

Quiz #6Assignment: due 10pm, Friday 16 April 2010

1. A diffraction grating has 1.26×10^4 rulings uniformly spaced over width $w=25.4\text{mm}$. It is illuminated at normal incidence by yellow light from a sodium vapor lamp. This light contains two closely spaced emission lines (a.k.a. the sodium doublet) of wavelengths 589.00 and 589.59nm.
 - a) At what angle does the first order maximum occur (on either side of the center of the diffraction pattern) for the $\lambda=589.00\text{nm}$?
 - b) Calculate the angular separation between two lines in the first order.
 - c) What is the least number of rulings a grating can have and still be able to resolve the sodium doublet in the first order?

2. Assume that the limits of the visible spectrum are arbitrarily chosen as 430 and 680nm. Calculate the number of rulings per millimeter of a grating that will spread the first order spectrum through an angle of 20.0° .

3. A beam of light consisting of wavelength from 460.0 to 640.0 nm is directed perpendicularly onto a transmission diffraction grating with 160 lines/mm.
 - a) What is the lowest order that is overlapped by another order?
 - b) What is the highest order for which the complete λ range of the beam is present?
 - c) In that highest order, at what angle does the light at 460.0nm appear?
 - d) In that highest order, at what angle does the light at 640.0nm appear?
 - e) What is the greatest angle at which the light at 460nm appears?

4.
 - a) White light falls normally on a transmission grating with 1000 lines per centimeter. At what angle will red light (650nm) emerge in the first order? At what angle will yellow light (550nm) emerge?
 - b) What are the dispersion D and resolving power R for the first and second order for both lines?

5.
 - a) What is the angular separation between the second-order principal maximum and the neighboring minimum on either side for the Fraunhofer pattern of 24-groove grating having a groove separation of 10^{-3} cm and illuminated by light of 600nm?
 - b) What slightly longer or slightly shorter λ would have its second-order maximum on top of the minimum adjacent to the second-order maximum of 600nm light?
 - c) From results in parts a) and b), calculate the resolving power in the second order. Compare it with the theoretical grating resolving power.

6. (Extra) A high resolution grating 260mm wide, with 300 lines per millimeter, at about 75° a resolving power of just about $R=10^6$ for $\lambda=500\text{nm}$. Find its free spectral range. How do these values of R and $(\Delta\lambda)_{fsr}$ compare with those of a Fabry-Perot etalon having a 1cm air gap and finesse of 25?