SOME PARTICIPANT QUESTIONS FROM OSA'S OPTICS AT HOME WITH JUDY AND NANCY

1. With the spectrometer and the laptop screen, am i supposed to see just red and green for yellow and just purple for purple?

The screen has three colors- red, green and blue (although the exact shade depends somewhat on the device). Yellow is made by combining red and green. Purple is a combination of red and blue. The exact shade (like, is it purple or pink?) depends on the relative brightness of the red and blue light sources. Here's a photo showing the mixing of colored light:

https://en.wikipedia.org/wiki/RGB_color_model#/media/File:RGB_illumination.jpg

2. Why does the spectrum have only red orange yellow green and blue? Why not brown black and pink?

Some colors don't appear in the spectrum of white light but are called "composite" colors. For "additive" colors (like the light sources on the screen on a laptop or tablet) the primary colors are red, green, and blue. You can think of this as three tiny lights that are turned on and off with varying brightness. The colors add to make a new color. Brown is made by adding red and green with a certain amount (brightness) of each color.

Color printers on the other hand use "subractive" colors: cyan, magenta, yellow and black. These colors are mixed together (like paint) and absorb light, you see what is reflected. Brown is made by adding red, yellow and black. The color pink is made like purple- some combination of red and blue, with just the right amount of each to make it pink, not purple. Black is the absence of color, all light is absorbed and nothing is reflected. In reality some small amount of light is reflected so you can still see a black object.

3. Can we do underwater photography using a spectroscope?

Yes, scientist do use underwater spectroscopy in several applications. The composition of underwater objects can be determined by using a process similar to the one we talked about that is used for rocks on Mars. A powerful laser pulse strikes a target and makes a plasma (hot glowing gas) that is then analyzed by the spectrometer. It has been used to study artifacts in underwater archeological parks.

4. Can you use the spectroscope to detect components of gas/air? For example, detecting virus or other bad stuff in the air or someone's breathing?

Yes, for example methane gas leaks can be detected using infrared spectroscopy because methane absorbs specific wavelengths of infrared light. A paper by Christopher F. Fronczek and Jeong-Yeol Yoon, *Biosensors for Monitoring Airborne Pathogens (2015,)* describes a cell phone based system for detecting pathogens that could use types of spectroscopy among other detection technologies to find pathogens in air

5. What is a laser made of?

A LASER, which stands for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation, can be made of many different materials as long as they allow "stimulated emission of radiation" to happen. Lasers have 3 essential parts:

1. A lasing material (may be a solid, liquid, or gas) called the lasing medium,
2. a source of energy (like light or electricity) that excites the atoms or molecules of the material,
3. and a "resonator" or "cavity" that allows the light to be amplified, or made brighter, by passing back and forth.

The first working laser's medium was a ruby rod, and the chromium ions in the host material of the rod made the laser light. The atoms were energized by a bright flash lamp. Since then (1960), lasers have been made with gases (for example, neon, argon or carbon dioxide), liquids dyes, solids like the ruby rod but with atoms of neodymium or holmium, for example, and semiconductor materials. Each material produces light with its own characteristic wavelength.

For stimulated emission to work, the atom or molecule is excited to an energy state where it can stay excited for a while, sort of like the glow-in-the-dark materials that keep emitting light even after the light source is turned off. Eventually one atom (or molecule) loses the excess energy and gives off a photon of light. When that photon passes by a second excited atom or molecule it forces it to produce a second exact copy of itself- then there are two identical photons. This process repeats as the light passes back and forth in the cavity, building up until some of it escapes through the laser output. The cavity can be made of two mirrors, one of which is partly reflecting so that it lets some light through and reflects the rest. There's a very short PowerPoint animation on this page describing how a laser makes light. https://www.pblprojects.org/videos/