The Bohr Model

Refining Rutherford
Zeroing in on the Electrons

A Step Beyond Rutherford

- According to Rutherford's model, the electrons are revolving somewhere outside the nucleus. But where exactly?
- Niels Bohr interpreted quantitative data about the electrons' energies that helped us to understand where the electrons are.

POTENTIAL ENERGY

- Consider an apple falling from a tree.
- It must have energy, because it is moving.
- It wasn't always moving. Where did the energy come from?

  It came from gravity.
- The energy that came from gravity is **potential** energy. As the apple falls, its potential energy is converted to kinetic energy.

Location, Location, Location!!

- As the apple falls, it picks up speed.
- The further the apple falls, the faster it goes.
- The higher the apple is before it starts to fall, the greater its potential energy is.
- Electrons are attracted to the nucleus just as the apple is attracted to earth.
- The further electrons are from the nucleus, the greater **their** potential energy is.

Measuring an electron's potential energy tells how far from the nucleus it is.

Zeroing in on the Electrons

Measuring Potential Energy

FLAME TESTS

- When solutions containing metal ions are heated, they impart characteristic colors to a flame.

Sodium

Potassium

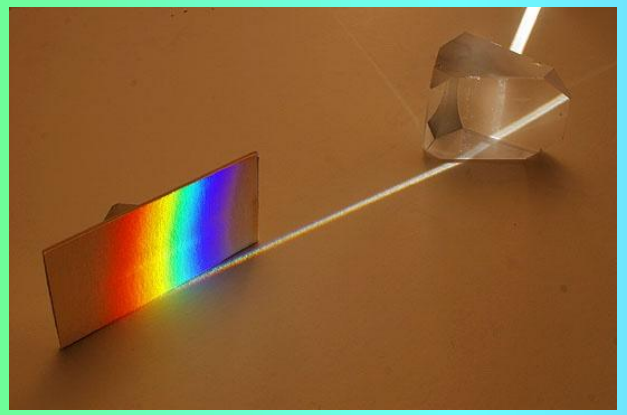
Calcium

Barium

- What do these colors mean?

Color and Energy

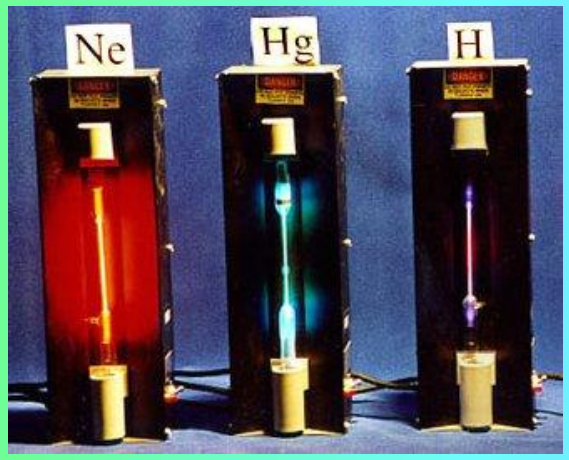
- Light is energy.
- Using a prism, light can be broken into different colors.



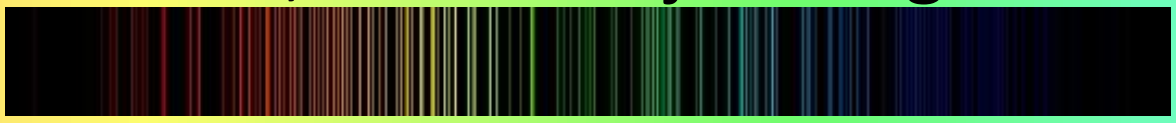
- Different colors of light have different amounts of energy.
- A full spectrum of light has many different amounts of energy.

Bright Line Spectra

- When the light given off by gas under low pressure in a discharge tube (CRT) is examined through a prism, it is not a full spectrum.



- Instead, there are just bright lines.



Neon

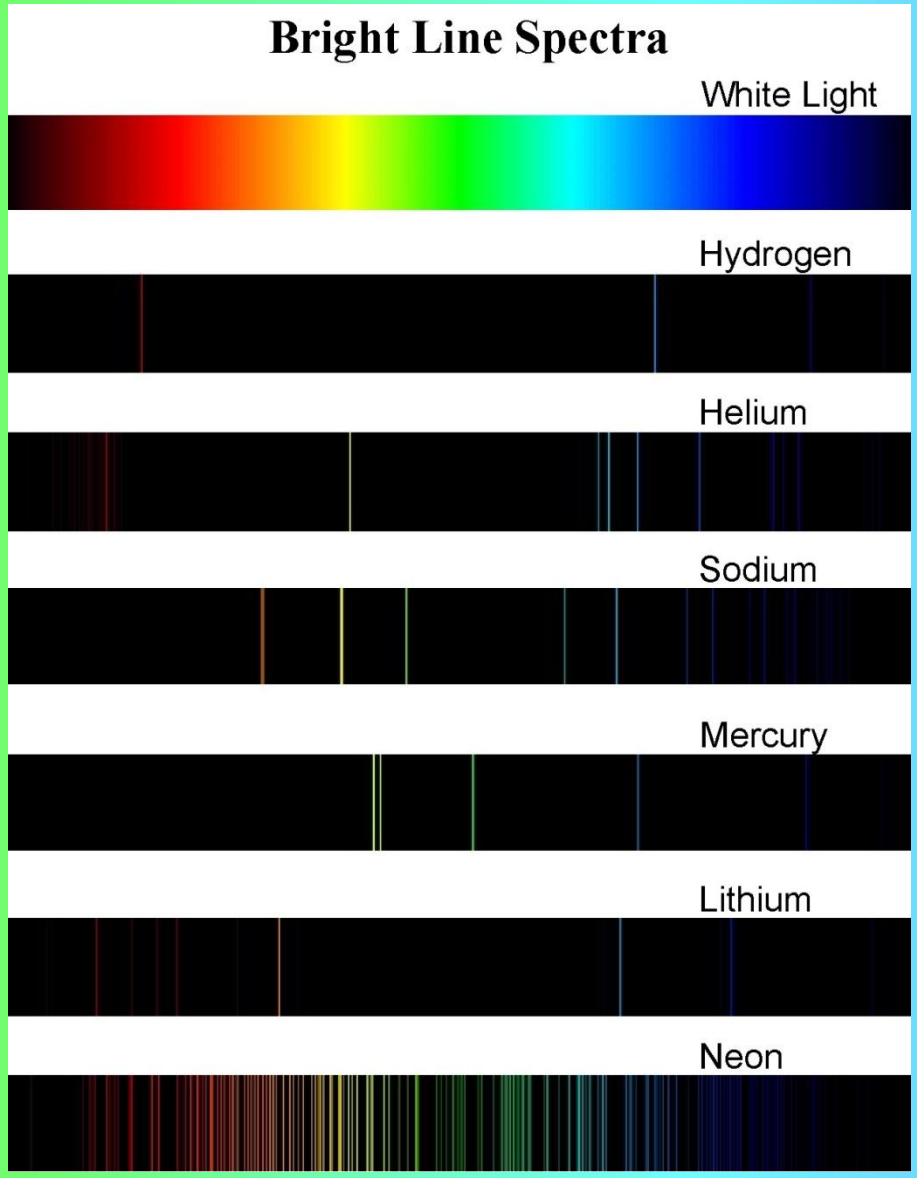
Mercury

Hydrogen

- This means some energies of light are missing.

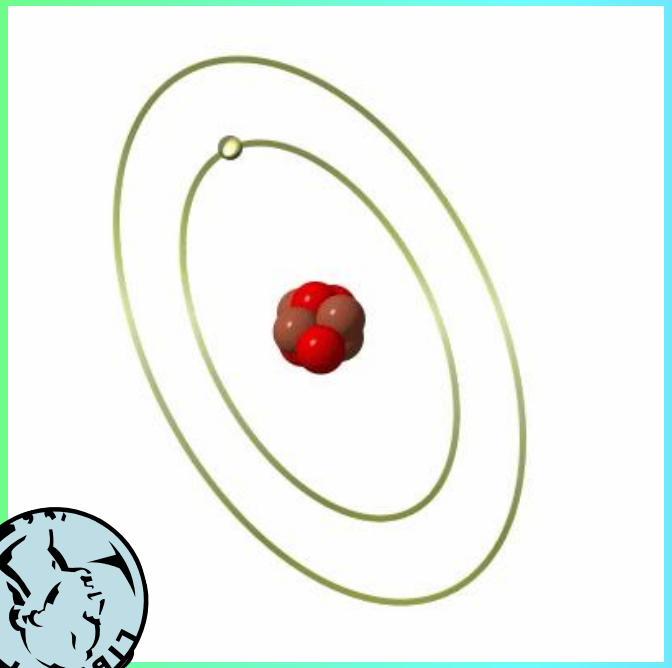
More on Bright Line Spectra

- Each element has a unique spectrum, which explains why each has a different flame test.
- But why do they give off light at all?
- And why are parts of the spectrum missing?



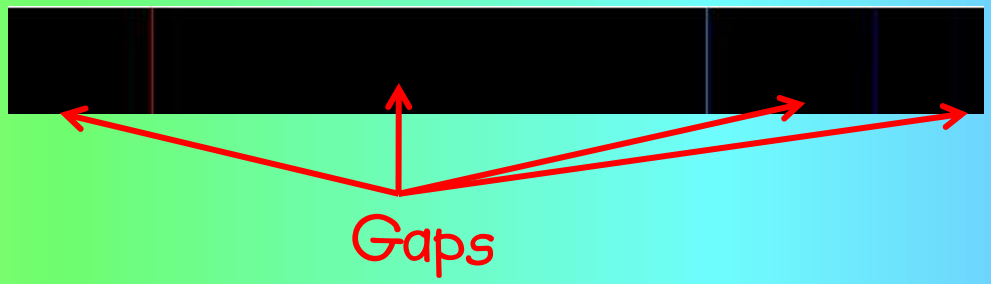
Explaining Bright Line Spectra

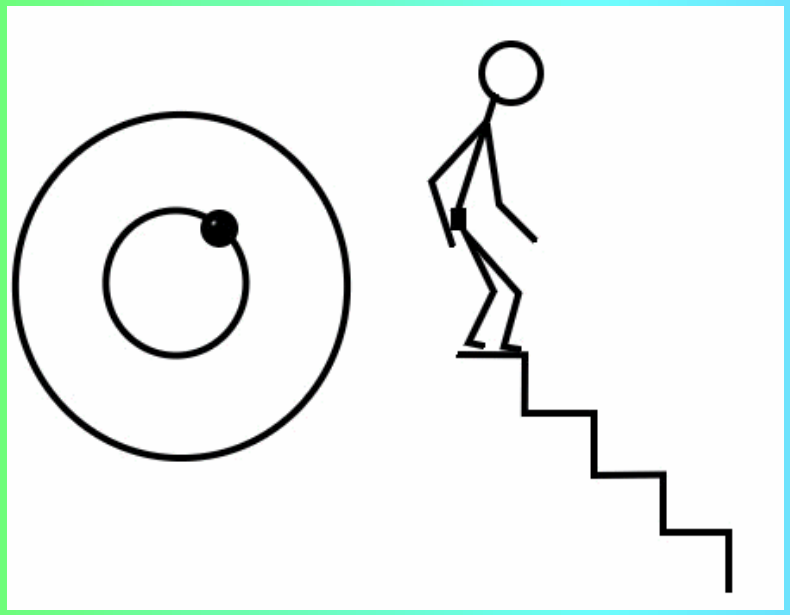
- Electrons pick up energy from the surroundings, and move faster.
- This makes them move farther from the nucleus.
- The excited electrons are unstable. (much like a quarter balanced on its edge.)
- They fall back toward the nucleus, giving off energy as light.



Bohr's Explanation

- Niels Bohr explained the frequencies of light and the gaps in the hydrogen spectrum.
- Bohr said the energy of the electron is quantized. Like a person going down stairs, an electron can only be stable in certain positions – not in between.
- That's why falling electrons only give off certain frequencies of light.





Bohr's Model

In 1913, Niels Bohr Proposed the following:

- Electrons continue to orbit the nucleus instead of being pulled into it because they have energy.
- The more energy the electrons have, the further away from the nucleus they are.
- When an electron absorbs energy it jumps to higher energy levels further away from the nucleus.
- The electron eventually gives off the excess energy as light and falls back down to lower energy levels.
- The energy given off corresponds to only certain frequencies of light (line spectrum) because as electrons fall from the excited state to the ground state they fall only from energy level to energy level, never anywhere in between.
- As a result, a falling electron always gives off a certain quantum of energy.
- Therefore, Bohr concluded, the electrons travel in circular pathways at fixed distances from the nucleus, held in place by the protons.