Exam 1 Review

1. Useful Equations: Use the word bank below to fill in the missing parts of the equations, then identify the meaning of each term in the equation. (Hint: Not all of the words in the bank will be used and some of them are wrong intentionally)

$$\epsilon bc \qquad \frac{h\lambda}{c} \qquad \frac{hc}{\nu} \qquad bx - m \qquad \frac{10s}{m}$$

$$\lambda\nu \qquad \frac{hc}{\lambda} \qquad mx + b \qquad \mu_{blank} + 3\sigma_{lowstds} \qquad \sigma_{lowstds} + 3\mu_{blank}$$

$$\frac{\lambda}{\nu} \qquad \frac{h}{\nu} \qquad \frac{m}{b}x \qquad \frac{3s}{m} \qquad \frac{5s}{m}$$

$$-\frac{b}{m} \qquad -\frac{m}{b} \qquad \frac{P}{P_0} \qquad \frac{P_0}{P} \qquad -\log T$$

(a) $A(c) =$

(b) $c =$

(c) $E =$

(d) $y =$

(e) $MDS =$

(f) $LLOD =$

(g) $LLOQ =$

(h) $x_{int} =$

(i) $T =$

(j) $A(T) =$

2. Unit Conversions

(a) How many grams of sodium are in 4.0 L of a 0.01 M salt solution?

(b) How many parts per million are sodium in the solution above? What important assumption are you relying on?

(c) Convert the molar absorptivity of 343 M^{-1} cm^{-1} for caffeine to mL mg^{-1} m^{-1}.

(d) Convert the energy 2.2 eV to units of kilojoules per mole. (Note: 1 eV $= 1.602 \times 10^{-19}$ J)

(e) Convert 98.3 wt% H_2SO_4 to molarity and to ppm. The density of the solution is 1.84 g/mL.

3. Errors, Accuracy, and Solutions

(a) For each of the following, identify the type of experimental error that best describes the situation. Then, state the statistical measures this would be most likely to effect.

   i. The last digit of your analytical balance flickers between two values on each measurement
   ii. The absorbance values for three blanks are all different, although they are between 0.00 and 0.05
   iii. Your lab partner spills coffee on his notebook and you copy down the wrong concentration value
   iv. The pH meter was calibrated using the wrong standards
   v. You forget to subtract the mass of the weigh boat for all of your samples

(b) Using the table below, rank the students' abilities to deliver 10mL of water in terms of accuracy and precision.

Run	Judson	Callen	Terri
1	9.42	9.78	9.49
2	9.25	9.15	9.85
3	9.02	9.66	9.87
4	9.42	9.03	9.05
5	9.88	9.66	9.29
Avg	9.40	9.46	9.51
St Dev	0.32	0.34	0.36

(c) Would you discard any of the students' data above? If so, explain why. If not, explain a situation in which it would be justified to discard data.

(d) Using a 10mL pipette and 25 and 50mL volumetric flasks, explain how you would prepare 5 standard solutions spanning the concentration range 0.04-0.40M starting with a 1.0M stock solution. Draw a flowchart like Figure 1 in the Solutions and Dilutions activity to show which steps are parallel and which are in series.

(e) Use the table below to determine which piece of glassware you would use to deliver 10mL of water.

| Glassware	Capacity (mL)	Tolerance (mL)
Flask	10	0.02
Pipet	10	0.03
Buret	10	0.02
Grad. Cylinder	10	0.09

(f) What makes the previous problem more straightforward than many tolerance problems?

(g) Do you think tolerance has a bigger effect on accuracy or precision?

4. Beer's Law and Spectroscopy

(a) Label the types of electromagnetic radiation and the types of transitions you would expect them to cause on the picture below. Also, draw arrows showing the direction of increasing energy, wavelength, and frequency.

Wavelength (m)

10^{-12} 10^{-8} 10^{-6} 10^{-2} 10^{0} 10^{4}
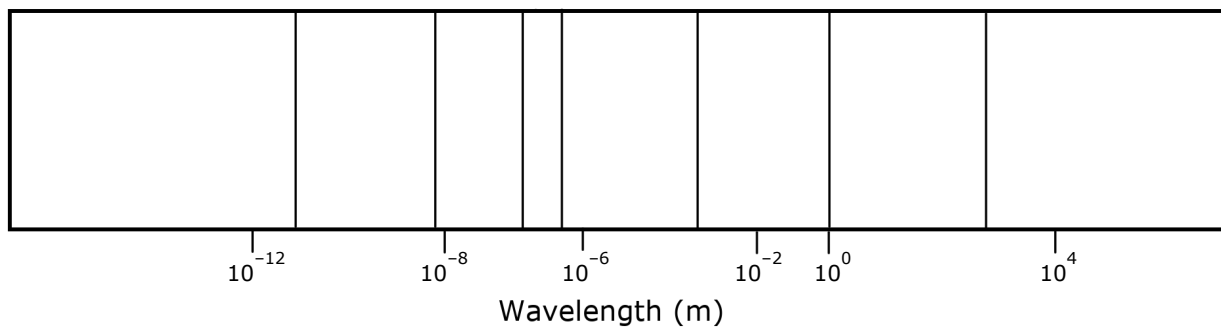
(b) Which of the following corresponds to an atomic absorption spectrum?
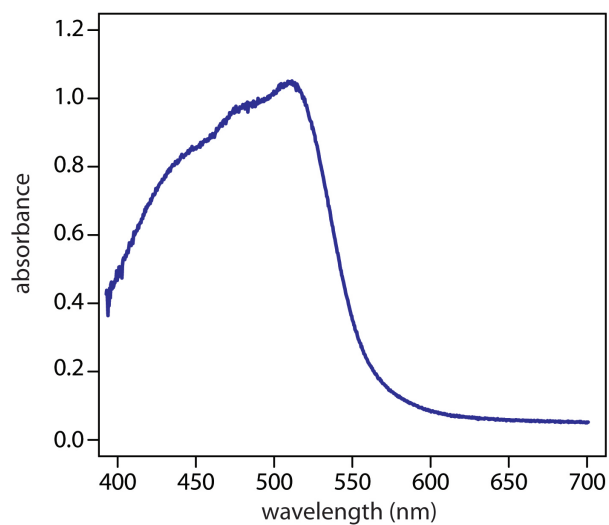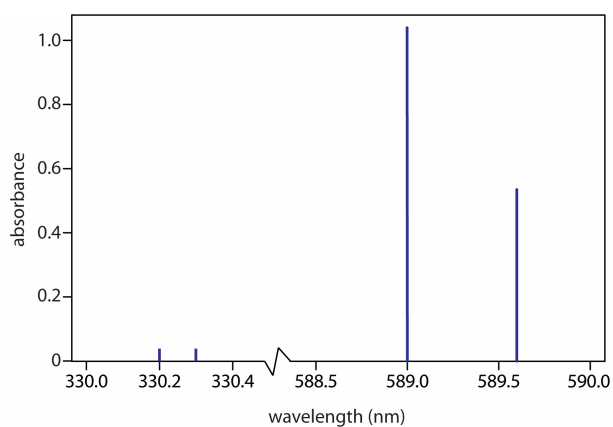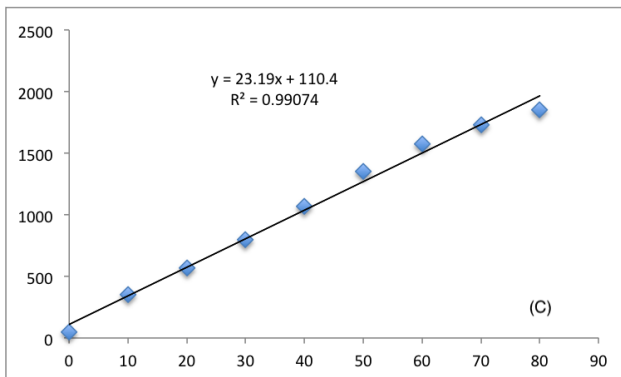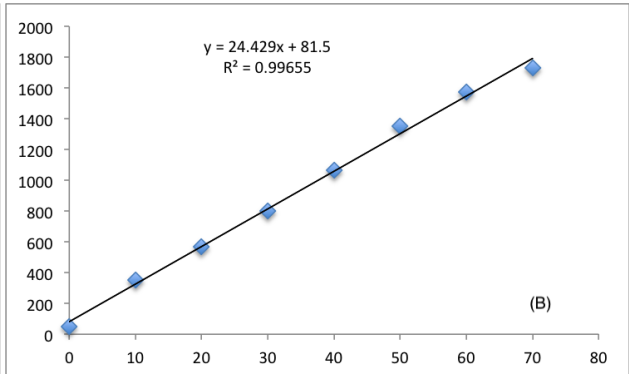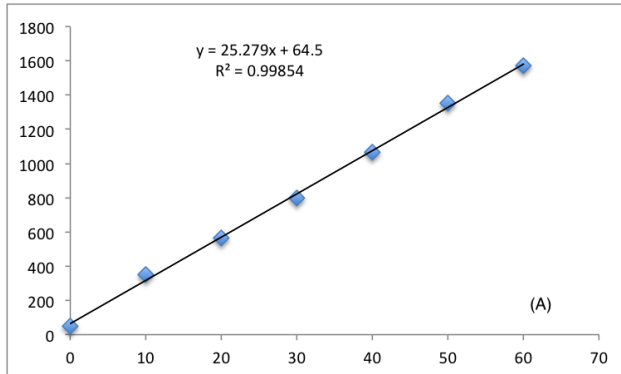

(c) Given a molar absorptivity of 8435 $M^{-1}cm^{-1}$ and an absorbance of 0.3547, calculate the concentration and the percent transmission of the sample.

(d) Why does the molar absorptivity have the units that it does in the previous problem? How would the units change if you wanted a concentration in mg/L?
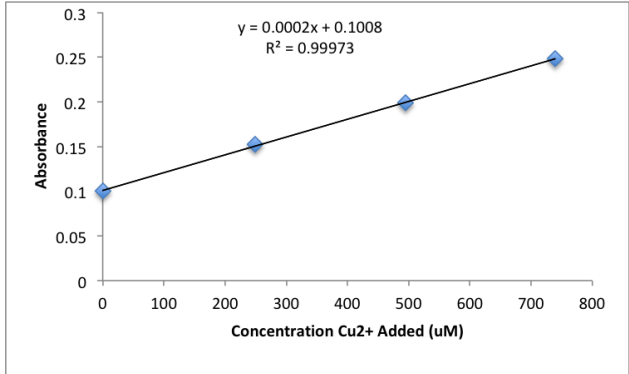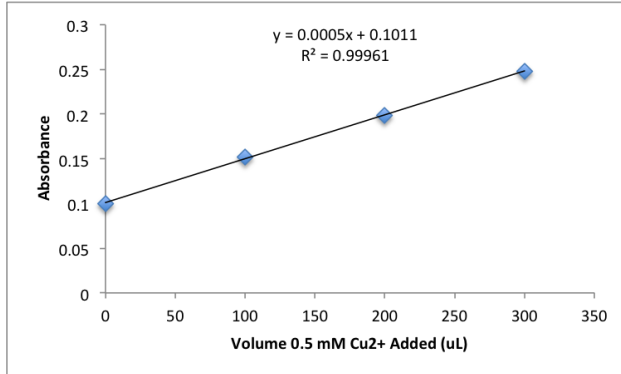
5. Quality Assurance and Standard Additions

   (a) Using the table and graphs below, determine the a) minimum detectable signal, b) the linear
       dynamic range, c) the lower limit of detection, d) the lower limit of quantitiation, e) the missing
       concentrations, f) the IPC and LFSM recoveries, and g) the relative deviation between the samples.

Sample	Concentration	Signal
Blank	0	50
Blank	0	46
Blank	0	54
Low Std 1	5	167
Low Std 2	5	177
Low Std 2	5	172
Std 1	10	350
Std 2	20	566
Std 3	30	800
Std 4	40	1067
Std 5	50	1354
Std 6	60	1573
Std 7	70	1732
Std 8	80	1850
Std 9	90	1950
Std 10	100	2100
IPC	45	1215
LFSM	+10	1558
Sample		1221
Duplicate Sample		1208

(A) $y = 25.279x + 64.5$, $R^2 = 0.99854$

(B) $y = 24.429x + 81.5$, $R^2 = 0.99655$

(C) $y = 23.19x + 110.4$, $R^2 = 0.99074$

(D) $y = 21.84x + 146.4$, $R^2 = 0.98246$
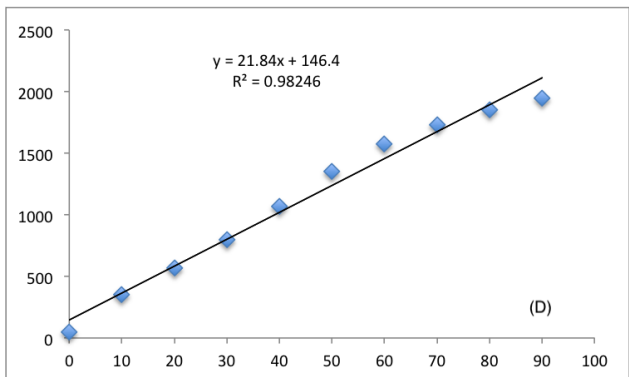
(b) If the samples in the previous problem had absorbances of 2000, could you have used your calibration curve? Why or why not?

(c) Using the standard additions curves below, calculate the concentration of Cu^{2+} in the sample, given the sample volume is 20mL, the concentration of the spiking solution is 0.5mM, and the fact that the solution has not been diluted.

Left plot: y = 0.0005x + 0.1011, R^2 = 0.99961, x-axis: Volume 0.5 mM Cu2+ Added (uL), y-axis: Absorbance

Right plot: y = 0.0002x + 0.1008, R^2 = 0.99973, x-axis: Concentration Cu2+ Added (uM), y-axis: Absorbance

(d) What types of conditions make the method of standard additions necessary?