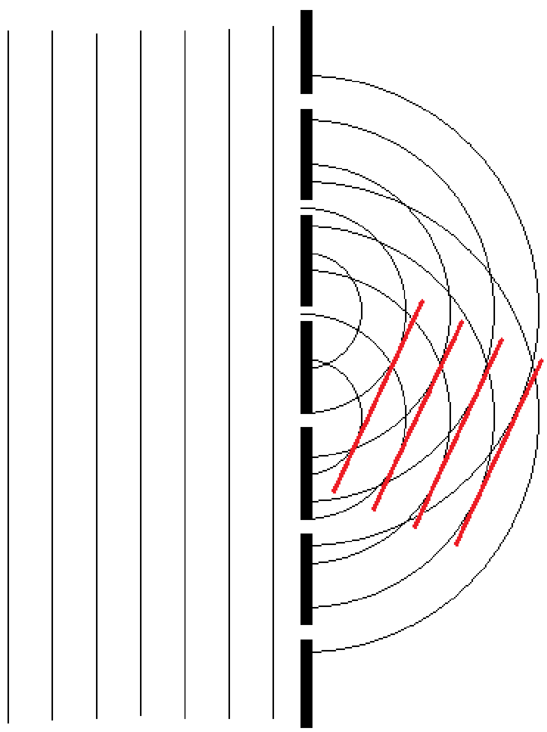
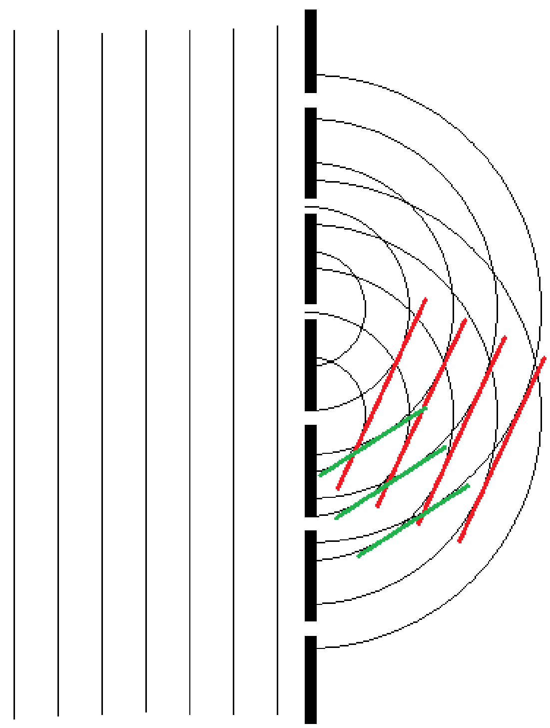
# Diffraction

| | |
|---|---|
| Soil screens | 3 |
| Laser & Power Supply | 1 |
| Dissecting Microscope | 1 |
| Optical Bench | 1 |
| Tracing Board | 1 |
| Flat Ruler | 1 |
| Tape Measure | 1 |
| Sharpie Marker | 1 |

Waves that travel through a series of slits are diffracted into a highly ordered pattern. Each slit produces its own diverging wave, and the peaks of waves from different slits can constructively interfere as in the figure below.



We're viewing a series of vertical slits from above, and a continuous plane wave is approaching from the left. Each slit emanates its own expanding cylindrical wave (the waves from only two slits are shown). The red lines indicate that in one particular direction, peaks of waves from two adjacent slits will constructively interfere even though they originate from different peaks in the original plane wave. Each of the other slits will also contribute a peak to the constructed wave in this direction (each from a different original peak), so that a strong wave will result in that direction. Another direction that will produce a strong wave is the one in which peaks add that are out of phase by multiples of TWO cycles (green lines in the figure below).

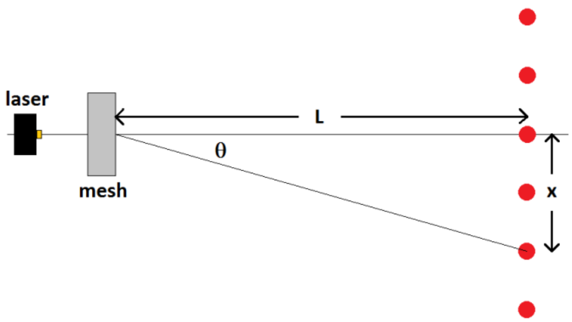


These directions of constructive interference are given by the following equation:

$$d \sin\theta = m\lambda$$

$d$ is the distance between adjacent slits, $\theta$ is the angle, $m = 0,1,2,3 \ldots$ is the order of the direction (we see orders 1 & 2 above), and $\lambda$ is the wavelength.

We'll be using a mesh in our experiment instead of slits, but the above equation will still apply. A mesh is like two crossed sets of slits, and so will cause light to be diffracted in two dimensions instead of one, and the angles in both dimensions will obey the above equation.




In the figure above the diffraction pattern due to the mesh is seen on the right. The angle $\theta$ is shown for the $m = 2$ peak (second peak from the central peak). $\theta$ can be determined from measurements of $x$ and $L$.

The meshes that we'll use are actually from sets of screens that soil scientists use for separating the particle sizes in a soil sample. The numbers on the screens relate to the fineness of the mesh. Higher numbers indicate a finer mesh (more wires per centimeter).

**Procedure:**

1. Mount the laser on the optical bench.
2. Place one of the screens in front of the laser so that the light shines through it.
3. Tape a piece of paper to the tracing screen and place it on the table across the aisle from yours (the group at that table will place their screen on your table).
4. Point the apparatus so that the diffraction pattern shines on the paper.
5. Measure the distance from the mesh to the screen. $L =$ __________
6. Trace the diffraction pattern using the Sharpie marker.
7. Measure the distance across the whole pattern, and from this calculate $x$ for $m = 1$ (the dots are evenly spaced).
8. Calculate $\theta$ using $\theta = x/L$ for the $m = 1$ peak.
9. Read the wavelength that's printed on the laser. $\lambda =$ __________
10. Use $d \sin\theta = m\lambda$ to find $d$, the distance between adjacent wires in the screen. Remember to be consistent with SI units.
11. The Mesh # is the number of wires per inch of its screen. From this find the number of wires per meter. By definition of the inch, $1\ in = 0.0254\ m$.
12. From the number of wires per meter, find $d$, the distance between two adjacent wire centers.
13. You have now calculated $d$ in two ways. Find the percent difference between the two values.
14. Repeat the entire procedure for the other 2 meshes.

| Mesh # | x | $\theta$ | d 1st | Wires per meter | d 2nd | % diff |
|---|---|---|---|---|---|---|
| 60 | | | | | | |
| 120 | | | | | | |
| 230 | | | | | | |