CHEM106 Section 001 Test #1
September 19, 2018

Name: Key

Answer Sheet

Fun!

1) D
2) A
3) B
4) A
5) D
6) B
7) A
8) A
9) A
10) B
11) B
12) E
13) C
14) A
15) B
16) A
17) D
18) B
19) A
20) C

Games!

1) pH = 3.57

2) a) 19.7mL of 0.778M $NaIO_3$

b) 3.33mL of 0.5M NaOH

3) a) 3-ethyl-2,5,5-trimethylhexane

b) Ortho-methyl-iodo benzene

c) trans-2-pentene

4) a) ion-dipole : Na^+/H_2O

b) dipole-dipole : H_2O/H_2O

c) dipole-induced dipole: H_2O/Lipid

d) London Forces: Lipid/Lipid

Games! (continued)

5) Functional groups in safrole:
ether (x2), arene, alkene

6) Functional groups in Aspirin:
carboxylic acid, arene, ester

Functional groups in Tylenol:
hydroxyl, arene, amide or phenol, amide

Functional groups in Advil:
Carboxylic acid, Arene, alkyl

Games!

1) Have from Problem:

Start with 0.045L of 0.02M WTH acid (WTH-H)

Add 0.036L of 0.02M KOH

The following chemical reaction occurs when you mix the two:

$$WTH\text{-}H + {}^{-}OH \longrightarrow WTH^{-} + H_2O$$

You will have reacted some WTH-H away and converted it to WTH^{-} (Conjugate base)

Once you've added the base and the reaction is done, everything goes back to equilibrium with new molarities

$$WTH\text{-}H + H_2O \rightleftharpoons WTH^{-} + H_3O^{+}$$

This can be described by the equilibrium equation

$$K_A = \frac{[WTH^{-}][H_3O^{+}]}{[WTH\text{-}H]}$$

Now, you are given the pK_A, not K_A

$pK_A = -\log K_A$ and to go back to K_A from pK_A you have to

$K_A = 10^{-pK_A}$ (Hit the 2nd or Shift key on your calculator, then the log button to get the $10^{\square}$ symbol(!))

$K_A = 10^{-2.97}$

$K_A = 1.07 \times 10^{-3}$

At this point, let's get some numbers.

At the start, you have $0.045L \times \frac{0.02 \text{ moles WTH-H}}{L}$

9×10^{-4} moles of WTH-H @ the start

You have added:

$0.036L \times \frac{0.02 \text{ moles } \bar{O}H}{L} = 7.2 \times 10^{-4}$ moles $\bar{O}H$ added

And from the chemical reaction stoichiometry

7.2×10^{-4} moles $\bar{O}H$ added $\times \frac{1 \text{ mole WTH}^- \text{ made}}{1 \text{ mole } \bar{O}H \text{ added}}$ =

7.2×10^{-4} moles WTH^- made

Now, you have changed the initial volume from 45ml of acid to 45ml acid + 36ml base = 0.081L

The molarities have changed to:

$$[WTH\text{-}H] = \frac{\text{moles WTH-H remaining}}{0.081L}$$

$$= \frac{9.0\times10^{-4}\text{ moles WTH-H start} - 7.2\times10^{-4}\text{ moles } \bar{O}H\text{ added}}{0.081L}$$

$$\boxed{[WTH\text{-}H] = 2.22\times10^{-3}}$$

$$[WTH^-] = \frac{7.2\times10^{-4}\text{ moles } WTH^-\text{ made}}{0.081L}$$

$$\boxed{[WTH^-] = 8.88\times10^{-3}}$$

and

$K_a = 1.07\times10^{-3}$, so:

$$K_a = \frac{[WTH^-][H_3O^+]}{[WTH\text{-}H]}$$

You are asked for the pH and the $pH = -\log[H_3O^+]$, so you need to solve for $[H_3O^+]$ after the reaction.

Let's rearrange the K_A equation to solve for $[H_3O^+]$:

$$K_A = \frac{[WTH^-][H_3O^+]}{[WTH-H]}$$

$$[H_3O^+] = \frac{K_A[WTH-H]}{[WTH^-]}$$

Plug in your numbers to get

$$[H_3O^+] = \frac{(1.07\times10^{-3})(2.22\times10^{-3})}{(8.88\times10^{-3})}$$

$$[H_3O^+] = 2.67\times10^{-7}$$

$$pH = -\log[H_3O^+] = -\log(2.67\times10^{-7})$$

$$\boxed{pH = 3.57}$$

2) a) Have from problem:

$0.778\ M\ Na_2CO_3$

Want:

$0.150\ L$ of $0.1022\ M\ Na_2CO_3$

you could use $C_1V_1 = C_2V_2$, but you have to get your C's and V's straight

Anything with the subscript "1" is what you have. Anything with subscript "2" is what you want.

$C_1 = 0.778\ M$ $\quad C_2 = 0.1022\ M$

$V_1 = ?$ $\quad V_2 = 0.150\ L$

$$V_1 = \frac{C_2V_2}{V_1} = \frac{(0.1022\ M)(0.150\ L)}{(0.778\ M)}$$

$V_1 = 0.0197\ L$ of $0.778\ M\ Na_2CO_3$

plus

$0.1302\ L\ H_2O$

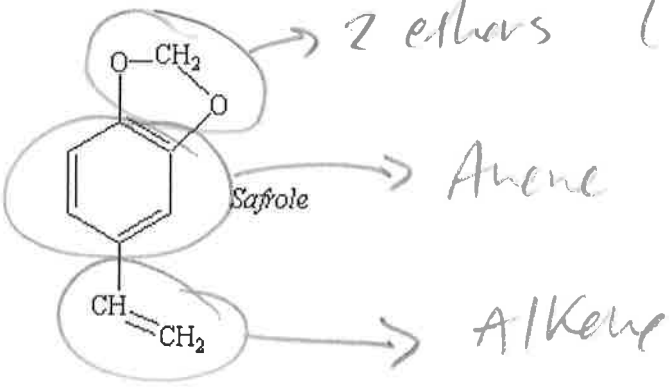
b) Same thing, just get your C's and V's straight

$$V_1 = \frac{C_2 V_2}{C_1}$$

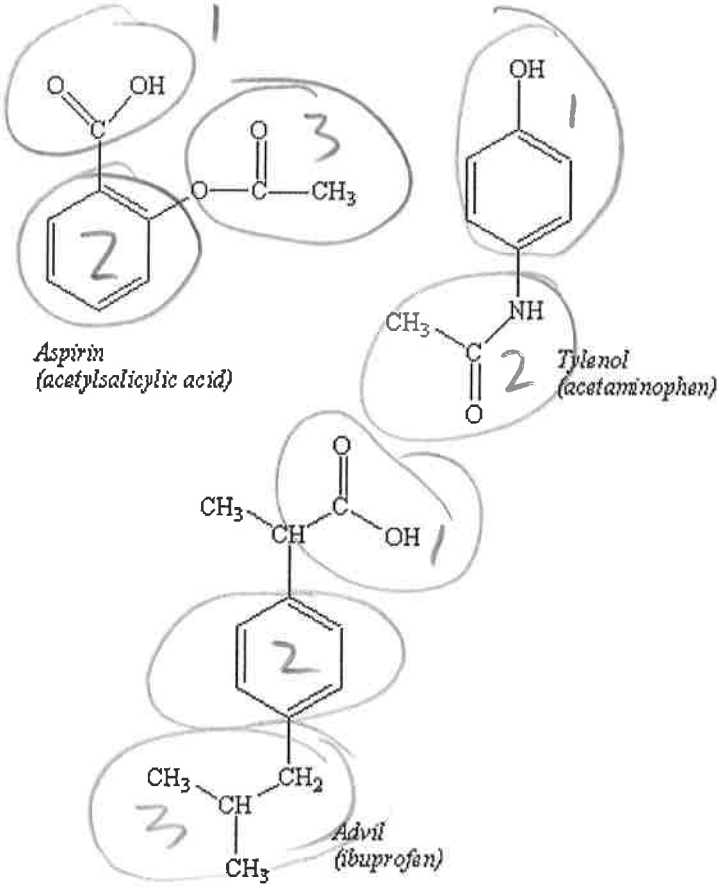
$$V_1 = \frac{(0.5\,M)(0.02\,L)}{3\,M}$$

$V_1 = 3.3 \times 10^{-3}$ L of 3M NaOH + 0.0167 L H_2O to make 20mL

5) (6 points) Root beer hasn't tasted the same since the use of sassafras oil as a food additive was outlawed because sassafras oil is 80% safrole, which has been shown to cause cancer in rats and mice. Circle and name the functional groups in the structure of safrole.



6) (12 points) The following compounds are the active ingredients in over-the-counter drugs used as analgesics (to relieve pain without decreasing sensibility or consciousness), antipyretics (to reduce the body temperature when it is elevated), and/or anti-inflammatory agents (to counteract swelling or inflammation of the joints, skin, and eyes). Identify the functional groups in each molecule by circling them in each molecule, putting a number next to the circle and then writing the name next to the same number in the textbox on the right.



Functional groups in Aspirin:
1: Carboxylic Acid
2: Arene
3: Ester

Functional groups in Tylenol:
1: Phenol
2: Amid

Functional Groups in Advil:
1: Carboxylic acid
2: Arene
3: Alkyl (Alkane)