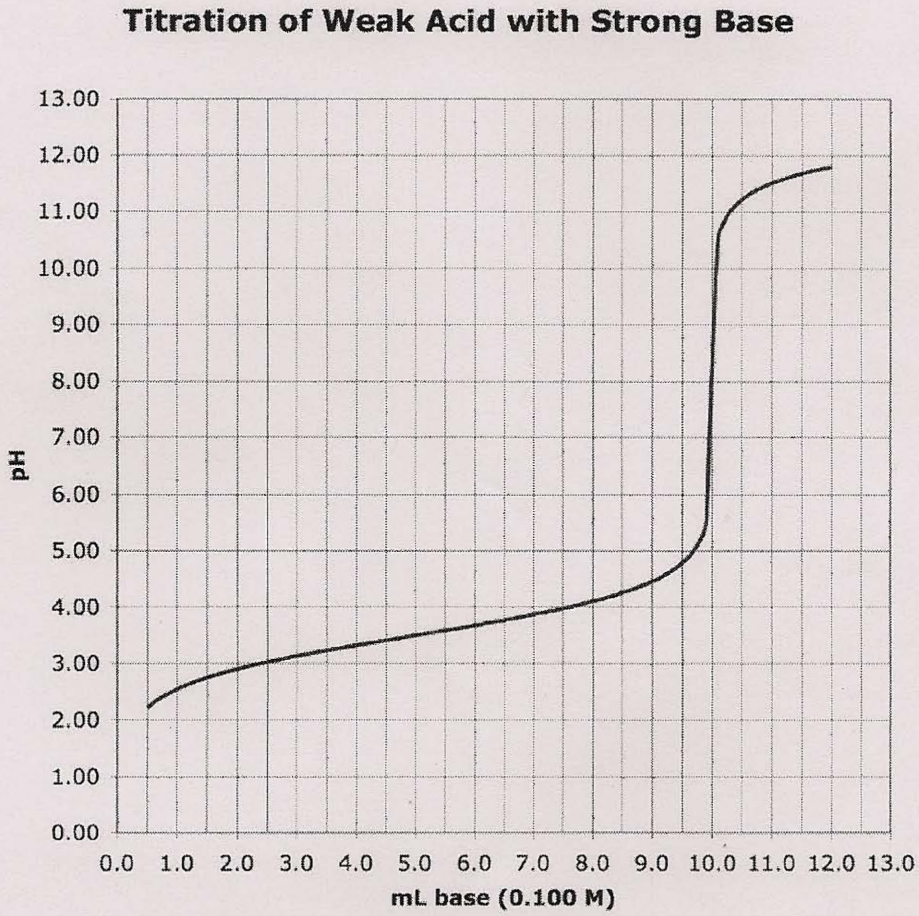
Strong Acid / Strong Base

40 mL

At equivalence point, the pH = 7.0

Double the initial volume of acid since the base is half the concentration.

5. The following questions refer to the figure. You must CALCULATE every answer, you cannot simply look at the titration curve and make an approximatation.



i) What is the pKa of the weak acid?

ii) What was the original concentration of the acid if the starting volume of acid was 18.60 mL?

iii) Calculate the pH at the equivalence point.

ii) It takes 10 mL of 0.1 M OH^- to reach the end point

$0.01 L \times \frac{0.1 mole}{L} = 1 \times 10^{-3}$ moles H^+ in $0.0186 L$ = **0.054 M acid**

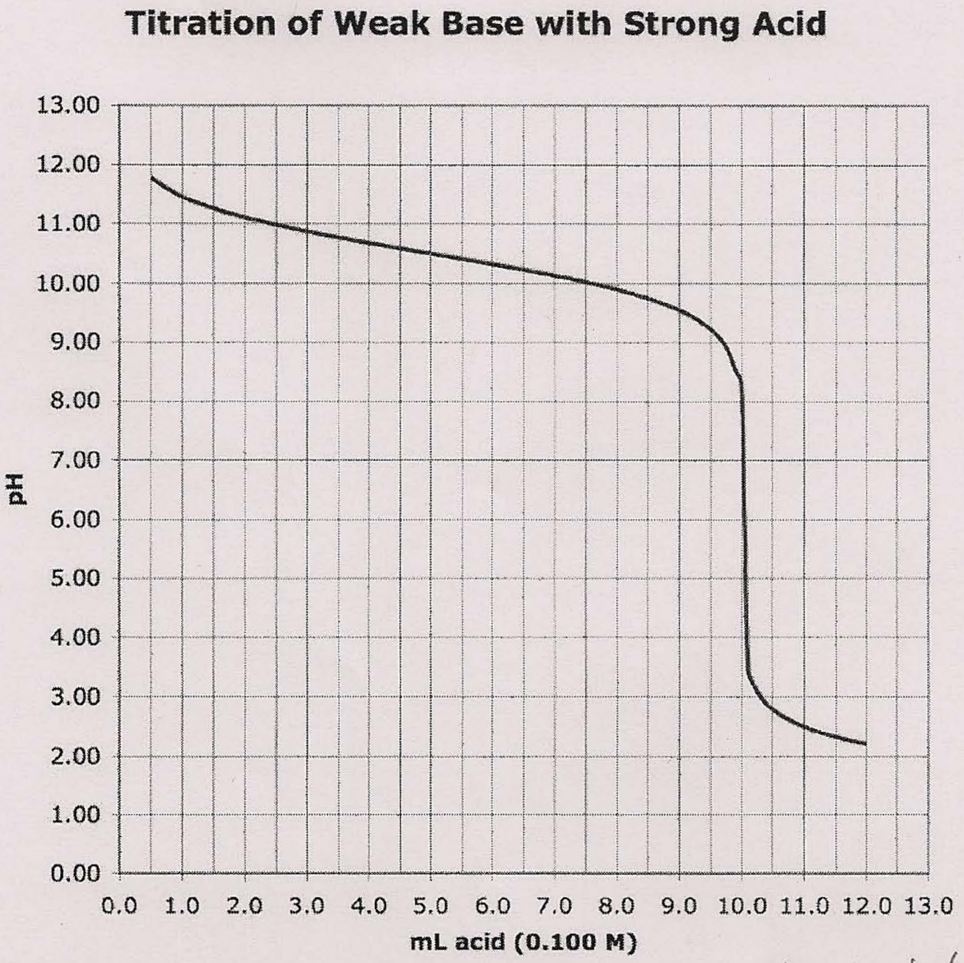
iii) $pK_a = 3.5$ therefor $pK_B = 10.5$

$K_B = 3.16 \times 10^{-11} = \frac{[HA][OH^-]}{[A^-]}$ $[A^-] = \frac{1 \times 10^{-3} \text{ moles}}{0.0186 L + 0.010 L} =$ **0.035 M**

$(3.16 \times 10^{-11})(0.035) = x^2$

$x = 1.05 \times 10^{-6} = [OH^-]$ $pOH = 5.98$ **pH = 14 - pOH = 8.02**

6. The following questions refer to the figure. You must CALCULATE every answer, you cannot simply look at the titration curve and make an approximatation.



i) It takes 10ml of acid to reach the equivalence point. At 5mL of acid added, the $pH = pKa + \log\left(\frac{[BH]}{[B]}\right)$ but $[BH] = [B:]$, so $pH = pKa$. The pH after 5mL of acid was added is 10.5. The $pK_A = 10.5$, therefore the $pK_B = 14 - pK_A = \boxed{3.5}$

i) What is the pKb of the weak base?

ii) What was the original concentration of the base if ~~the starting volume of base~~ was 7.50 mL?

iii) Calculate the pH at the equivalence point. → use $\boxed{K_A = \frac{[B:][H_3O^+]}{[BH]}}$

ii) 10ml of 0.1M acid was necessary to reach the equivalence point. $0.010L \times \frac{0.1 \text{ mols } H^+}{L} = 1 \times 10^{-3} \text{ mols } H^+ \times \frac{1 \text{ mole Base}}{1 \text{ mol } H^+} = 1 \times 10^{-3}$ moles Base at start, so: $\frac{1.0 \times 10^{-3} \text{ moles Base}}{0.0075 L} = \boxed{0.133 M \text{ Base}}$

7. Answer the following questions.

i) Draw a tripeptide having R groups consisting of methyl, hydroxyl, and phenol groups.

ii) When a protein is dissolved in water, the amino acids found in its interior are likely to have R groups which are:
a) hydrophilic
b) charged
c) highly reduced
d) polar
e) all of the above
f) none of the above

8. Draw the structure of the following compounds:

i) 2,4-dimethyl-3-pentanol
ii) 1-ethyl-3-methylbenzene
iii) 2,6-diaminohexanoic acid
iv) 1-methoxy-3-hexanone
v) benzaldehyde

9. You have 200 mg of aspirin (FW= 180g/mole) dissolved in 50 mL of water. You take 5 mL of this solution and bring it to 200 mL with water. You then take 100 mL of that and bring it to 1000 mL with water. You take 5 mL of that solution and add it to 10 mL of water. What is the molarity of aspirin in the final solution?

$200\,mg \times \frac{1g}{1000\,mg} = 0.2\,g$ aspirin $\times \frac{1\,mole}{180\,g} = 1.11\times10^{-3}$ moles aspirin

$\frac{1.11\times10^{-3}\text{ moles aspirin}}{0.05\,L} = 0.0222\,M$ aspirin in 50 mL solution

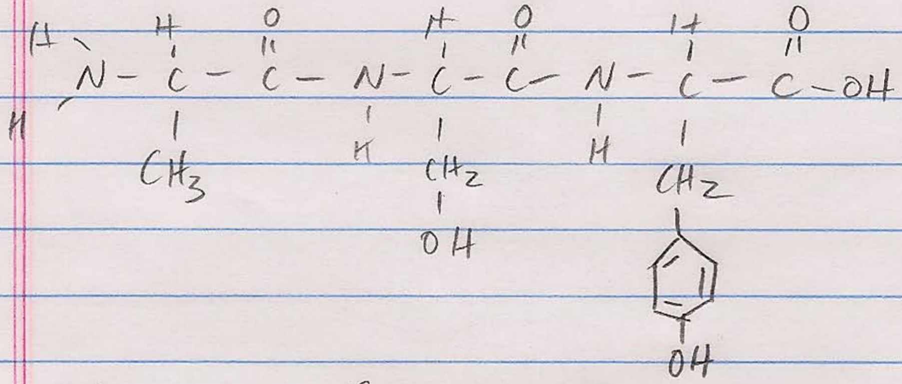
50 mL, 0.0222 M aspirin → 5 mL → 195 mL H_2O → 100 mL → 900 mL H_2O → 5 mL → 10 mL of H_2O

40 fold dilution: $5.55\times10^{-4}\,M$ aspirin

10 fold dilution: $\frac{5.55\times10^{-5}\text{ mole aspirin}}{L} \times 0.005\,L = 2.775\times10^{-7}$ moles aspirin in the 5 mL volume

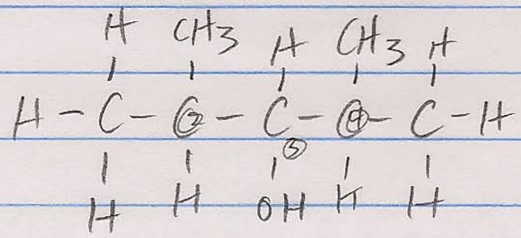
$\frac{2.775\times10^{-7}\text{ moles aspirin}}{0.015\,L} =$ $1.85\times10^{-5}\,M$ aspirin in final 15 mL solution

7. i) Tripeptide with R groups of methyl, hydroxyl and phenol substituents

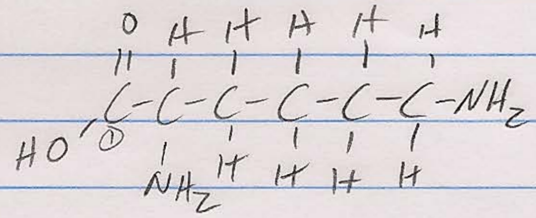


Ala - Ser - Tyr

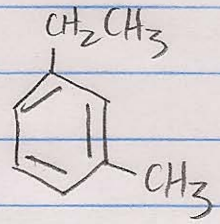
⑧ i) 2,4-dimethyl-3-pentanol



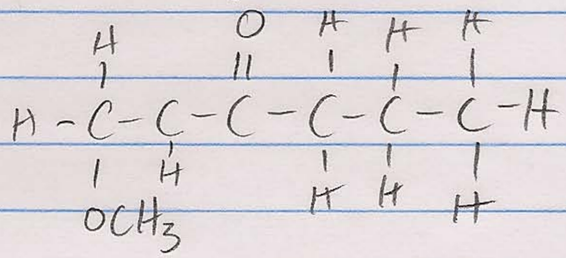
iii) 2,6-diaminohexanoic acid



ii) 1-ethyl-3-methyl benzene



iv) 1-methoxy-3-hexanone



v) Benzaldehyde