Geology
Period:

Name:
Date:

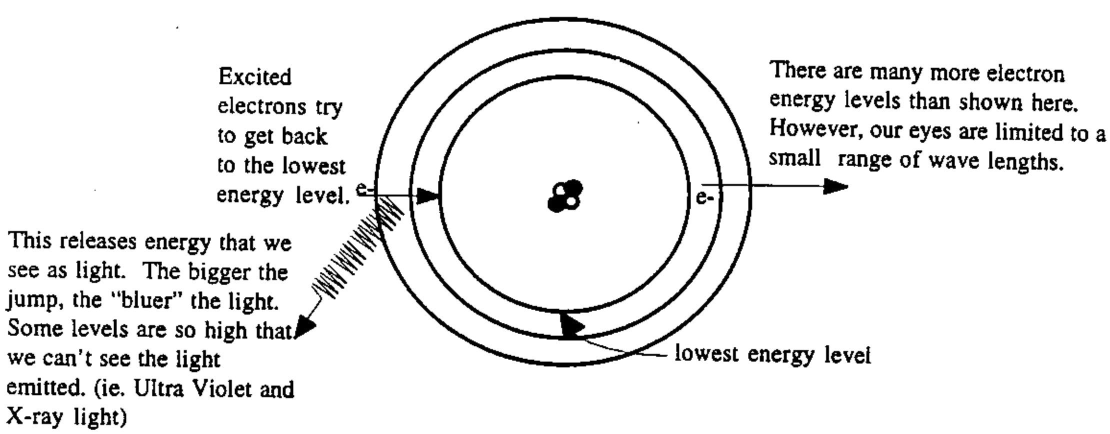
Spectroscope Lab

Purpose: To use a spectroscope to determine the elements present in a light source.

Materials: discharge tubes
spectroscope
colored pencils
Caution: Do not touch the ends of the discharge tube – shock danger.

Background:

The elements on the Periodic Table have electrons that circle around their nuclei. The electrons do not move in one perfect orbit. There are actually many different orbits (or levels) that they can be in. If an electron is energized, it will jump to a higher level.



Once the electron is no longer energized, it will fall in toward the nucleus and assume a lower energy level (orbit). When the electron falls to the lower energy level, it gives off some energy in the form of photon light. The amount of drop in electron energy levels will determine the type (color) of light that will come from the atom that is being excited. Higher energy levels cause electrons to fall farther and emit light closer to the blue side of the spectrum (400 nm); lower the energy levels cause electrons to fall a lesser distance and emit light closer to the red side of the spectrum. Blue light has a higher frequency than red light, and therefore contains more energy than red light.

Different elements give off different patterns of light (the different frequencies emitted have different colors associated with them). We usually see the different colors mixed together, allowing us to see only one color (a combination of all the colors emitted by the element). A spectroscope is able to split the light into its separate colors for us to look at. It works almost exactly like a prism. We are interested in seeing these different colors because we can determine which elements a star contains by examining its electromagnetic spectral pattern.

The different circles that we see in the atom drawn above represent different states of electron orbital excitation. In other words, different elements have different levels of electrons moving around the outside of the atom. These different levels of electrons make the different lines you will see in the spectroscope, as electrons are forced up, and then drop back down from one orbit to the next.

Procedure:

1. Turn the discharge tube on (turn it off when not in use – if the tubes get too hot they will burn out quickly).
2. Record the name of the gas (Helium and Hydrogen have been recorded for you.)
3. Underneath the name of the gas record the color it emits when the discharge tube is on, when viewed *without* the spectroscope.
4. Look at the gas through the spectroscope. Using your colored pencils, draw a picture of the spectral lines. Pay careful attention to the spacing between the colors.
5. Compare your drawings to the Spectrum Chart in front of the room.
6. Answer the following questions.

Questions:

1. Why are the spectra discrete lines instead of a continuous "rainbow" of colors?

2. What does each spectral line represent?

3. What causes the atoms of the gases in each of these tubes to produce the spectra you observed?

4. Why does every element give off a different spectral "fingerprint?"

5. Approximately how many different energy levels did you observe for Hydrogen?

6. Why are there more lines on the chart than you can see through the spectroscope?

7. Between Hydrogen and Helium, which has more electron energy levels in the visible spectra? How do you know this?

8. Why do you suppose Helium has an orange color when viewed without the spectroscope, while Mercury has more of a blue color? Explain.

9. Draw what the spectral lines might look like for a middle-aged star which contained about equal amounts of Hydrogen and Helium:

10. Are you looking at bright-line (emission) spectra, or dark-line (absorption) spectra?

11. What can spectral lines tell us about stars?

HYDROGEN

V 400 | B | G | Y | O | R 700

HELIUM

V 400 | B | G | Y | O | R 700

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V 400 | B | G | Y | O | R 700

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V 400 | B | G | Y | O | R 700

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V 400 | B | G | Y | O | R 700