Horned-rimmed glasses
Put on the pair of horned-rimmed glasses.  Close your right eye and observe at your partner wearing the same glasses, looking specifically at their lenses. Draw and describe what you see.



Now close your left eye and observe at your partner wearing the same glasses, looking specifically at their lenses. Draw and describe what you see.

Round rimmed glasses

Put on the round rimmed of glasses.  Close your right eye and observe at your partner wearing the same glasses, looking specifically at their lenses. Draw and describe what you see.

Now close your left eye and observe at your partner wearing the same glasses, looking specifically at their lenses. Draw and describe what you see.

Quarknet: Activities with Lasers

In this activity you will be learning about lasers through direct observations of a running laser, and by performing a simulation of lasing in an atomic gas.

The Helium Neon Laser

## Anatomy of the Helium-Neon Laser



Figure 1
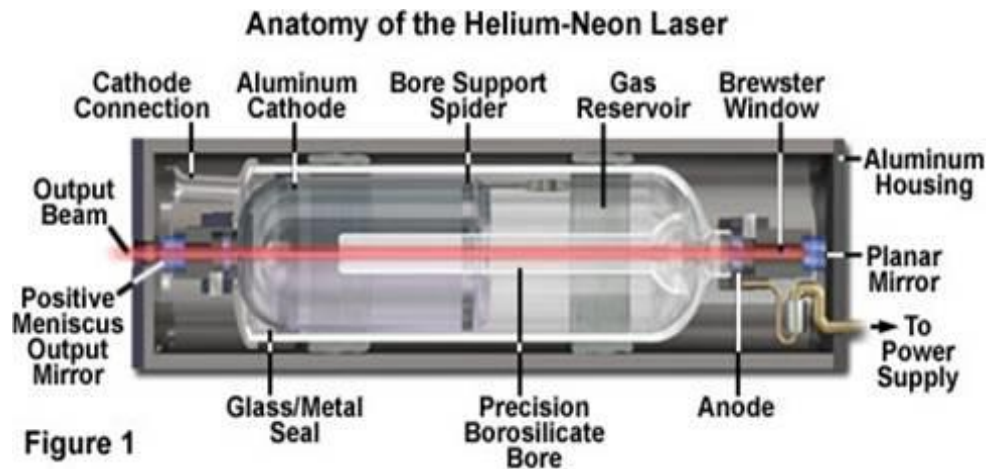
You instructor will show you the insides of a helium-neon laser while the laser is "lasing". You will be given a small diffraction grating. You instructor will guide you through the following observations and questions:

First, let's look at the light coming out from the side of the gas tube
- Look at the light coming out of the side of the gas filled tube with your eye only. Describe the color of this light.
- Look at the light coming out of the side of the gas filled tube with your diffraction grating. Do you see one color or many colors?

Now let's look at the laser beam emitted from the laser onto a card. SAFETY: do not have the laser beam go directly into your eye!
- Your instructor will put a card in front of the laser to see the laser spot. What is the color of the laser spot?
- Your instructor will put a diffraction grating between the laser and the card. Do you see one color or many colors?

Laser Simulation

For this demo we will be using a simulation developed by PhET at the University of Colorado, Boulder. The purpose of this simulation is to alter the parameters of the gain medium and cavity properties in order to get lasing. Open the Lasers simulation and choose the Multiple Atom (Lasing) tab. Enable mirrors and set mirror reflectivity to 90%. In the laser tube there are atoms that can be excited. The number on the atom shows which state it is in. The energy diagram to the right shows the population of atoms in a given state. The "Lamp" is the laser pump which is used to shown above the laser tube. You can control the wavelength and intensity of the lamp. The lasing state of this laser is from State 2 to State 1.
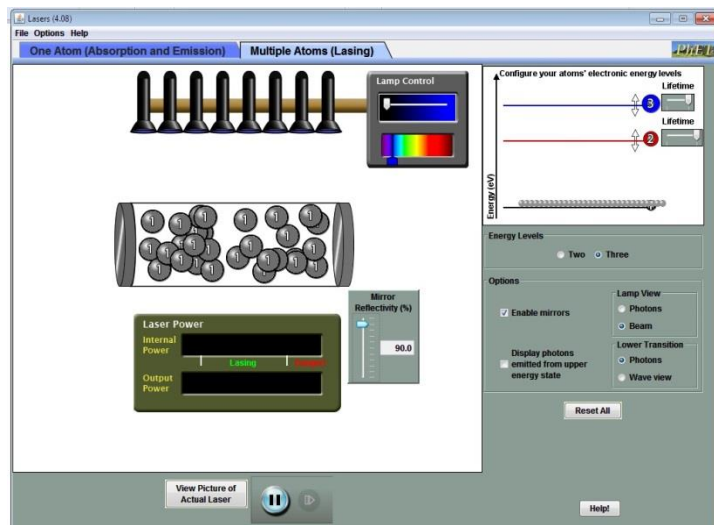


Set the lamp wavelength to blue. Increase the lamp intensity to maximum and observe what happens. You will see little blue and red balls. These balls are the photons emitted from the excited atoms.

- Describe what happens once the intensity is its maximum.
- What is the difference between the red and blue photons?

Your laser should not lase at this point. The reason why is the lifetimes of the excited states are not suited to hold a population inversion. Look at the "lifetimes" at the energy levels.

- You can adjust the lifetimes of States 2 and 3. To get a lasing how would you adjust the lifetimes of these states?
- Which state would be called the metastable state?
- Does your laser lase? Write down the parameters for your laser.



Congratulations, you have made a laser lase! You are now an official junior laser jock. The laser you made is pumped at a blue wavelength and lases at a red wavelength.

The simulation has many other neat features, for example you change the energy levels of the atoms in the energy level diagram. The best part of this simulation is that it is free to download at http://phet.colorado.edu/en/simulations/category/physics .

Try to do the following the laser simulation:

- Make your laser explode! The laser will explode from too much power built up in the cavity under the right conditions.
- Make your laser lase at a green lamp wavelength.
- Make your laser lase with the smallest mirror reflectivity.
- Try to make a laser that lases at a blue wavelength.
- Try to make a total population inversion.
- Make the laser blow up with the lowest mirror reflectivity.