Physics Lab 206 | Apr 2016
Quiz #6 | Light Wave Interference, Atomic Spectra

Name:

1) Giambattista della Porta has a green laser with wavelength 520 nm. He uses this laser to measure the slit width b and the slit space d of a double slit. The pattern he gets is shown in fig. 1. Each mark on the ruler is 2 mm and the distance between the double slit and the screen is 2.00 m.

a) Find the slit space. [**2 pts**]

b) Find the slit width. [**2 pts**]

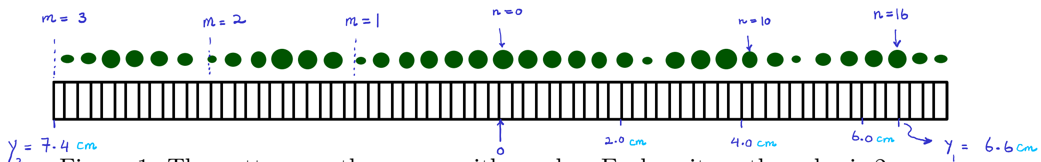


Figure 1: The pattern on the screen with a ruler. Each unit on the ruler is 2 mm.

a) $d \sin\theta = n\lambda$ $\quad \tan\theta = \frac{y_1}{2.00\ m} = \frac{6.6\ cm}{2.00\ m}$ for $n = 16$. & $\lambda = 520$ nm. → $d = 0.25$ mm.

b) $b \sin\theta = m\lambda$ $\quad \tan\theta = \frac{y_2}{2.00\ m} = \frac{7.4\ cm}{2.00\ m}$ for $m = 3$. & $\lambda = 520$ nm. → $b = 42$ μm.

2) James Franck uses the same setup as we used for the lab 'Atomic Spectra'. The diffraction gratings inside the spectroscope has 620 lines/mm. He uses the mercury lamp and puts the hairline on the green line. He uses a vernier to read the angle.

a) Read the angle with the precision ±0.1 deg using fig. 2. [**2 pts**]

b) Find the wavelength of this green line in the mercury's spectrum. [**2 pts**]

a) 19.8°.

b) $d \sin\theta = 1\,\lambda$

→ $\lambda = \frac{1.00\ mm}{620} \sin 19.8^\circ = 547$ nm.

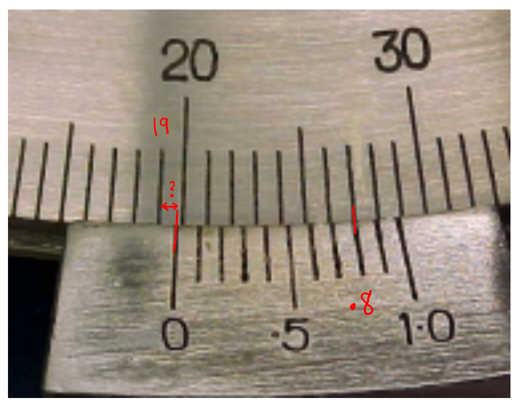
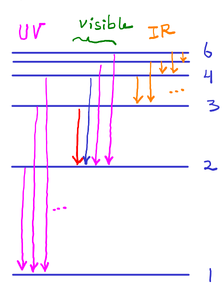


Figure 2: The angle of the green line in mercury.

3) Joseph von Fraunhofer uses an IR camera sensor, instead of human eye, to measure the hydrogen lines. This sensor can detect an IR range of wavelengths, 1000 nm to 10 μm. The spectrometer has a diffraction gratings of 60 lines/mm.

a) Find at least two of the hydrogen lines that can be measured with this device. Specify the upper energy level n_u and the lower energy level n_l. [**2 pts**]

b) Determine the angles for each one of the above lines you have found. [**2 pts**]



a) $\frac{1}{\lambda} = R_y \left(\frac{1}{n_l^2} - \frac{1}{n_u^2}\right)$

1. $n_u = 5$, $n_l = 4$ → $\lambda_1 = \frac{1/R_y}{1/16 - 1/25} = 4052$ nm.

2. $n_u = 4$, $n_l = 3$ → $\lambda_2 = \frac{1/R_y}{1/9 - 1/16} = 1875$ nm.

b) $d \sin\theta = 1\,\lambda$

$d = 16.7$ μm

→ $\theta_1 = 14.1^\circ$.

→ $\theta_2 = 6.5^\circ$.