Name:_____

1. You are asked to measure the percent iron in a steel sample you believe to be about 85% Fe by mass. You dissolve four replicate samples in nitric acid and dilute them by mass to a concentration of 3 mg Fe L^{-1} for analysis by Flame AA. You begin by dissolving 1.0000 g of steel and dilute it to a final volume of 50 mL. Then you dilute an aliquot of your solution to a final volume of 100 mL for analysis.

(10 pts) Calculate the concentration (in mg L^{-1}) of the initial solution and the volume of the aliquot required to make the final solution for analysis. BE SURE TO NEATLY WRITE OUT ALL CALCULATIONS INCLUDING UNITS OR YOU WILL NOT RECEIVE CREDIT.

(10 pts) Is this a reasonable dilution scheme considering the equipment available in this course? If not, suggest another scheme and compare the relative merit of each.

2. You weigh the volume of water delivered by an automatic pipette 10 times. The pipette is adjusted to deliver 4.50 mL. The mass of the water delivered was found to be 4.62 $\pm$ 0.08 g. Assume the density of water is 1.00 g cm^{-1}.

(2 pts) Define random error.

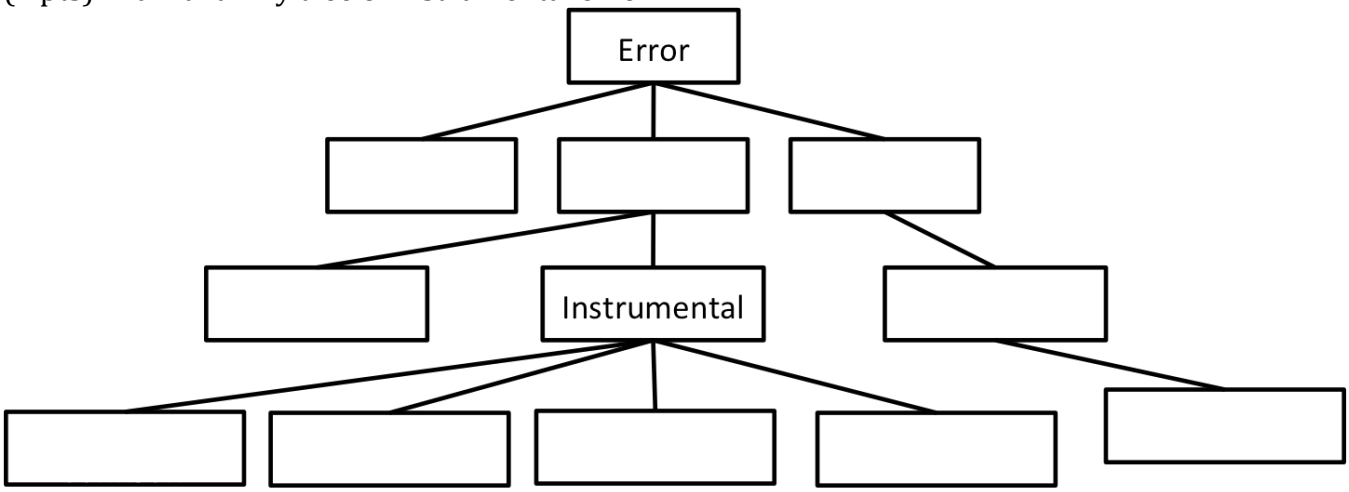
(2 pts) Do you observe evidence of random error in the measurement described above? If yes, what is the magnitude of the error?

(2 pts) Do you observe evidence of systematic error in the measurement described above? If yes, what is the magnitude of the error?

(2 pts) Compare the relative difficulty of detecting and quantifying random and systematic error.

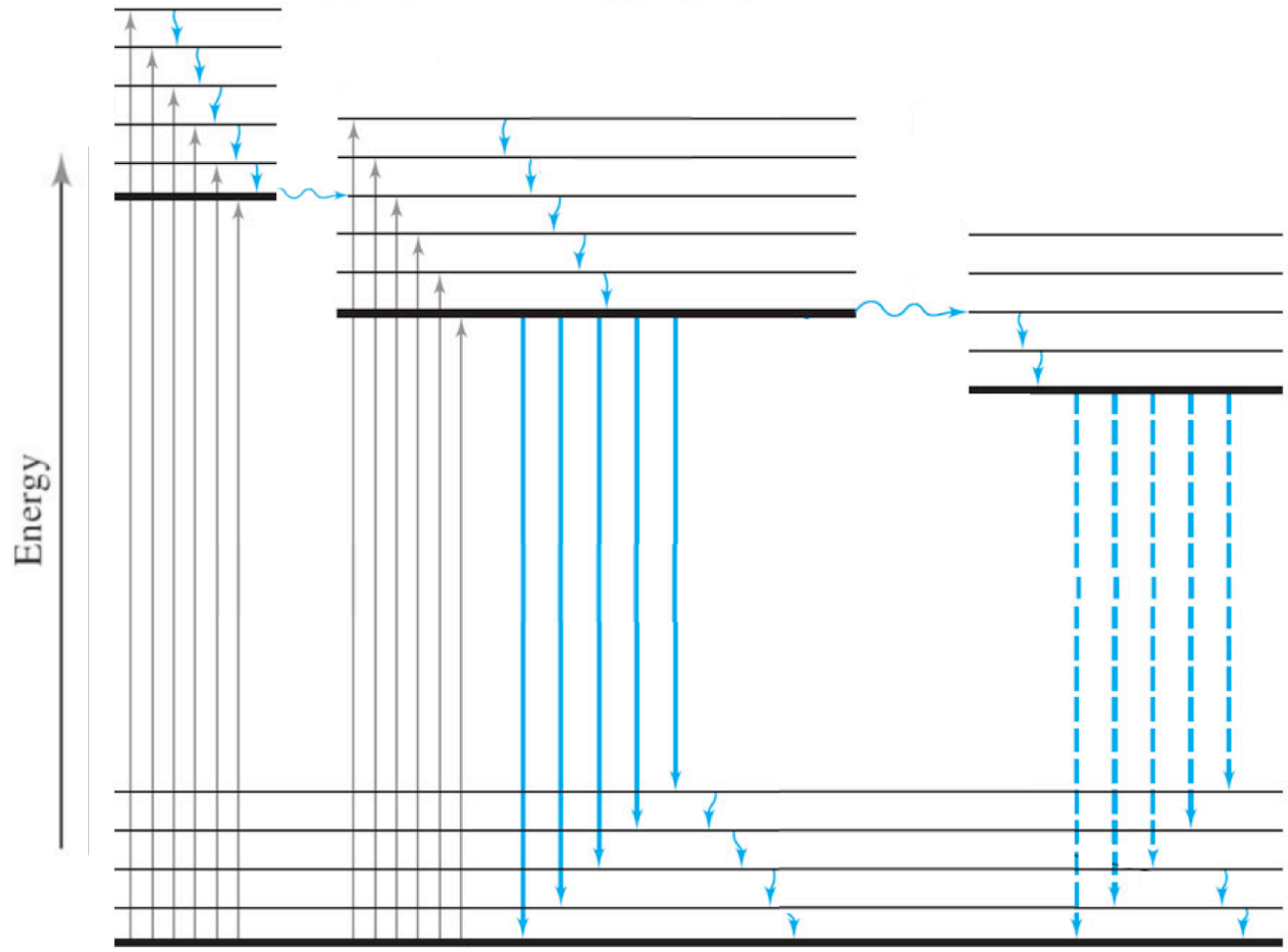
(2 pts) List at least four ways you could assess a method for systematic error.

(7 pts) Draw a family tree of instrumental error.



(3 pts) Provide a 1-sentence description of 3 of the 4 types of instrumental error you listed above.

4. (10 pts) Label the Jablonksi diagram below.
Indicate the excited and ground singlet and triplet states.
Indicate the following transitions: absorption, fluorescence, phosphorescence, nonradiative decay, internal conversion and intersystem crossing.
Label the transitions probed by at least 4 types of spectroscopy studied.



5. (2 pt each) State the identity of each instrument shown on the computer screen. Then describe the distinguishing features of the instrument that helped you with the identification.

ID	Instrument	Distinguishing Features
Ex.	Atomic fluorescence	Fluorescence: Bent geometry Atomic: no excitation monochromator
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		

(2 pts) What is the advantage of double beam instruments?

(4 pts ea) Select two instruments from the previous page. Draw a box diagram of the instrument, label each part and describe what purpose it serves. Then suggest an appropriate source, wavelength selector, and detector.

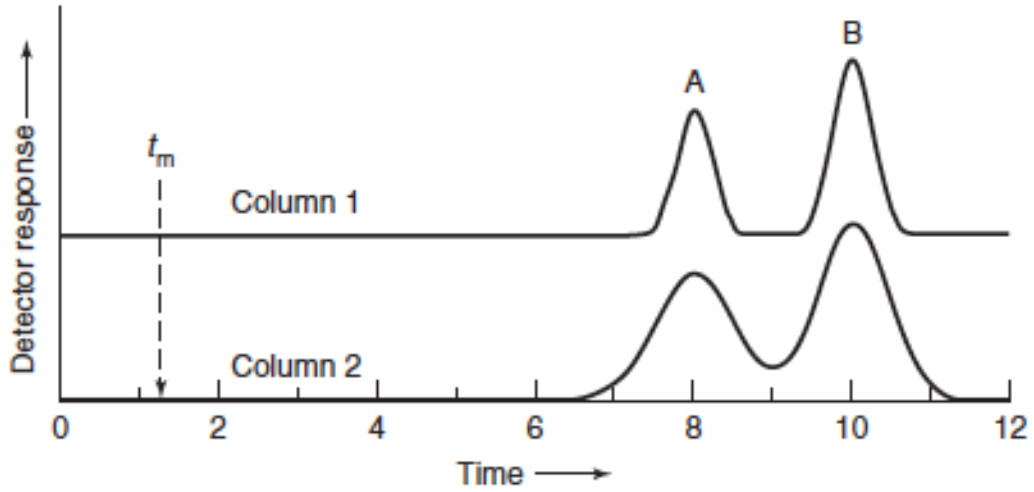
Instrument:

source	Wavelength selection	detector

Instrument:

source	Wavelength selection	detector

6. Chromatograms of compounds A and B (shown below) were obtained at the same flow rate with two columns of equal length. (1 pt ea)



Which column has more theoretical plates? Why?

Which column has a larger plate height? Why?

Which column gives higher resolution? Why?

Which column gives a greater relative retention? Why?

Which compound has a higher retention factors? Why?

Which compound has a greater partition coefficient? Why?

What is the numerical value of the unadjusted retention? Why?

(6 pts) Estimate the resolution of compounds A and B in each column. Is quantitative resolution achieved? Use a ruler to assist in estimating the needed values from the chromatogram.

(5 pts) Diagram, label, and describe the function of each component of a HPLC.

(2 pts) Suggest two detectors that can be used in conjunction with this instrument.