The Chemistry of Light Class: Al DeGennaro

Teacher's Guide

Goals

- To understand that different energies are associated with different photons
- To involve students in kinesthetic learning

The Class

Mr. DeGennaro demonstrates electronic transitions by letting students act out electrons, which give off light by throwing colored cards upon jumping from a higher electronic level. Thus they visualize the energy of light: the relationship between color and wavelength.

Lecture Notes

What is light made of?

We will use the same explanation that another famous scientist used; namely, Albert Einstein. He thought that light was made of photons.

Photons are tiny pieces of light.

Is visible light the only kind of light?

It's the only kind of light that people can see but there are other types of light (show the electromagnetic spectrum).

The lowest energy of light that we're going to deal with are radio waves.

When I turn the radio on, those radio waves are changed back to sound.

Do you realize that the radio waves from the radio transmitting station are going through your brains right now?

They have to be, because they're coming from Baltimore and going into my radio, and all of these people are in the way. Fortunately they have such low energy that you don't have to worry about it.

A more energetic light is the UV light. Where does the most famous UV light come from?

The sun gives off lots of UV light. Some of it gets through the atmosphere and hits the stuff on the ground.

Now, this is both bad news and some good news. Because if you have UV light which is far enough from visible light, then it is energetic enough to kill cells. We use it to kill germs which might be on our safety goggles. The cupboard has a lamp, which gives off UV.

What does this have to do with atoms?

Instructions

You will need several rigid buckets, or something similar, at different heights, and pieces of paper in different rainbow colors (red, blue, green, orange, yellow, etc.).

Organize the buckets, facing downwards, by their height.

Define each bucket to be an electronic level—the floor being the ground level 1S orbital, the shortest bucket will be the 2S orbital, the next one up is the 2P orbital, and so on.

Ask one student-electron to "excite himself"—by stepping up on top of the first bucket. Explain that if it was a real electron, you would have to add some energy for this transition to occur, such as heating. The student now represents an excited hydrogen atom, with a single electron at its 2S electronic level.

Make the student jump from the higher energy level to the floor and explain that if an electron has jumped to a lower energy level, then it must give off a photon. Since this transition has occurred from the lowest excited energy level, it gives off the least energy, and thus emits a low energy photon giving off red color.

Give the student a red (low-energy) piece of paper and "excite" the electron again. When the student jumps back to the floor, the student lets go of the red "photon," similar to light emission by real electrons.

Now ask the students to model an excited helium atom, where electrons are one in the 2S and one in the 2P orbitals.

If the 2S orbital of helium is higher in energy than that of the hydrogen atom, then the electron should give off a higher energy photon, i.e., orange "photon," for example. To jump from the 2P level would take a "green" photon, since its energy is even higher. And so on. Thus, the connection is made between energy difference and color, and the energy level structure is emphasized.

Comment

The transitions to 1S in the hydrogen atom are really so energetic, that they all appear in the UV spectrum, called the Lyman Series of spectral lines. Only the transitions to the n=2 (2S, 2P) level are found in the visible part of the spectrum (the Balmer Series). In advanced courses, this is the place to introduce quantum numbers and their relationships to energy levels.

Teaching Tips From Mr. DeGennaro

Teaching about light is no weirder than teaching about the elements.

Light and colors are interesting for kids.

I would like to spend more time on it [light]…but there are so many things that I have to do.

I used to have them watch my demonstrations about light and all they had to say is that it's green, and if it's green it can be potassium.

Now, I'm pushing it a step further, because we're talking about electron layers and they can actually understand that there are different energies associated with different photons.

There are kids that are kinesthetic learners, who must get up from their chairs and do something, even trivial, that relates to the subject. That helps them change their whole point of view about the subject.

References: Links

http://csep10.phys.utk.edu/astr162/lect/light/absorption.html
A brief illustrated tutorial on continuous spectra and emission spectra of atoms.

http://javalab.uoregon.edu/dcaley/elements/Elements.html
An interactive periodic table that shows the emission spectra of each element.

References: Readings

Minas da Piedade, M.E.; Berberan-Santos, M.N. (1998) "Atomic Emission Spectra Using a UV-Vis Spectrophotometer and an Optical Fiber Guided Light Source," *Journal of Chemical Education,* Vol. 75, No. 8, pp: 1013-1017.