

CHEM 221
Instrumental Analysis
EXAM #2

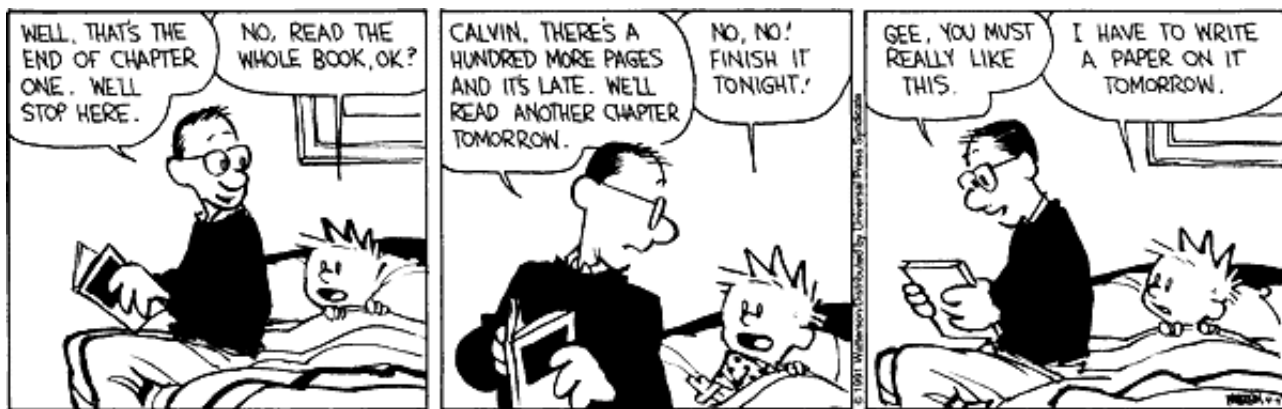
March 26, 2003

Name: _____

INSTRUCTIONS: Read through the entire exam before you begin. Answer all of the questions. For questions involving calculations, show **all** of your work -- **HOW** you arrived at a particular answer is **MORE** important than the answer itself!

The entire exam is worth a total of 200 points. Provided are a periodic table and a formula sheet jam-packed with useful stuff!

Good Luck!



1. **a. (20 pts)** The Pd 4,4'-bis(dimethylamino)thiobenzophenone complex, in aqueous solution, absorbs very strongly in the UV/Vis spectral region, with a molar absorptivity of 2.12×10^5 . Assuming that the minimum measurable absorbance is 0.010 and that a cell with a 2.50-cm pathlength is available, what is the lowest possible concentration (**ppb**) of Pd that can be determined spectrophotometrically?

b. (15 pts) Assuming that the readout uncertainty of the spectrophotometer is $\pm 0.10\%$ -T, what is the %-relative uncertainty in making an absorbance measurement of 0.010?

c. (15 pts) Assuming that the Pd 4,4'-bis(dimethylamino)thiobenzophenone system follows Beer's Law in this concentration range, calculate the detection limit for Pd with this system (i.e., the concentration of Pd, in ppb, that would give a $S/N = 3$).

d. (10 pts) Assuming that the Pd 4,4'-bis(dimethylamino)thiobenzophenone absorption bandwidth is 50 nm and the monochromator $\Delta\lambda_{\text{eff}}$ is 5 nm, what effect would a 10x increase in the slitwidth of the monochromator have on the applicability of Beer's Law with this system? Illustrate with a Beer's Law plot.

- c. **(15 pts)** Calculate the distance (cm) that the moving mirror needs to travel in order to "barely resolve" the two copper emission lines at 2199.58 Å and 2199.75 Å.
- d. **(5 pts)** If the moving mirror in the interferometer travels at a velocity of 0.50 cm/sec, how long does it take to acquire a single interferogram capable of resolving the two copper lines (in part c, above)?
- e. **(10 pts)** Give two advantages (relative to dispersive spectrometry) to using FT-interferometry to acquire spectra.

4. QUICKIES - No more than 2 sentences! – 10 points each

a. Diffraction gratings are usually used with a small angle of diffraction (θ). Give the most significant advantage and the most significant disadvantage of using a small angle θ .

b. Why is the sky blue? (This is a *serious* question!)

c. What is usually the most likely decay route to the ground state after a molecule or atom absorbs a photon of electromagnetic radiation (EMR)? Does this decay process result in the emission of a photon of EMR?

BONUS! EXTRA CREDIT! – 10 points, maximum

Where (city and state) was the Pittsburgh Conference (PittCon) held this year?

Where (city and state) and *in what year* was the **first** Pittsburgh Conference held?

The first Pittsburgh Conference had 14 exhibitors and 56 technical papers, but this year's Pittcon had more than 1300 exhibitors and more than 1200 technical papers! If one were to stop at EACH of the 1300 exhibitors' booth(s), how much time (minutes) would you be able to spend with each exhibitor if you spent 30 hours (the number of hours that the exhibition hall is open during the entire conference) visiting exhibitor booths?

This year, there were two conference plenary lectures, one by a recent Nobel Laureate (and analytical chemist!) and the other by a very distinguished and well known analytical chemist. Name each of these distinguished lecturers and identify the analytical research area common to both.