LAB [30 pts]
Molarity and Absorbance
With Analysis of Aspirin

Name _____
Lab partners _____
Period _____ ***Date*** _____

Purpose: To become familiar with making solutions by dissolving solids into water and by diluting solutions. The concentration of the solutions will be tested by determining their absorption of light. Also, you will test for the contamination of salicylic acid in your aspirin sample you made earlier this year.

Procedure Part A: [6 pts] Making solutions of $CuSO_4$ and testing their absorbance.
Complete parts 1a, 1b, 2a, 2b & 3b as prelab

1) **Make 50.0 mL of 0.50 M $CuSO_4$ sol'n from solid $CuSO_4 \cdot 5\ H_2O$ crystals and measure its absorbance**
   a) Determine the mass of $CuSO_4 \cdot 5\ H_2O$ needed to make 50.0 mL of 0.5 M $CuSO_4$ (aq). Show work here.

   b) Describe how you will make this 0.50 M solution here.

   c) Make 0.50 M solution and measure the absorbance. *Record in Data Chart.*

*** **To measure Absorbance:** Use the colorimeter/computer setup.
   a) Carefully fill a colorimeter cuvet (plastic container) ~ ¾ with one of the solutions. **Wipe dry!!!**
   b) Take the filled cuvet to the colorimeter/computer. Put the sample into the sample chamber. *(Make sure that the clear sides align with the white line on the colorimeter.)*
   c) Close the lid of the colorimeter. Read the **absorbance** off the computer screen. Record value.
   d) Take cuvet out. Go back to lab bench. Pour out old solution, and repeat with another solution.

2) **Make a Solution by dilution and measure its absorbance**
   a) Make **25.0 mL of a 0.35 M $CuSO_4$** solution by diluting your 0.50 M solution you just made. Show needed calculation here and briefly

   b) Describe how you will make this 0.35 M solution.

   c) Make 0.35 M solution and measure its absorbance**.** *Record in Data Chart*.

3) **Making four more solutions by dilution of your 0.50 M $CuSO_4$ solution.**
   a) Label four large test tubes-- #1, 2, 3, 4. Place them in your test tube rack.
   b) Obtain two graduated pipets and a filler. Use pipets to make 4 different dilutions of your 0.50 M solution by filling each test tube with the amounts of each solution shown in the table below.

Test tube #	**#1**	**#2**	**#3**	**#4**
Vol of water (mL)	8.0	6.0	4.0	2.0
Vol of **0.50 M** $CuSO_4$ (mL)	2.0	4.0	6.0	8.0
Molarity of solution (M)				

   **Show sample calculation of M for TT #1 (Hint: what is V_{dil}?)*

   c) Measure the absorbance of each of the solutions just made. *Record in Data Chart*

Data Chart [2 pts]

Molarity (M)	**0.10 M**	**0.20 M**	**0.30 M**	**0.35 M**	**0.40 M**	**0.50 M**
Absorbance						

Procedure for Part B: Analysis of the purity of Aspirin

- Earlier this year you synthesized aspirin and made a qualitative determination of salicylic acid contamination by mixing your aspirin sample with $Fe(NO_3)_2$, and observing whether a purple solution formed. If salicylic acid was present, the formation of a Fe^{3+}/salicylate complex caused the solution to turn purple. The deeper the purple color, the more salicylic acid contaminated your aspirin. You will now quantitatively determine its purity.

1) Make your solution of your aspirin sample. (Be sure the spec 20 is free.)
   a) Place 0.10 g of your aspirin sample into a 100 mL or 150 mL beaker.
   b) Dissolve the solid by adding 5.0 mL of 95% ethanol. (Use graduated cylinder)
   c) Add 5.0 mL of 0.025 M $Fe(NO_3)_3$ in 0.5 M HCl. (Use graduated cylinder)
   d) Lastly, add 40.0 mL of distilled water. Stir with glass rod until most of the solid is dissolved.
2) Measure the absorbance of the solution using the Spec 20. *You must measure the absorbance within 5 minutes of dissolving your aspirin in the ethanol since aspirin slowly decomposes in the solution.*
   a) Do not touch the wavelength value (It should be set at 524 nm)
   b) Make sure the *Spec 20* is zeroed. (transmittance = 0 when nothing is in machine)
   c) Put *Blank Sample* in holder, close top. Make sure it reads at 100 % absorbance.
   **** Note: The blank solution was prepared by mixing 5 mL of 95% ethanol, 5 mL of 0.025 M $Fe(NO_3)_3$ in 0.5 M HCl and 40 mL of distilled water.*
   d) Pour some of your aspirin solution into a clean cuvet. Measure its absorbance, NOT %T.
   e) Rinse out your sample cuvet with some water and put in the beaker labeled "used cuvets."

DATA: absorbance of your aspirin sample =_____

Graph: [9 pts] Open up the Google Sheets Graph template that is posted on Google Classroom. Enter in your absorbance values into the chart. Once you have entered all data, a straight line should be obtained. To label the graph with names of people in lab group, just click twice on the "names in lab group" on the graph. Type in your names in the "chart editor" at the right-hand side.

a) The equation of the line is shown at the top of the graph. Write the equation of the line here:

$$y = (\quad\quad)\,x + \_\_\_\_\_$$

b) Now, instead of using the letters "x" and "y" in your equation of the line, rewrite your equation using the letters "A" for absorbance and "C" for concentration.

c) Your y-intercept value should be very close to zero. Rewrite your equation again assuming that your y-intercept is equal to zero. (Still use the variables, A and C in your equation)

d) What must be the units on your slope value?_____
(Hint—what are the units for absorbance and concentration?)

e) Your data shows that as a $CuSO_4$ solution gets more concentrated, its absorbance increases. This suggests that there is possibly a direct relationship between concentration and absorbance. Justify that there is a true, mathematical direct relationship between concentration and absorbance by discussing….
   1. two specific data points from your data chart.

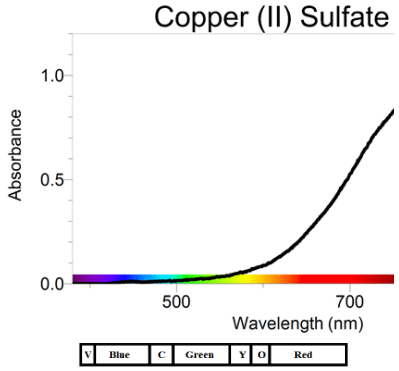
   2. your equation of the line.

f) Based on your data points in your graph, discuss how well you made your solutions. *(Did all points fall close to the line? Did you have any particularly inconsistent points? If so, which ones?)*

g) Suppose you have a $CuSO_4$ solution of unknown concentration and you want to know its concentration. You use a colorimeter and find that the absorbance of the solution is 0.55
   1. By just looking at your graph, approximate the concentration of this solution?_____
   2. Now, use your equation of your line to calculate a more precise concentration of this $CuSO_4$ solution. *(Show units on all numbers that have units!)*

Post-Lab Questions: [13 pts]

1) [1pt] The full visible light absorbance spectrum of a $CuSO_4$ solution is shown at the right. Based on this spectrum, why are $CuSO_4$ solutions blue?



2) [1 pt] The colorimeter in this lab was set to 630 nm (red) light. Why was this a good choice of wavelength for this lab and 480 nm (blue) would have been a poor choice?

3) [1 pt] More concentrated $CuSO_4$ solutions have a **(lighter, darker)** blue color because they absorb **(more, less)** visible light and transmit **(more, less)** visible light.

4) **Determining the amount of salicylic acid contamination in your aspirin sample:**
   a) [1 pt] Determine the concentration of the salicylic acid in your solution. A plot of absorbance vs. salicylic acid concentration, gives a straight line with the equation, **$A = (1200\ M^{-1})\ C$.**
   (Show calculation and make sure to show units on all numbers that have units.)

   b) [1 pt] Determine the moles of salicylic acid in your solution. *Remember, the volume of the solution was 50.0 mL.*

   c) [1 pt] Determine the grams of salicylic acid in your solution. *(MM of salicylic acid is 138.13 g/mole)*

   d) [1 pt] Determine the percent (by mass) of salicylic acid in your aspirin sample.
   Remember: You made the solution using 0.10 grams of your aspirin.

$$\%\text{Salicylic Acid} = \frac{\text{mass of salicylic acid (g)}}{\text{mass of aspirin sample (g)}} \times 100\% =$$

5) [3 pts] Suppose you wanted to make 100.0 mL of a 0.500 M $CaCl_2$ from solid $CaCl_2$. Make any necessary calculations and briefly describe how you would make the solution in the lab. *(Determine amounts- use proper sig figs! What size and type of glassware?)*

6) [3 pts] Suppose you wish to make a 250.0 mL of 2.00 M HNO_3 (aq). You will accomplish your goal by diluting a 15.0 M HNO_3 solution. Make any necessary calculations and briefly describe how you would make the solution in the lab. *(Determine amounts-use proper sig figs!, What size and type of glassware?)*