Diffraction of light

Procedure 1

Take two pen (or pencils), put them together so that there is a small aperture (hole) between them. To do that you may put several (1-3) layers of thing tape at two end of one of the pens. Look through the slit at a flashlight bulb from a distance of 15-20 feet in darkened room. See how what you see changes as you squeeze the pens together.

At one point when the separation between pens becomes very small you should see stripes developed to the sides of the bulb. This happens due to diffraction. Depict schematically what you see below for vertical and horizontal orientation of the pens.

Pens are vertical   Pens are horizontal

On the picture above indicate which side of the first diffraction peak is more red and which on is more blue. The angle of diffraction θ is given by the wavelength of light λ and size of the aperture a: $\sin\theta = \lambda / a$. Based on this which color (blue or red) has shorter wavelength: ____________________.

When you see the diffraction and squeeze the pens tighter together does diffraction angle increase or decrease: _____________________.

Observe diffraction of light from a laser pointer on a slit formed by two razor blades. Below depict schematically how the light propagates in two cases (with and without diffraction). In which case the size of the slit larger: __________________________.

Procedure 2

To amplify diffraction gratings are used. They are multiple slits placed right next to each other. They all produce the diffraction patterns similar to that of a single slit. When placed together their diffraction patterns amplify each other and as a result much stronger first diffraction peak is observed. The diffraction angle is given by the distance between two slits and wavelength.

Draw below how white light diffract on a grating. Indicate which side of the first diffraction peak is red and which one is blue.

We will estimate the size between grooves on CD and DVD disks using diffraction. Place a CD at a given distance from a blackboard with the data side parallel to the blackboard (12 inches is a good distance). Point the laser pointer to the CD, keep it perpendicular to the blackboard and make sure that not diffracted peak comes back to the laser pointer. Mark the position of the first diffracted peak. On a separate sheet of paper draw *to scale* the schematics of the experiment. Measure the angle of diffraction, and calculate its sine function. From the diffraction formula, estimate the separation between the grooves (red laser pointers typically come in three wavelengths 670 nm, 650 nm, and 635 nm, we use 670 nm).

$d_{\mathrm{CD}} =$

How many CD disk grooves fit into one hair thickness (100 μm, http://en.wikipedia.org/wiki/Hair) __________________. Repeat the same procedure for the DVD disk

$d_{\mathrm{DVD}} =$

On the optical disks each bit of information is written in an area that has size of the order of d^2. On area A on a CD disk one can write approximately A/d_{CD}^2 bits of information, for a DVD disk about A/d_{DVD}^2. By how many times more information can be written on DVD because of smaller grooves spacing ______________.

Actual ratio of ratio DVD to CD capacity is even larger because better error correction algorithms are used there (less amounts of extra copies of information has to be written, http://www.howstuffworks.com/dvd.htm). In the future technology even smaller groove spacings will be used, which will allow to have even more information written on the discs of the same sizes.