Balmer spectroscopy Pre-Lab

After reading Melissinos (2003) chapters 1.4, 1.5, and 6.1 (especially 6.3.2, 6.3.3 and 6.3.4) , as well as the experiment Guide, answer the following questions:

1. Why use a Hg vapor discharge tube initially in setting up your experiment, rather than the HD tube you will use in the final experiment?

2. Sketch how a simple grating spectrograph works in first order. How many groves per mm in the diffraction grating do you need at optical wavelengths (~600nm) and why?

3. Your spectrograph disperses light of different wavelengths into beams at different angles. In your apparatus what adjustable hardware sets the wavelength resolution?

4. Your spectrum of H mixed with D in a discharge tube has pairs of emission lines. Explain why the D line in the pair is always shifted to the red.

5. What is the purpose of the light chopper at the input of your spectrograph?

6. You try unsuccessfully to detect (at a good signal-to-noise level) a blue DH pair. How could a phase sensitive detector improve the S/N ratio?

7. In a motorized scan of the spectrograph through your weak lines, with a 0.1 sec integration time on your phase-sensitive detector, you estimate a S/N ratio of only two. If you want a S/N ratio of four, how long will you have to integrate with your phase-sensitive detector?

8. You want to get the highest precision possible in fitting for the wavelength separation of the two emission lines. If your slowest scan takes 100 seconds to scan through 4 Angstroms covering the two lines, what is the maximum integration time you could use? Why? Hint: consider the steepest part of the line shape.

9. Assuming only the ratio of proton to electron mass (1836.15), express the result you seek in this experiment, the Hydrogen to Deuterium mass ratio, in terms of your measured quantity: $\Delta\lambda/\lambda$. You will have to do some algebra, and expand 1/(1-x) for small x.