Interference of Light Waves

Review the text book: chapter 24.6 Diffraction (pg.836) and chapter 24.8 The Diffraction Grating (pg.839)

- **Phys 1402:** Serway/Vuille: Sections. 24.6, 24.7, 24.8.
- **Phys 2426:** Serway/Jewett: Sections. 38.1, 38.2, 38.4

Diffraction grating and two-slit apparatus characterized by the spacing between lines/slits, *d*.
When monochromatic light goes through either of the above devices, beams of light emerge from the other side only at specific angles (Figure 1): $\boldsymbol{m\lambda = d \sin\theta}$, where m is a positive or negative integer, or zero.
The middle beam corresponds to $m = 0$. Beams on each side are symmetrically correspond to *m* of the same magnitude but opposite sign.
When the beams hit a screen, they appear as dots. We usually talk about the dots.
The maximum possible angle is, of course, 90°. Setting a value of m too high causes the angle to become impossible. To find the maximum m, set $\theta = 90°$, then round down.

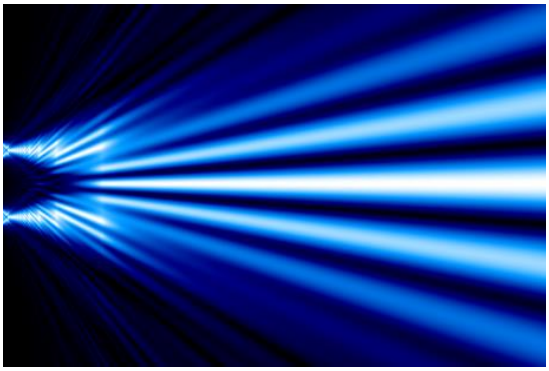

Figure 1: Graphic demonstration of the two-slit interference pattern. (*Image Source: IOP*)

1. The diffraction grating has 457 rulings per mm. What is the separation of slits for this diffraction grating? (2.189×10^{-6} m)

2. When light with a wavelength of 546 nm passes through a particular diffraction grating, a second order principal maximum is observed at an angle of 16°. What is the separation of this diffraction grating? (3.96 μm)

3. Light of 530 nm passing through a diffraction grating with a separation, $d = 8.5 \times 10^{-6}$ m creates an interference pattern on a screen 2.3 m away. What is the maximum number of bright fringes that it is possible to see? (Hint: Find the maximum *m* value. There are that many fringes on each side, plus one in the middle.) (33)

4. Light passing through a diffraction grating with a separation, $d = 8.5 \times 10^{-5}$ m creates an interference pattern on a screen 2.3 m away. If the 10th bright fringe above the central fringe is a linear distance of 12 cm from it, what is the wavelength of light used in the experiment?
(440 nm)

5. Light with a wavelength, $\lambda = 511$ nm forms a diffraction pattern after passing through a single-slit of width, $a = 2.20$ μm on a screen 2.31 m away. Find the angle associated with the second dark fringe above the central bright fringe and its linear distance on the screen from the central fringe. Hint: the condition of destructive interference for a single slit is $a\sin\theta = m\lambda$
(27.7°)