Chemistry 620
Analytical Spectroscopy
PROBLEM SET 5: Due 03/20/08

1. At a recent birthday party, a young friend (elementary school) noticed that multicolored rings form across the surface of soap bubbles. Explain the source of the colored rings to your friend. Be complete and precise, but answer in clear terms (avoiding jargon) that anyone can understand. Draw a diagram that illustrates your answer.

2. For a Fabry-Perot intererometer, when the cavity spacing is set to 0.540 cm, calculate three visible wavelengths close to 600 nm that would be transmitted. How large are the mode orders?

3. Calculate the cavity spacing (d) needed to set a Fabry-Perot interferometer to pass λ = 351 nm in the 10,000th order assuming the dielectric between the reflective plates is air, the mirror reflectances are 0.925 and the beam falls on the device at normal incidence. Calculate the free spectral range, full-width at half-maximum (also the resolution) in wavelength and frequency units.

4. One of the most widely used monochrometer (spectrometer) designs is the Czernzy-Turner (CT) design. Do some investigating and make a list of up to five monochromator designs. Your list should include diagrams of each of the designs and a brief explanation of the advantages and disadvantages of the device relative to the CT design.

5. Derive an expression for the throughput of a reflective grating monochromator, then compute the radiant power of a beam passed through the monochromator in part at 532 nm if the spectral radiance of the source is 0.5 W cm^{-2} sr^{-1} nm^{-1} and the features of the grating are given in the list below.

W = 2.00 mm	d = 0.5 μm groove^{-1}
H = 5.00 mm	θ_{in} = 10o
F/# = 3.7	f = 0.25 m

6. The Michelson interferometer is one of the most widely used interferometer designs making spectral measurements. Describe the construction, operation and relative performance of a second interferometer of your choice, excluding the Fabry-Perot.

7. The cavity lifetime described in Section 3 was derived assuming that all losses are reflective. It is clear that scattering, diffraction and absorption losses affect cavity performance. Derive an expression for the cavity lifetime that includes such losses.

8. One of your responsibilities in your new position at Wonderful Instrument Company is to interface with the heads of other departments as the company prepares to release products. Please respond to the following memo.

September 15, 2007

To: Leader, Spectrometer Development Group
From: V.P., Marketing
Re: Resolution

We have been working with our advertising consultants on the layouts for the product brochures and print media ads. The documentation sent by your people uses the terms resolution and resolving power. While it is clear that they are not exactly the same thing, they seem related. What is the distinction between these two terms? Please advise us on when and how to use these two terms correctly. Thank you for your prompt response.