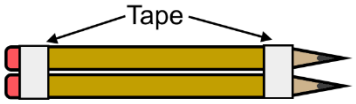
DIY Optical Diffraction Experiment

Queen's University Student Chapter

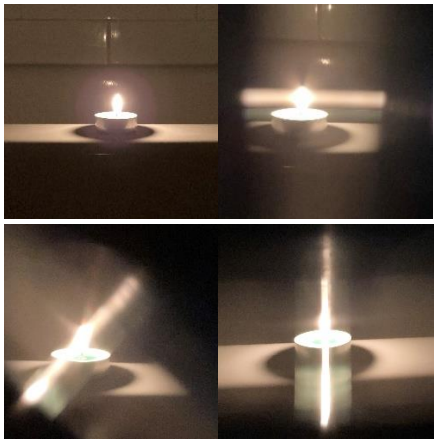
What you'll need: 2 pencils, scotch tape, a candle, and a camera (optional, to record your results!)

What you'll do:



1. Tape two pencils together at each end, forming a narrow gap (around 1 millimeter) between them.
2. With an adult's help, light the candle and stand back about a meter.
3. Holding up the pencils close to your eye, look at the candlelight through the gap. You should see the light from the candle 'smear out' into a line that is perpendicular to the pencils – physicists call this line a *diffraction pattern*!
4. Try rotating the pencils to different angles, and see how the diffraction pattern rotates along with the pencils. Squeeze the pencils together with your hands to adjust the width of the gap, and see how the pattern changes.
5. Optional: Hold up the pencils to the lens of your camera, and take pictures of the diffraction patterns you see! *You may need to clean the lens with a lens cloth, as any smudges on the lens can introduce their own diffraction effects.*

What you'll see:



The candle viewed normally, then viewed through vertical, diagonal, and horizontal slits.

Go further:

Try to guess what would happen if you viewed the candle through a tiny circular hole instead of a narrow gap. How would the diffraction pattern change? Try to figure out how you could test this hypothesis!

What's going on:

Normally, we think about light as travelling in a straight line. However, when light passes very close to an obstacle like a slit, it will *diffract*! There are two ways of thinking about this, depending on whether you imagine light as a *wave* or as a *particle.*

Classical "Wave" Description	Quantum "Particle" Description
Think of how waves move in water – if you drop something onto the surface at a particular point, the waves will move outward in a circle. Light waves behave in a similar way! Each point on the wave acts as a source of new circular wavelets. This is called **Huygen's principle.** By only allowing light to pass through a narrow slit, we are creating a 'point source'. The light from this source then moves outwards from the point in a circle, causing the light to spread out.	Quantum mechanics tells us that the *position* and *momentum* of a particle are linked in a very special way: if one of them is known very precisely, the other one must be somewhat uncertain. This is called the **uncertainty principle**. By forcing the light to pass through a thin slit, we are forcing it into a very precise position. This introduces some uncertainty to the momentum, causing it to spread out in many directions!