

Chem 310
Review topics for the 1st Hour Exam
Topics I - XI

I, II, III & IV. MEASUREMENT METHODS.

Definitions: analyte; sample; blank; standard; sensitivity; dynamic range; precision; accuracy; random and systematic error; limit of detection (LOD); limit of quantitation (LOQ); matrix effects; signal-to-noise. Note: a formula is not a definition.

Concepts: What are the 5 techniques for reducing matrix effects? What is an absolute method? What are calibration curves? What is standard addition? What are the 4 types of instrument noise? What strategies can be used to enhance S/N?

Calculations: From replicate measurements of one sample, calculate the mean, standard deviation, RSD and S/N. From calibration curve data, calculate sensitivity. Given sensitivity and the standard deviation of the blank, calculate LOD and LOQ. Calculate concentration from calibration curve or standard addition data for any method for which the signal is linear in concentration; be able to state any necessary assumptions needed to do the calculations. Calculate the change in S/N with N (# of measurements averaged).

V. BASIC OPTICS.

Definitions: Wavelengths and/or wavenumbers for the UV, VIS, near IR, mid-IR and far IR regions; index of refraction; optical dispersion; collimation; focal length and f# for convex lenses and concave mirrors.

Concepts: What optical materials are suitable for use in the UV, VIS + near IR, or IR regions?

Calculations: Snell's law; reflection losses for one or more interfaces given the indices of refraction.

VI. LIGHT SOURCES.

Definitions: continuum and line sources.

Concepts: What are the 3 common continuum sources? Over what spectral regions are they useful?

VII. DETECTORS.

Definitions: quantum and thermal detectors; MCT, CTD, CCD, DTGS.

Concepts: What are the 4 types of quantum detectors? How does a PMT work (include a sketch)? Why are vacuum phototubes and PMTs blind to IR wavelengths?

VIII. OPTICAL FILTERS.

Definitions: cutoff, bandpass & interference filters.

Calculations: the wavelengths associated with each order in an interference filter, given the thickness and index of refraction of the dielectric layer.

IX. MONOCHROMATORS.

Definitions: monochromator; angular dispersion; bandwidth; resolution; throughput; focal length and $f\#$; echellette and echelle gratings; blaze wavelength; stray light.

Concepts: What are the 5 basic elements of a monochromator? Sketch the Czerny-Turner monochromator with either a planar or a concave grating. How is the wavelength scanned? How is stray light reduced? How is a grating matched to a spectral range? Why must cutoff filters be used with grating monochromators?

Calculations: Calculate the minimum Resolution needed to resolve two spectral lines. Calculate the wavelength of a given order from the grating equation. Calculate the maximum theoretical resolution of a grating.

X. QUANTITATIVE ANALYSIS BY SPECTROSCOPY.

Definitions: Beer's law plot, isosbestic point.

Concepts: Sketch an energy state diagram showing absorption of light to form an electronic or a vibrational excited state. What assumptions must be true for Beer's law to be valid? What are the factors (both general and instrumental) that cause deviations from linearity in a Beer's law plot? How is an absorption spectrum distorted if the bandwidth of the monochromator is too large?

Calculations: Conversion between T , $\%T$ and A ; Beer's law calculations for one or two analytes; sensitivity from a Beer's law plot.

XI. UV/VIS SPECTROMETERS

Definitions: single and double beam spectrometers, multichannel spectrometers.

Concepts: Sketch a single beam, double beam or multichannel spectrometer. What determines the wavelength range of these instruments? What determines the bandpass? What are the common sources and detectors, and in which spectral domains are they used? What are the advantages of the double beam design? What are the advantages of the multichannel design?