Simulation: Exciting Electrons

FOR THE TEACHER

Summary
In this simulation, students will explore what happens when electrons within a generic atom are excited from their ground state. They will see that when an electron relaxes from an excited state to its ground state, energy is released in the form of electromagnetic radiation. This is a qualitative investigation, not meant to mimic any particular atom.

Grade Level
High school

AP Chemistry Curriculum Framework
This simulation supports the following unit, topics and learning objectives:

- **Unit 3: Intermolecular Forces and Properties**
  - **Topic 3.11:** Spectroscopy and the Electromagnetic Spectrum
    - SAP-8.A: Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region.
  - **Topic 3.12:** Photoelectric Effect
    - SAP-8.B: Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule.

Objectives
By the end of this activity, students should know

- Conservation of energy.
- It takes energy to excite an electron, and energy is released when an electron relaxes to its ground state.
- Energy is quantized.

Chemistry Topics
This activity supports students’ understanding of

- Atomic theory
- Atomic structure
- Conservation of energy
- Exciting electrons
- Ground state electrons

Time
**Teacher Preparation:** 10 minutes
**Lesson:** 1 class period

Materials
- Computer with internet access

Teacher Notes
- Student can explore the simulation with the guided help of the lesson, or you can use it as a demonstration tool for explaining atomic theory related to exciting electrons from their ground state.
- This could be used either as an introduction or follow up activity to flame tests.
FOR THE STUDENT

Lesson

Background
Electrons are organized within an atom; they each “live” in a specific place within energy levels, which surround the nucleus. When an atom is left to its own device, the electrons are organized in what is called their ground state configuration. But when an atom is exposed to energy, electrons may absorb that energy and become excited. This means the electron is promoted to a higher energy level. The electron doesn’t stay there forever; it eventually returns to its ground state, and it releases the energy it initially absorbed. This energy is released in the form of a photon. In this activity, you will explore these ideas further with the help of a simulation.

Prelab questions
1. The simulation screen (right). The Energy Inventory (on the left) includes four quantities that can be excite the electron, currently in its Ground State. You will drag various amounts of energy be exposed to the into the ground state. you click on the button (top right), triggers the electron absorb the energy. do you think will happen immediately after clicking Excite!? Explain.
2. A few seconds after clicking Excite!, what do you think will happen, based on your answer to the previous question? Explain.
3. Why do you think there is an axis with the label Energy in the bottom right corner of the screen?

Procedure
2. Choose energy from the inventory that will excite the electron. You can choose one bar, or more than one bar. Indicate in the screen shot below the energy you chose. Do not yet click Excite! Predict what will happen.
   Prediction

   3. Click Excite! Did you predict correctly what would happen? Explain.
5. Clear the simulation by clicking 

6. Choose a different quantity of energy from the inventory. Indicate below the energy you chose. Do not yet click Excite! Predict what will happen to the electron and what you will see on the energy axis.

**Prediction**

7. Click Excite! Did you predict correctly what would happen to the electron? Explain.


9. Clear the simulation by clicking 

10. Have you received the message “Insufficient Energy Added Try Again!”? If yes, explain why you received that message. If no, choose energy from the inventory that you think may result in that message for step 11.
11. Choose a different quantity of energy from the inventory. Indicate below the energy you chose. Do not yet click Excite! Predict what will happen to the electron and what you will see on the energy axis.

**Prediction**

12. Click Excite! Did you predict correctly what would happen to the electron? Explain.


14. Clear the simulation by clicking

15. Choose a different quantity of energy from the inventory. Indicate below the energy you chose. Do not yet click Excite! Predict what will happen to the electron and what you will see on the energy axis.

**Prediction**

16. Click Excite! Did you predict correctly what would happen to the electron? Explain.

18. Clear the simulation by clicking

19. Refer to the photons you “observed” in questions 4, 8, 13, and 17. Identify what type of electromagnetic radiation each could be using this electromagnetic spectrum. Justify your choices.

20. If there was an additional excited state possible in this simulation, complete the diagram, including the energy needed to excite the electron to that excited state. Indicate what the energy axis would look like when the electron relaxes. Explain in words your justification for your drawings.

**Conclusion**
What did you learn from this investigation?