Excited States

A Musical Demonstration

Introduction

Help students learn the Bohr Theory and the basic concepts of energy levels, ground states, and excited states by performing this energetic musical demonstration.

Concepts

- Energy levels
- Ground states
- Excited states
- Photon emission

Materials

Step stool or set of chairs at different heights

Foam balls or plastic lids, 5–8*

Tape of song "I'm So Excited" by the Pointer Sisters (from 1:49 to 2:32 in song)

**Foam balls or plastic lids will be used to simulate photons and the loss of energy when an electron drops from an excited state to a lower energy state.*

Safety Precautions

Clear away all items from the "landing area." Be careful when jumping off the chairs or step stools. To avoid possible injury to students or damage to equipment, use only soft and flexible "photons" and gently throw them up into the air.

Procedure

1. Demonstrate the definition of quantized electron energy levels by first standing on the floor *(ground state)*, and then stepping onto a chair or the first step of a step stool *(first excited state)*. The electron in the excited state is at a higher potential energy compared to the ground state. Energy must be added to "climb" from a lower energy state to a higher energy state. *(In this analogy, the potential energy is due to gravity.)*
2. Explain that there are no *stable* energy levels between the ground state and the first excited state.
3. Jump down to the floor to simulate an electron dropping back down to the ground state. Again, note that there are no stable energy levels between the first excited state and the ground state. Discuss the fact that energy is lost or released when an electron drops from a higher energy, excited state to the lower energy ground state.
4. If possible, step onto a higher chair or onto the second step on a step stool to demonstrate the second excited state.
5. Jump down to either the "first excited state" or the "ground state." Note that both options are possible, but that different amounts of energy will be lost when an electron drops from the second excited state to the first excited state compared to when it drops from the second excited state to the ground state.
6. Ask students to imagine what this process would look like at the subatomic level. What happens to the energy that is lost in the process? *(The loss of energy when an electron drops from a higher energy level to a lower energy level may be observed as light emission, as in flame tests.)*
7. At this time, pull out the boom box to play a selected portion of the Pointer Sisters' song "I'm So Excited." As the music starts, leap onto the chair and shout, "I'm so excited!"
8. Pull the "photons" from your pocket and, as you jump back down to the floor, toss a "photon" out into the classroom over the heads of the students.
9. Repeat the process of climbing from the ground state to excited states, jumping back down, and releasing photons until the supply of photons has been exhausted or the song has ended.

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Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation

Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy

Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, conservation of energy and increase in disorder, interactions of energy and matter

Tips

- The musical component of this activity provides enthusiasm for the concepts. Many students will recognize the song and relate the science concepts to the demonstration. The abstract ideas of electrons, energy levels, and photons have suddenly become con crete and even entertaining to the students. The entertainment factor is quite refreshing—quantum mechanics often causes students much frustration as they attempt to comprehend abstract concepts that seem so far removed from their daily lives.
- Use soft or lightweight "photons." Nerf™ balls or plastic lids to margarine or other plastic containers work well.
- A step stool with two or three steps works great. Two chairs of different heights or a chair and a lab bench will also work. Use your imagination but always stay within your physical limitations.
- If possible, toss the "photon" as you are in the air to symbolize that the photon is emitted as the electron drops to a lower energy state.

"I'm So Excited"
Modified Lyrics

Let's get excited!!!
Oh, we just can't hide it
I'm about to lose a photon and I think I'll like it!
I'm so excited!!!
And I just can't hide it! Oh, no
I know, I know, I know, I know, I know I want to
I'm so excited!!!
And I just can't hide it
I'm about to lose a photon and I think I'll like it
Oh yeah
I'm so excited!!!
And I just can't hide it
I know, I know, I know, I know, I know I want to.
I want to.

- To demonstrate two different excited states and the different possible energy transitions, use different colored foam balls to represent photons of different energy (color and wavelength) that may be emitted.

Discussion

Introduce the Bohr theory of the atom and the concepts of ground states, excited states, and photons. There are four fundamental concepts: (1) Energy is quantized. (2) Electrons that are closer to the nucleus are generally lower in energy than electrons that are farther away from the nucleus. (3) Energy is required to promote an electron from a lower energy level to a higher energy level. (4) Energy is released (often in the form of light) when an electron drops from a higher energy level to a lower energy level.

Reference

This activity was adapted from *Flinn ChemTopic™ Labs*, Volume 3, Atomic and Electron Structure; Cesa, I., Editor; Flinn Scientific: Batavia, IL (2003).

Materials for *Excited States—A Musical Demonstration* are available from Flinn Scientific, Inc.

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AP6365	Atomic and Electron Structure, Flinn ChemTopic™ Labs, Volume 3

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.