Title: What Happens when we excite atoms and molecules?

Author: Carla Brathwaite
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Subject: Chemistry
Level: High School
Standards: New York State - www.emsc.nysed.gov/ciai/
Standard 1 – Analysis
Standard 6 – Interconnectedness, common themes
Schedule: 1 or 2 - 45 Minute class periods

Objectives:

At the end of this lesson, students should be able to:

- State how an atom becomes excited and what happens as an atom returns to the ground state
- Show using the Bohr model of the atom – an atom in the excited state
- List common examples and applications of atoms or molecules being excited and returning to the ground state

Students will:

- Review the Bohr model of the atom
- Learn how to excite an atom and molecule
- Learn how to identify when an excited atom/molecule is returning to the ground state
- Excite atoms using heat
- Excite molecules using light
- Depict atoms in the excited state by drawing their corresponding Bohr models

Vocabulary:

Bohr Model of the atom
Ground state
Excited State

Materials:

Bunsen Burners or butane torches
Solutions of metal ions
Metal wands for flame test
Spectroscopes
Data tables
Fluorescent dyes – dissolved
Focused beam flashlight or UV light
Matches or lighter to light burners

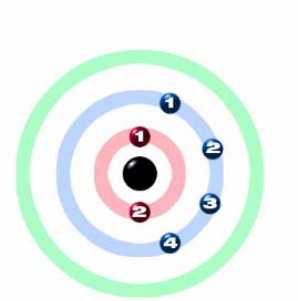
Safety:

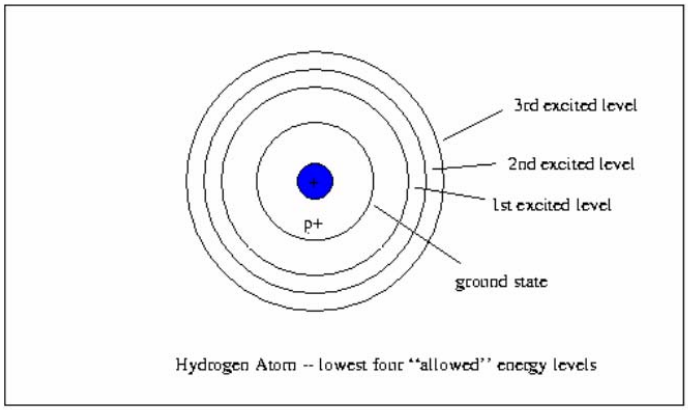
Flames
Hot wire (flame test)
Use basic fire safety precautions

Science Content for the Teacher:

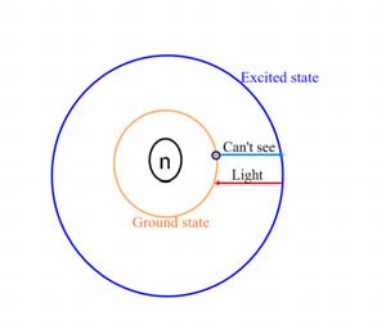
Students should be familiar with the Bohr model prior to this lesson. Students should be able to draw the Bohr model of any atom represented on the periodic table, especially your main block elements (Groups 1, 2, 13 to 18).

Aufbau Principle - each electron occupies the lowest energy orbital available.

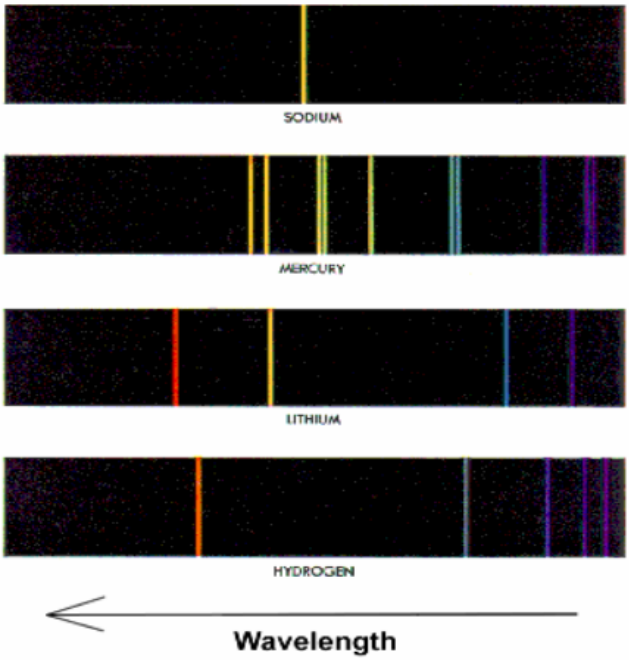




Ground state - The lowest allowable energy state of an atom. (All electrons are in the lowest available orbitals)
When electrons are subjected to stimuli like heat, light or electricity an electron may jump to a higher energy level. This is the excited state. (See picture above)
The electron quickly returns to a lower available energy level giving off the energy it absorbed in the form of light.



The light emitted is made up of light of different wavelengths. These components make up a bright line spectrum.

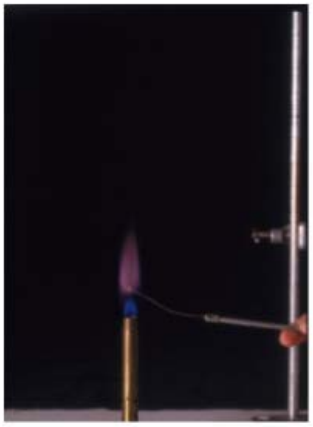


Each element produces its own spectrum!

(Fingerprints of an element)

Flame Tests: Have students perform 2 flame tests

Sodium

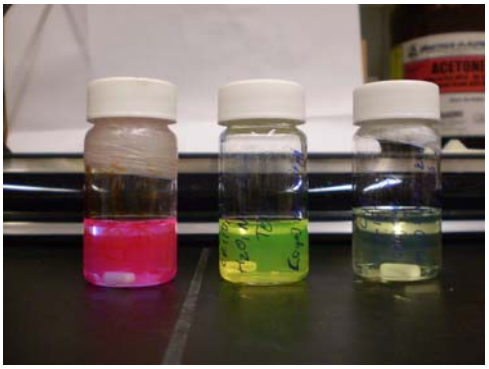


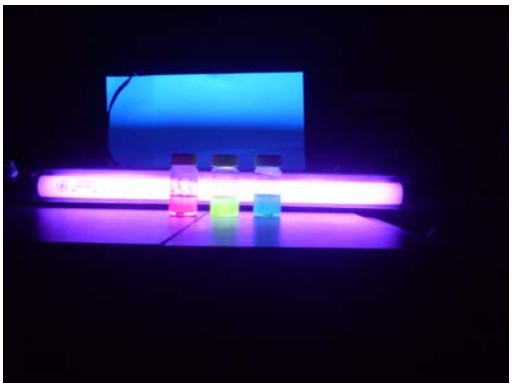
Potassium Chloride

Have students look at the colored flames produced in the flame test through a spectroscope and indicate the exact colors/pattern produced. This is the bright line spectrum for this atom/molecule/compound.

Fluorescent C Dots and/or Fluorescent Dyes

Take the dissolved dye, in a glass vial
Turn the lights off; close the shades/blinds of the classroom
Shine a focused beam flashlight on the solution
Notice the distinct color change
Discuss the distinct change in color between the color noticed with our eye (reflection) and the color produced when excited by light (fluorescence).





Expand:
Applications:

- Neon signs
- Bioimaging

Showing the excited atoms:

- Students should draw the Bohr model of the atom(s) they excited in the flame test. Draw the Bohr model of the ground state and excited state
- Give the students other atoms from the periodic table to practice drawing in the ground state and excited state
- Students should draw an arrow from the Bohr model of the excited state to the Bohr model of the ground state. Write on the arrow “gives off energy in the form of light.” This will remind students that we do not see an atom becoming excited, we see the atom going back to its ground state as it gives off energy in the form of light

Extension Activities:

Have students present information in the form of a class discussion the next day, posters, web discussions, information about bio-imaging and the use of fluorescent dyes. This is an emergent field in biomedical applications which should be of great interest to students.

Supplemental Information:

Fluorescence - http://en.wikipedia.org/wiki/Fluorescence
Light absorption, reflection and transmission - http://www.physicsclassroom.com/class/light/u12l2c.cfm
Biosensors - http://www.fizyka.umk.pl/~lum98/abstr/wolfbeis.html

Safety:

Look up the MSDS for the chemicals in use, follow proper guidelines outlined in the document
Basic fire safety precautions necessary during the flame test
If UV light is used to excite the molecules – limit exposure to extended UV radiation
Standard safety equipment – goggles, gloves, loose articles (clothing, hair, etc) should be tied back

Acknowledgments:

Professor Ulrich Wiesner – Cornell University
http://people.ccmr.cornell.edu/~uli/pages/silicaparticles.htm
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