

Analytic Chemistry Cumulative Exam

January 17th, 2019

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1) (10 points) absorbs a photon of energy 5.94×10^{-20} J. What spectral region (X-ray, UV-vis, IR, microwave) is this in? _____

(Planck constant = 6.626×10^{-34} Js; Speed of light = 3.0×10^8 m/s)

2) (10 points) Choose A-D for the following processes:

Raman scattering (); Photon-induced Fluorescence ()

A. One photon process B. two photon process

C. Three photon process D. Four photon process

3) (40 points) You have finally graduated from UIC (in 2024 or 2025) with a Ph.D. You go to a job interview with Company "Surface". Part of the interview consists in answering the following questions. (10 pts each).

Name a good technique to image the surface of a copolymer and briefly describe how it works.

Name a good technique to determine the structure of a reconstructed clean surface and briefly describe how it works.

Name a good technique to find the geometry of a molecule adsorbed on a surface and briefly describe how it works.

Name a good technique to measure the size of atomic-size defects on a Si surface and briefly describe how it works.

4) (20 points) You are running a spectroscopy experiment using 532nm laser. A sharp peak and a broad peak were brought to your attention. A sharp peak is at 572nm, and the broad peak is at 600nm. Assuming the sharp peak is a Raman scattering peak, and the broad peak is a fluorescence peak. When you switch the excited laser with a 514nm laser. What are the new peak positions for this Raman scattering peak and fluorescence peak? (Planck constant= 6.626×10^{-34} Js; Speed of light= 3.0×10^8 m/s)

5) (20 points) UV-vis and IR absorption as well as much fluorescence are linear in concentration but have different design elements, signal to noise, sampling needs and restrictions and applications. **Answer questions below, briefly:**

- a. Why are FTIRs single beam and UV-vis double beam (for the most part)?
- b. Discuss why UV is more commonly used for quantitative analyses and IR for qualitative analyses.
- c. Demonstrate (quantitatively) the absorbance limits for a fluorescence measurement to be linear in concentration.
- d. Discuss why UV-vis spectrometers have two sources but one detector but (research level) FTIRs often have one source and multiple detectors.