



8) Light Scattering

9) LASER

10) Light dispersing grating

Part II Short Essay: (10 points each)

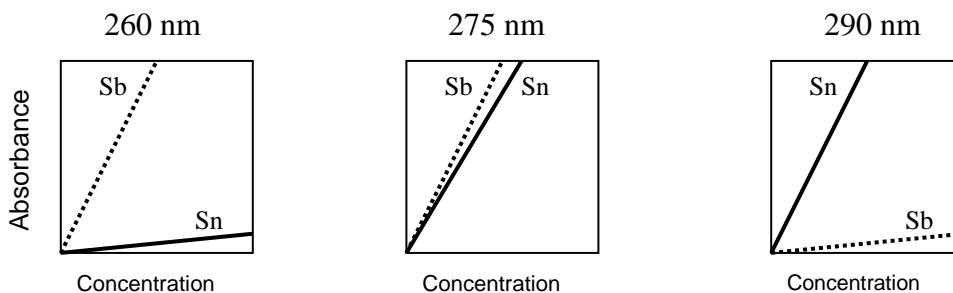
- 1) Describe in detail the construction and operation principle of a photo multiplier tube
- 2) Draw and explain the function of each component of a generic space-resolved double beam UV-VIS spectrometer. Justify the choice of components and the proposed optical layout.
- 3) Give a detailed explanation using energy diagrams for the processes of emission, absorption and fluorescence. State the differences between each one and elaborate on the differences between atomic vs. molecular transitions.
- 4) Why do we have a lot of UV skin protection products but no IR protection ones?

Ok, Let's re-phrase the question!

Show (calculate) why IR light at 1600 nm produces only rotational and vibrational molecular transitions while UV radiation at 254 nm produces transitions involving bonding electrons.

Part III Problems: (20 points each)

- 1) The following data show the results of the analysis of an antimony sample by atomic absorption spectroscopy using tin as internal standard. To check the interferences between the two elements, calibration curves were constructed at three different wavelengths as follows:



With this in mind:

- a) Suppose you have to detect both components at once. Fill in the blanks in the table for the wavelengths you selected to conduct the analysis to avoid interference between Sb and Sn. Comment on calibration sensitivity and selectivity

[Sb] ppb	[Sn] ppb	Sb absorbance measured at ____ nm	Sn absorbance measured at ____ nm
1	10	0.0101	1.010
5	10	0.0496	0.960
10	10	0.110	1.000
20	10	0.200	0.990
100	10	0.987	1.050
Blank	10	0.0005	1.001
Unknown	10	0.125	0.751

Now, using the rest of the data shown above please answer the following questions:

- b) Use the provided graph paper to plot an Internal Standard (IS) based Calibration Curve.  
 c) If the equation for the calibration curve is :

$$y = 0.0935x + 0.007 \quad r^2 = 0.9996$$

What is the antimony concentration for you unknown?

- 2) Since we were hired to do this analysis routinely we have some numbers to do some statistics on the quality of the data. You are in charge of generating the report using the following numbers gathered from two different instruments:

Nominal [Sb] (ppb)	Calculated [Sb] concentrations (ppb)	
	Perkin Elmer AA	Hewlett Packard ICP
10	10.0	10.01
10	10.4	10.22
10	10.3	10.11
10	9.80	9.990
10	9.40	9.870
10	9.66	10.03
10	9.28	10.07
10	10.6	10.21
10	9.40	10.00
10	9.50	10.04
0	0.21	0.05
0	0.30	0.03
0	0.44	0.04
0	0.10	0.00
0	0.15	0.06

You need to report:

- Average Sb concentration, absolute standard deviation ( $s$ ), and % Relative Standard Deviation (%RSD)
- % Relative Percent Difference (%RPD) for each instrument

Now you have to answer these questions:

- Are any of the instruments biased? In which direction?
- Discuss the accuracy and precision of the results from each instrument. Which will be your recommendation for future analysis?

Things you may need: (FORMULAS WILL BE GIVEN IN THE TEST, PLEASE USE THE BOOK TO GET THEM)

Speed of light (c)	$3.0 \times 10^8$ m/s
Plank Constant (h)	$6.6254 \times 10^{-34}$ joule second

Absolute standard deviation (s)

Relative Standard Deviation (RSD)

Absoulte Error (E)

