Analytic Chemistry Cumulative Exam

Feb 6th, 2020

Dr. Nan Jiang

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

1) (12 points) Express 500nm, as Frequency, as a wavenumber, and an energy in joules, electron volts.

2) (10 points) Emission and luminescence techniques both involve the measurement of the emission of photons from excited species. What makes these techniques different?

3) (18 points) A beam of 632.8 nm photons from a He-Ne laser strikes a detector area of 5.0 mm^2. The laser has a flux of 3.18×10^{15} photons s^{-1}.

(a) What is the laser radiant power in watts?

(b) What is the laser irradiance at the detector?

(c) Express the answer for part (b) in term of photons s^{-1} rather than watts.

4) (12 points) Calculate the numerical aperture and F/n for a fiber optic with core and cladding refractive indices of 1.50 and 1.48, respectively.

5) (24 points) A grating has a groove density of 1500 grooves per mm. If the incident beam strikes the grating at an angle of 20.0 degree.

(a) What diffraction angles will the first order of 400, 500, 600am appear?

(b) What wavelength in the second order overlaps the 600 nm first-order beam?

(c) What is the free spectral range for the first order at 600 nm?

6) (24 points) A point source of radiant intensity 1.0 W sr^{-1} is placed at the focal point of a 1.0-cm-diameter F/6.0 lens. Calculate the following value:

(a) The focal length of the lens.

(b) The solid angle collected by the lens.

(c) The radiant emittance of the collimated beam (ignore transmission losses).