CHEMISTRY 14 BL – MIDTERM (Fall 2015) FORM A

NAME: Myer Matthew
(LAST NAME) (FIRST NAME)

ID#: [redacted]

CIRCLE THE NAME OF YOUR TA:

Jonathan	Chencai	Yilliu	Brian	Zying	Anush	Jialin	Grace

Instructions:

1. This exam consists of **THREE** questions (7 pages).
2. **Before starting, write your name on every page.**
3. Include units with your answers and show your method of calculation or reasoning. **Place a box or circle around your final answer**
4. You must show **ALL** work for **FULL** credit.
5. No credit will be given for a numerical answer alone or for an illegible answer.
6. If you run out of space working a problem, use the back of that page and indicate on the front that you have done so.

Question	Value	Score
1	21	24
2	9.5	16
3	2	20
Total	32.5	60

Useful Information:

$pX = -\log X$; $pH = 14 - pOH$; $K_w = 1.00 \times 10^{-14}$; $K_b = k_w / k_a$; $pKa + pKb = 14$

$A = \varepsilon Lc$; $A = -\log T$; $A = \text{slope} \times C$

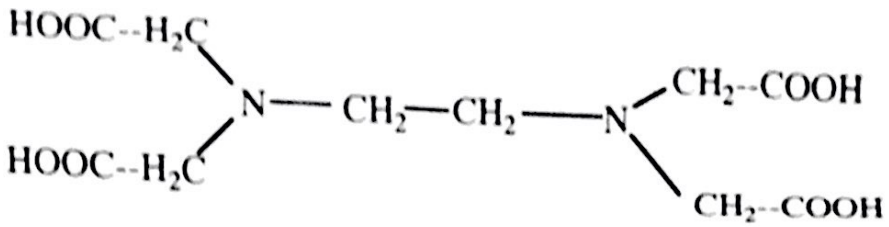
$$pH = pk_a + \log\frac{[\text{conjugate base}]}{[\text{acid}]}$$

Solution of quadratic equation of the form $ax^2 + bx + c$ is $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

GOOD LUCK!

PROBLEM 1 (Concentration Units) **NAME:** _____

(Part A) Ethylene diamine tetra acetic acid (EDTA) is an organic acid and its structure is shown below:



Each molecule of EDTA contains a total of four acidic protons. Each **–COOH** functional group in EDTA is capable of reacting with one equivalent of base. Suppose a solution was prepared by dissolving 0.5000 g of EDTA in 2.50 L of water. **Molecular weight of EDTA = 292.1300 g/mol**

You may assume the density of the solution to be 1.000 g/mL.

+4.5 (a) (5 points) Calculate the molarity of the EDTA solution described above.

$.5000\,g \times \frac{1\,mol}{292.1300\,g} = .0017\,mol \times \frac{1\,M}{2.5\,l} = .000685\,M$

$6.8463 \times 10^{-4}\,M$

(-0.5)

+3 (b) (3 points) What is the normality of the EDTA solution?

$.00685\,M \times 4_{eq} = .00274\,N$

+3 (c) (3 points) What is the w/v% of the EDTA solution?

$.500\,g \times \frac{1}{2.50\,l} \times \frac{1\,l}{1000\,ml} \times 100\% = .02\%$

+3 (d) (3 points) Express the concentration in ppm.

$1\,g = 1\,ml$

$.5\,g \times \frac{1}{2.50\,l} \times \frac{1\,l}{1000\,ml} \times 10^6 = 200\,ppm$

13.5

PROBLEM 1 (Continued) (dilution / errors) NAME: _____

(Part B) A student made a standard solution by transferring 0.5687g of $FeSO_4.7H_2O$ into a 100-mL volumetric flask, dissolving the salt and diluting to the mark. He then withdrew a 5-mL aliquot with a volumetric pipet and transferred it to a 100-mL volumetric flask. The solution was diluted to the mark and mixed well.

Atomic weight: Fe = 56.00 g/mol; S = 32.00 g/mol; O = 16.00 g/mol and H = 1.00g/mol

+6 (a) (6 points) Calculate the concentration of the **iron** in the final **$FeSO_4.7H_2O$** solution above in **parts per million**? Since this is an aqueous solution you can assume that 1mL of solution = 1g.

$.5687\,g \cdot \frac{56}{56+32+11(16)+14} = .1146\,g$ ±1 in the grams of Fe

$.1146\,g \cdot \frac{5\,ml}{100\,ml} \cdot \frac{1}{100} \geq \times 10^6 =$ ~~57.279~~ 57 ±3 ok

Don't round too much

~~60 ppm Fe~~

+1.5 (b) (4 points) If the tolerance of the balance is ±0.2 mg, the volumetric flask is ± 0.08 mL and the pipet is ±0.02 mL, calculate the percent inherent error in the final diluted solution in (a) above.

(relative error $\frac{0.2}{568.7} + \frac{\pm 0.5}{100} \cdot \frac{.08}{100} + \frac{\pm 0.5}{5} \cdot \frac{.02}{5} + \frac{\pm 0.5}{100} \cdot \frac{.08}{100}$

$.00351 + .0016 + .004 = .04077 =$ ~~4%~~ 0.59%

$\frac{\Delta C}{C} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$

7.5

PROBLEM 2 (Beer's Law) **NAME:** _____

Brass is an alloy of copper and zinc. A 14BL student was given a brass sample and asked to analyze it for copper using colorimetric analysis. He first dissolved the brass sample in hot nitric acid and transferred the solution in a 100.00-mL volumetric flask and diluted the solution to the mark with distilled water. He labeled the flask as unknown brass solution. Then he prepared a set of standard solutions using copper sulfate. The following data were recorded using a spectrophotometer for the set of three standard solutions containing the copper (II) ion and the unknown brass at 600 nm.

Solutions	Absorbances	Concentration of copper (M)
Blank	0.00	0.00
Standard 1	0.21	8.05×10^{-4}
Standard 2	0.43	1.65×10^{-3}
Standard 3	0.66	2.53×10^{-3}
Unknown brass solution	0.29	------

(a) (6 points) Without plotting any graph, **calculate** the concentration of copper in **molarity** in the **unknown brass solution.** You **MUST** show all the work in order to receive full credit.

$\text{slope} = \frac{.66}{2.53 \times 10^{-3}} = 260.870$

$A = \varepsilon l c \qquad c = \frac{A}{\varepsilon l}$

$\varepsilon l = \text{slope}$

$\varepsilon l = 260.870$

units? -0.5

$c = \frac{.29}{260.870}$

$= \boxed{1.11 \times 10^{-3}}$

(b) (4 points) Calculate the inherent error range in the absorbance of the unknown brass solution above if the colorimeter has an absolute error in the % transmittance which is $\pm$ 1%.

$.01 \cdot .29 = .0029$

-4

$\boxed{.29 \pm .0029}$

PROBLEM 2 (Continued)

NAME: Matt Ngo

(c) (6 points) In lecture I have discussed THREE various analytical methods to analyze a real sample in the laboratory. Which method did you use for experiment #2 (blue food dye experiment) and which one did you use for experiment #3 (Vinegar-A study of a weak acid and its buffer). **Discuss the advantages and disadvantages of each method.**

Experiment #3
Used titration of acid against base to find concentration of unknown sample
Adv.: Reliable, easy Disadv Time consuming, error with each dilution

Experiment #2
Used Wavelength : Absorbance to unknown Concentration.
Adv: Easy, little human error disadv: expensive
fast - 1 to background? - 1

4

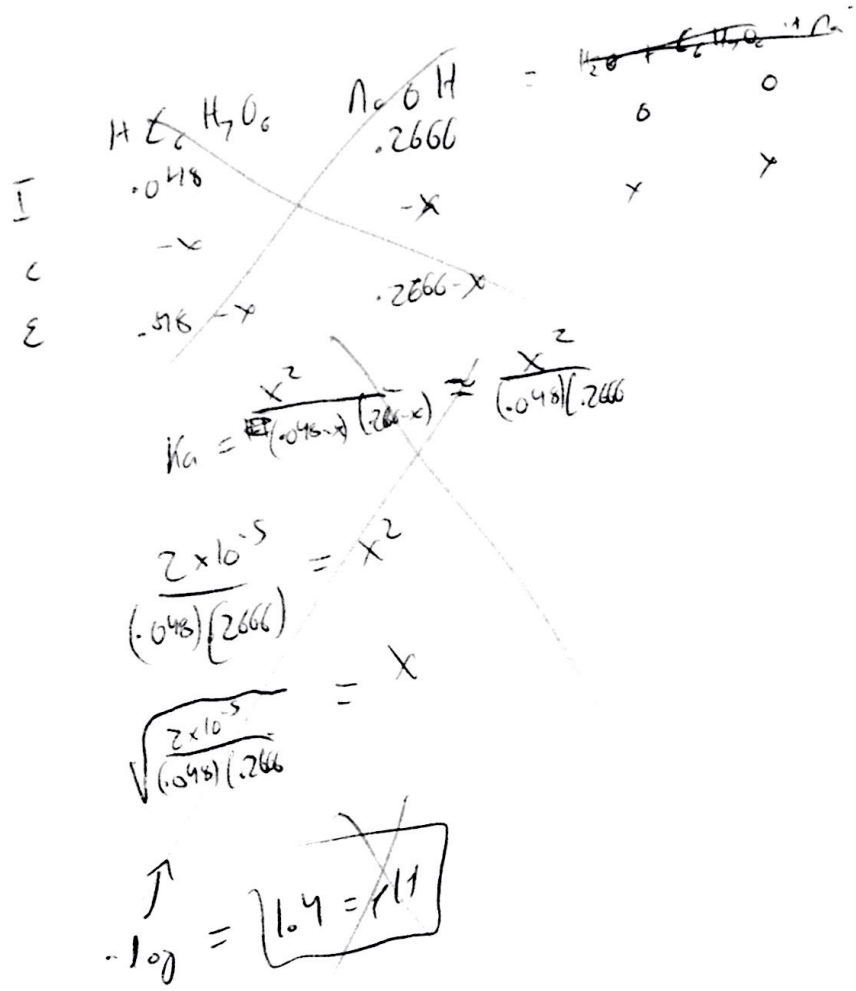
PROBLEM 3 (Acid / /Base)

NAME: Mark Myers

Always check any assumption that you make during the calculation. Show ALL your WORK to receive a FULL credit.

Similar to acetic acid, ascorbic acid ($HC_6H_7O_6$) is a weak monoprotic acid (HA); which has K_a of 2.0×10^{-5}

(a) (7 points) Calculate the pH of a solution produced by mixing 100.00 mL of 0.0480 M ascorbic acid (**HA**) with 14.00 ml of 0.2666 M NaOH.



PROBLEM 3 (continue) NAME: Matt Ryan

Always check any assumption that you make during the calculation. Show ALL your WORK to receive a FULL credit.

(b) (13 points) Calculate the pH of a solution produced by mixing 100.00 mL of 0.0480 M ascorbic acid (HA) with 18.00 ml of 0.2666 M NaOH.

$K_a = 2 \times 10^{-5}$

$HA + NaOH \rightarrow NaA + H_2O$

	HA	NaOH	NaA	H_2O
I	.0480	.2666	0	0
C	-.0480	-.0480	+.0480	+.0480
E	0	.1866	.0480	.0480

$K_b = K_w / K_a$

$K_b = 1 \times 10^{-14} / 2 \times 10^{-5}$

$pH = pK_a + \frac{[H^+][OH^-]}{[HA]}$