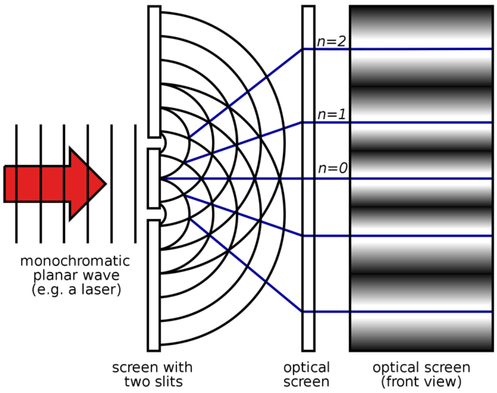
videos

3.5.2 More on single slit diffraction

Let us consider Young's double slit experiment, covered in Core Task 3.4.2.

In this experiment waves pass through two slits and produce a characteristic interference pattern.

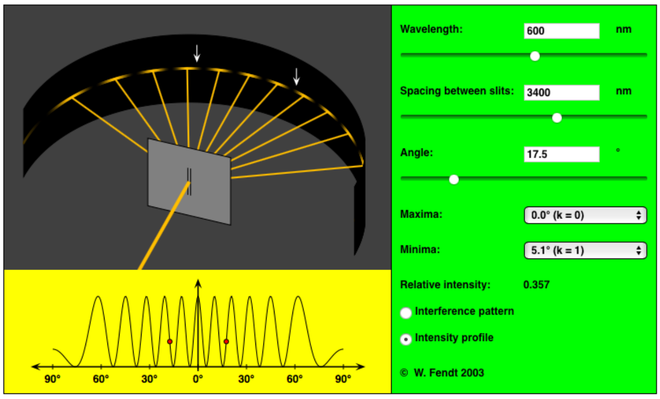


We see a bright central fringe and then further fringes off to either side.

However, we have seen in 3.5.1 that a single slit can also produce an interference pattern.

Take a look at the following simulation:

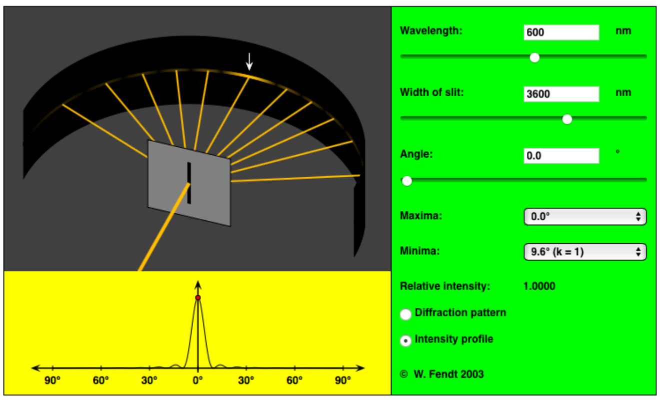
http://www.walter-fendt.de/html5/phen/doubleslit_en.htm



You will see that all the bright fringes have the same intensity. This is actually only true if the width of the individual slits is very small.

Next take a look at simulation for a single slit:

http://www.walter-fendt.de/html5/phen/singleslit_en.htm



You will see that the intensity falls off very strongly, so that the centre bright fringe is much brighter than the subsequent bright fringes.

What we find is that the width of the individual slits in the Young's double slit experiment modifies the intensity profile.

Run the following simulation:

http://www.wiley.com/college/halliday/0470469080/simulations/sim48/sim48.html

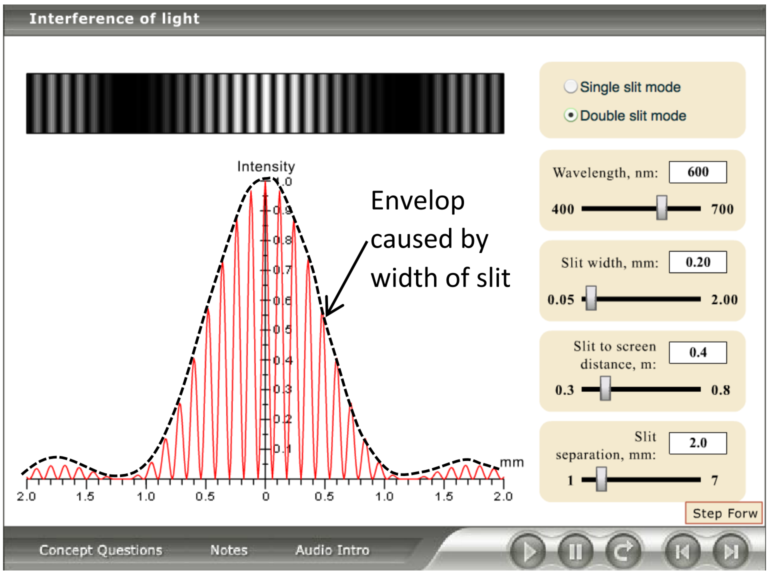
Choose the single slit mode.

(1)✐Now adjust the slit width. What happens to the intensity pattern as you move from a narrow slit to a wider slit?

Choose the double slit mode.

(2)✐Now adjust the slit width. What happens to the intensity pattern as you move from a narrow slit to a wider slit?

The outer envelope of the intensity pattern is modified by the individual slit width, whereas the inner pattern is modified by the double slit separation.



Look at the screen grab from this simulation.

The spacing of bright fringes in the double slit experiment is given by:

$$w = \frac{\lambda D}{s}$$

where λ=wavelength, D=slit to screen distance, s=slit separation

(3)✐Calculate the separation of bright fringes using the formula above and the data from the screen grab. Compare you answer to the separation shown in the intensity graph.

The width of the central bright fringe for a single slit is given by:

$$W = \frac{2\lambda D}{a}$$

where λ=wavelength, D=slit to screen distance, a=slit width

(4)✎Use this formula to calculate the width across the bright central fringes (look at the envelope). Compare your answer to that shown in the intensity graph.

White light

(5)✎What do you think happens when white light, consisting of different frequencies of light, are passed through a double slit? You might like to run the following simulation, changing the frequency of light.

http://www.walter-fendt.de/html5/phen/doubleslit_en.htm

Check you answer here:

https://www.itp.uni-hannover.de/~zawischa/ITP/multibeam.html