Chem 454 – Exam 1 – February 14, 2005
100 total points
You are more likely to obtain partial credit if you clearly label your work.

1] What are the differences between an analyte versus a sample. Define both terms. (5 points)

2] What is the mean and the standard deviation for the following set of data? (15 points)

1.57   1.71   1.63   1.69   1.52   1.88

3] Which of those values in problem 2 can be dropped based on solid statistical grounds. Assume a 90% confidence limit. (5 points)

N	Q
3	0.94
4	0.76
5	0.64
6	0.56
7	0.51

4] What is the 90% confidence limit interval for the values in problem 2? (5 points)

df	50%	90	95
4	.741	2.132	2.776
5	.727	2.015	2.571
6	.718	1.943	2.447
7	.711	1.895	2.365

5] A pH electrode responds to a solution of pH 4.223 with 522.1 mV. What is the pH of an unknown solution that gives a voltage of 623.7 mV with that same electrode? (10 points)

6] Sketch a diagram of a functioning Ag/AgCl reference electrode. Also write down the important half reaction(s) involved with this electrode (5 points)

7] What is voltammetry? What would appear on the x and y axes in a typical voltammogram? (5 points)

8] Describe the source for the background in voltammetry. (5 points)

9] Why are three electrodes used in voltammetry and what are those electrodes? (10 points)

10] Sketch and label the major components of an absorption spectrophotometer. (5 points)

11] The following diagram applies to the questions below (25 points).

S_2

S_1

S_0

IC   VR   IS   VR T_1 EC   EC   VR   VR
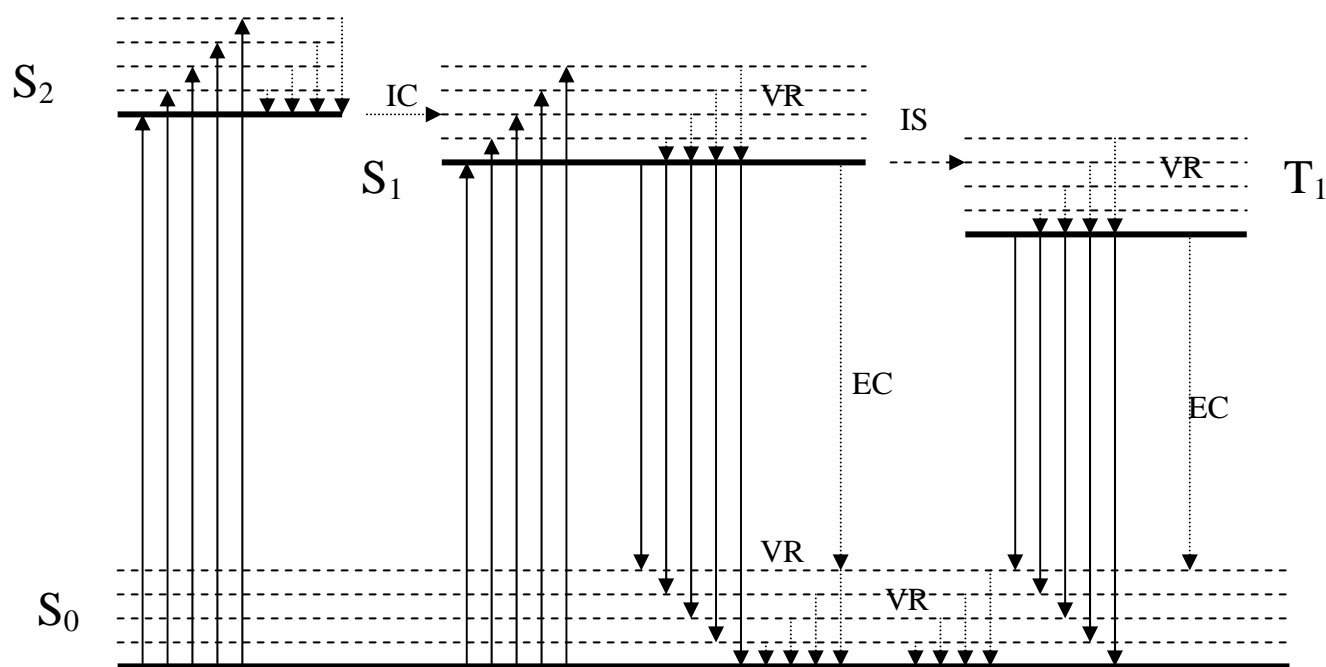
a) Clearly label the transition(s) which represent absorption.

b) Clearly label the transition(s) which represent fluorescence.

c) Clearly label the transition(s) which represent phosphorescence.

d) Why does VR represent and why is it necessary for relaxation transitions?

e) What is EC and does it do for signals based on relaxation mechanisms?

12] A standard solution of 11.6 mM of compound XYZ gave an absorbance of 0.447. A spike of 1.00 mL was added to a 10.00 mL of this standard solution. The absorbance of that spiked solution is 0.512. Full credit is given for the correct setup necessary for the solution of the unknown. (5 points)

Extra Credit – What is the concentration of that unknown? (5 points)

Chem 454 – Spring 2005 – Exam 2

100 total points. $\dfrac{N_j}{N_0} = \dfrac{P_j}{P_0} e^{-\frac{E_j}{kT}}$ $k = 1.28 \times 10^{-23}$ J/K

1] Using the example of CO_2, draw two vibrational modes, one that is Raman active and another that is IR active. (5 points)

2] Draw the major features of the Michelson interferometer. Label the moveable and the stationary mirrors of this device. Also label the source and the detector. Illustrate the optical paths with arrows indicating the direction of the photon flux. Why is there usually a laser in this device? (15 points)

3] List and explain three advantages of FT-IR over dispersive instruments. (10 points)

4] Which of the following would you classify the best analytical technique for the determination of Pb in drinking water? (5 points)

    a) IR   b) Raman   c) Flame AA   d) AF

5] Using an electronic energy diagram, draw and label the transitions associated with Stokes, Anti-Stokes, and Rayleigh scatterings. Rank the three in terms of probability. Which of the three is considered the Raman effect? (10 points)

6] What is meant by the term "pumping" when discussing lasers? (5 points)

7] Sketch the 4 major components of a CCD array UV-vis spectrometer. What does CCD stand for? How do configurations of the CCD and the photodiode arrays differ from one another? (10 points)

8] Why are gratings preferred over prisms in research-grade spectrometers and spectrophotometers? (10 points)

9] Suppose you are analyzing the concentration of ethanol (CH_3CH_2OH) in water in approximately the 1-5% m/m range. Which of the techniques you studied for this exam would you use and why? (10 points)

10] How and why do the refractory oxides affect atomic absorption spectroscopic analyses? (10 points)

11] An unknown element X was analyzed by AA spectrometry. The unknown was mixed with a 985.0 µg/mL standard solution of X. The results are reported below.

Volume of unknown (mL)	Volume of standard (mL)	Total volume after dilution (mL)	Absorbance at 566 nm
10.0	0	100.0	0.112
10.0	5.00	100.0	0.492

What is the concentration of that unknown? (10 points)