TEACHER'S GUIDE: HYDROGEN EMISSION LINES

Purpose: Students observe the line spectra produced by hydrogen atoms. Students relate their observations to the idea of quantized energy in the atoms.

Materials:

- Gas Tube Light Socket
- Hydrogen gas lamp
- Spectroscopes or Diffraction slides

Procedures:

1. Give each student a spectroscope and explain how to use it. Have students observe the ceiling lights in your room. They should observe a continuous spectrum.
2. Turn the room lights off and the hydrogen lamp on. Have students observe the line spectra of hydrogen.
3. Turn the lights back on.

Concept questions for discussion:

1. Describe what you saw when you looked at the light coming from the hydrogen atoms. You may want to draw a picture and label it.
    a. A red line, bluish green line, a violet line(s)
2. The lamp socket provided electricity to the hydrogen lamp. What could the electricity be energizing within the hydrogen atoms? Electrons in the hydrogen atoms.
3. Based on your previous activities, what could happen to an electron in an atom if it gained energy? Leap to a higher energy level.
4. Do we know if electrons are ionized by the lamp? No, but it is possible.

Concept Questions:

1. What is the lowest potential energy value an electron can possess in a hydrogen atom?

    The ground state, $n=1$.

2. What is the highest potential energy value an electron can possess in a hydrogen atom?

    $n=\infty$

3. When an electron is in a state higher than its ground state it is described as being in an excited state. What principal numbers in Figure 1 represent excited states in a hydrogen atom? All n values greater than one.

4. If an electron in the ground state gained sufficient energy, what could happen to the electron? It could leap to a higher energy state.
5. If an electron in an excited state returned to the ground state, what would happen to the lost energy? It would lose energy and emit photons.
6. Where would the lost energy go and how would that energy be transported? Think about what you learned in the Photoelectric Effect activity. The lost energy would be carried off by photons.
7. Based on equation 1, write a statement that describes the relationship between the wavelength of photons and their energy. Photons of shorter wavelengths have higher energies.
8. According to Table 1, which type of radiation is made up of photons possessing the largest energies? UV
9. In Figure 2, which energy transition is the most energetic? $n=6 \rightarrow n=1$
10. In Figure 2, which energy transition is the least energetic? $n=6 \rightarrow n=5$
11. If you were looking at electrons transitioning from n=3 to n=2, what would you observe? (Refer to Figures 2 and 3) Red photons
12. Can you observe the Lyman series with your eyes? Explain. (Refer to Figure 2 and Table 1) No, the photons are outside the visible spectrum in the UV.
13. Does the hydrogen lamp emit photons from the Paschen series? (Hint: Is the light bulb hot?) If so, would you be able to see these photons? Yes, but they are in the IR spectrum so you could not see them. You can feel the heat of the IR photons.
14. When you observed the line spectra, why did you see a line of violet color? (Refer to Figures 2 and 3) This results from electrons transitioning from n=5 and n=6 to n=2. There are actually two lines produced but they are difficult to distinguish.
15. Why don't you see a yellow line in hydrogen's spectrum? Electron energy is quantized, and only certain energy transitions are possible. To create yellow photons requires a transition between allowed energy levels.

16. Based on Figure 2, explain the spectral lines you observed when you looked at the hydrogen lamp. The four lines come from the transitions from the third, fourth, fifth, and sixth energy shells down to the second shell.
17. Explain how your observations in this activity support the idea that electron energies are quantized. Only certain energy levels are allowed therefore only certain photons are produced and only certain lines appear in the spectrum. If energy was continuous, all photons would be produced and the spectrum would be continuous.