CHEM 322 **Name**__________________________________
Exam 4 **Fall 2009**

Due by 5:00 PM Friday, December 11
NO LATE PAPERS ACCEPTED!

Complete these problems on separate paper and staple it to these sheets when you are finished. Please put your name or initials on each sheet as well. Clearly mark your answers. YOU MUST SHOW YOUR WORK TO RECEIVE CREDIT.

Instructions

- This is **NOT** an open-book, open-note take exam. You MAY NOT consult any human or nonhuman resource besides Dr. Lamp as you complete the exam. This exam MUST be completed INDIVIDUALLY and in your own words. Group work or plagiarism will result in a zero for the exam.
- You will be allowed to ask Dr. Lamp a maximum of two (2) questions regarding the exam. Additional questions may be asked at a 3-point penalty per question. If you are working on the exam in the evening, you may try to reach Dr. Lamp on his cell phone at 660-341-0067 before 10:00 PM.
- Before opening the exam, prepare for it like you would for a traditional, in-class exam. Review concepts and examples from the text, as well as those discussed in class. This preparation will help to maximize your effort on the exam and allow you to complete it more efficiently.

Time Restriction

You may spend no more than two (2) hours working on this exam. This <u>must</u> be in one continuous block of time. You are on your honor to adhere to this restriction and record the time spent in the chart below.

Date	Time Began	Time Finished	Total Time
Total Time Spent on the Exam			

Pledge

I pledge on my honor that I have completed the exam in accordance with the above instructions and that I have not provided or received unethical assistance. I realize that failure to comply with these instructions will result in a score of zero on the exam.

____ ________________
Signature Date

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Warm-up (2 points each)

1. An ___________________________________ is an instrument that uses the combination of a coarsely ruled grating and a prism to achieve wavelength resolution by dispersing light in two dimensions.

2. An inductively coupled plasma is produced by interaction of ionized __________________ gas with an induced radio-frequency magnetic field.

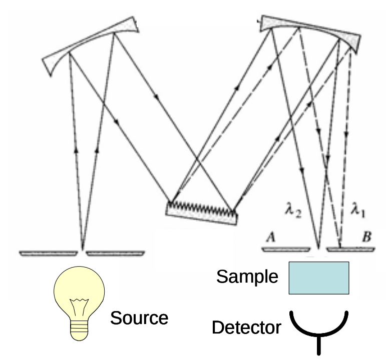
Complete seven of the following, be concise. Clearly indicate which problem is not to be graded. (14 points each)

3. Briefly compare and contrast 2 of the following 3 items:
   a. linear dispersion versus angular dispersion
   b. deuterium arc lamp versus tungsten lamp
   c. stray light versus scattered light

4. Compare and contrast the operation of a PMT versus a PDA as a detector in a spectroscopic measurement, as well as any benefits or challenges associated with each device. Feel free to use well-labeled sketches to clarify your discussion.

5. Suggest reasons why spectrophotometric precision is poorer:
   a. when the absorbance is near zero,
   b. when the absorbance is greater then three.

6. There is currently a great deal of interest in decreasing the size of traditional bench-top instruments, resulting in small, portable analytical devices. This is true for optical instruments as well, leading to the development of devices like the Ocean Optics spectrometers we use in several courses. Typically, the resolution for these small instruments is poorer than that for traditional bench-top devices. Discuss possible reasons for this observation. For convenience, you may want to consider "large" and "small" versions of the design at the right.



7. Beer's law is theoretically valid only if monochromatic radiation is used. In practice, it is impossible to deliver truly "monochromatic" radiation. What components of the spectrophotometer determine how monochromatic the incident beam is? What will the impact be for a quantitative measurement if the beam is too polychromatic?

8. Draw and label a diagram of an instrument used for flame atomic emission spectroscopy of solution-phase samples. How would a ICP-AES instrument differ?

9. Why does the identity of flame components and fuel to oxidant ratio play a major role in detectability and sensitivity for atomic spectroscopy?

10. Describe the operation of a pneumatic nebulizer and graphite furnace atomizer as sample introduction methods for AAS. Specifically note the benefits and challenges of each sample introduction technique.

11. You have been given the task of establishing the detection limits for the determination of several elements using atomic spectroscopy. The data below are the detection limits in ppb that were determined for Flame AAS, Flame AES, GFAAS and ICP-AES for two elements. Your colleague is somewhat confused by the different behavior of each element. Clearly explain the trends in the data, including why the trends for the two elements are different. (15 points)

Element	Flame AAS	GFAAS	Flame AES	ICP AES
K	1	0.004	0.01	30
Ag	0.9	0.001	2	0.2

Possibly Useful Information

$\eta_1\sin\theta_1 = \eta_2\sin\theta_2$	$R = \frac{\lambda}{\Delta\lambda} = nN$
Planck's Constant = 6.63×10^{-34} Js	$c = 3.00 \times 10^{8}\ ms^{-1}$
$\Delta\lambda_{eff} = wD^{-1}$	$n\lambda = d(\sin i + \sin r)$
$D = \frac{dy}{d\lambda} = F\frac{dr}{d\lambda}$	$\frac{dr}{d\lambda} = \frac{n}{d\cos r}$
$T = P/P_0$	$D^{-1} = 1/D$
$A = -\log T = \log(P_0/P) = \varepsilon bc$	$E = \frac{hc}{\lambda}$