Chapter Twelve: Atoms and the Periodic Table

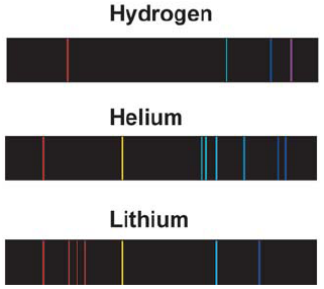
- 12.1 The Structure of the Atom
- 12.2 Electrons
- 12.3 The Periodic Table of Elements
- 12.4 Properties of the Elements

12.2 Learning Goals

- Compare spectra of elements.
- Explain the Bohr atom model.
- Apply principles of quantum theory to explain the behavior of electrons in atoms.

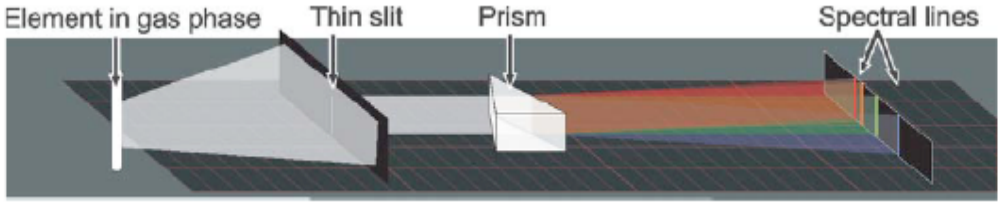
12.2 Electrons in the atom

- Each different element has its own characteristic pattern of colors called a **spectrum**.
- The colors of clothes, paint, and everything else around you come from this property of elements to emit or absorb light of only certain colors.

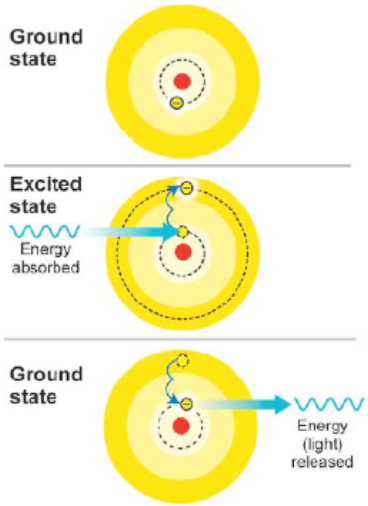


12.2 Electrons in atoms

- Each individual color in a spectrum is called a spectral line because each color appears as a line in a spectroscope.
- A spectroscope is a device that spreads light into its different colors.



12.2 Bohr model of the atom

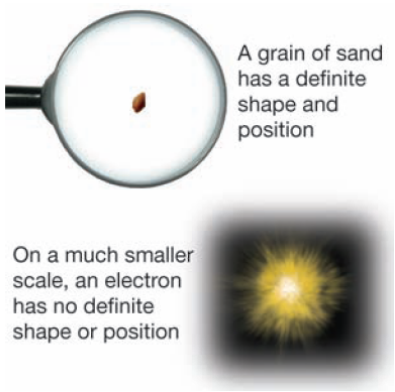


- Danish physicist Neils Bohr proposed the concept of energy levels to explain the spectrum of hydrogen.
- When an electron moves from a higher energy level to a lower one, the atom gives up the energy difference between the two levels.
- The energy comes out as different colors of light.

12.2 The quantum theory

- **Quantum theory says that when things get very small, like the size of an atom, matter and energy do not obey Newton's laws or other laws of classical physics.**

12.2 The quantum theory



- According to quantum theory, particles the size of electrons are fundamentally different.
- An electron appears in a wave-like "cloud and has no definite position.

12.2 The quantum theory

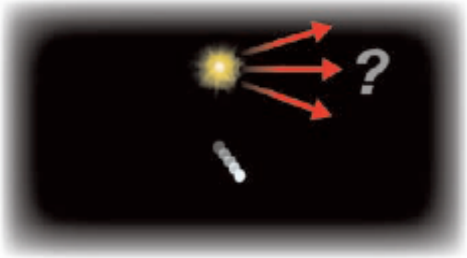
- The work of German physicist Werner Heisenberg (1901–1976) led to Heisenberg's uncertainty principle.
- The uncertainty principle explains why a particle's position, momentum or energy can never be precisely determined.
- The uncertainty principle exists because measuring any variable disturbs the others in an unpredictable way.

12.2 The uncertainty principle

An electron is moving

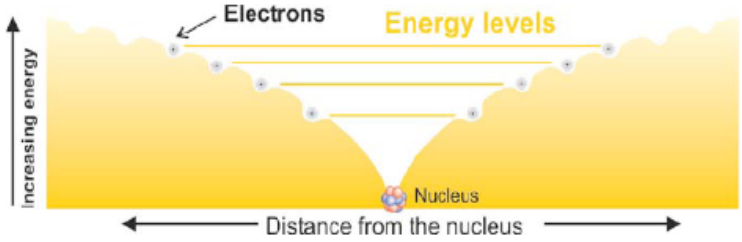
To see the electron you must bounce a photon of light off it

When you receive the photon you know where the electron ***was***, but the photon disturbed it, so you don't know its speed and direction any more



12.2 Electrons and energy levels

- In the current model of the atom, we think of the electrons as moving around the nucleus in an area called an electron cloud.
- The energy levels occur because electrons in the cloud are at different average distances from the nucleus.



12.2 Rules for energy levels

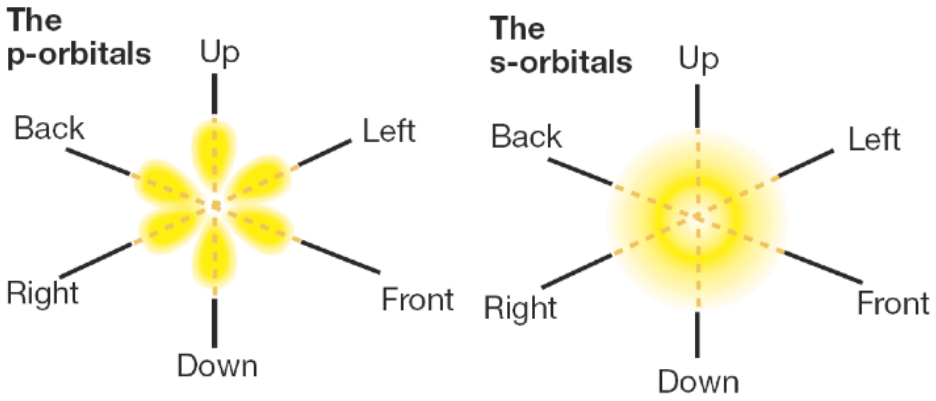
Inside an atom, electrons always obey these rules:

1. **The energy of an electron must match one of the energy levels in the atom.**
2. **Each energy level can hold only a certain number of electrons, and no more.**
3. **As electrons are added to an atom, they settle into the lowest unfilled energy level.**

12.2 Models of energy levels

- While Bohr's model of electron energy levels explained atomic spectra and the periodic behavior of the elements, it was incomplete.
- Energy levels are predicted by quantum mechanics, the branch of physics that deals with the microscopic world of atoms.

Orbitals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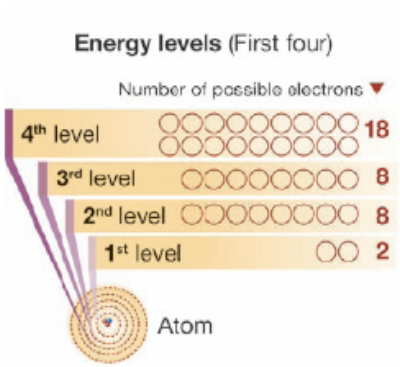
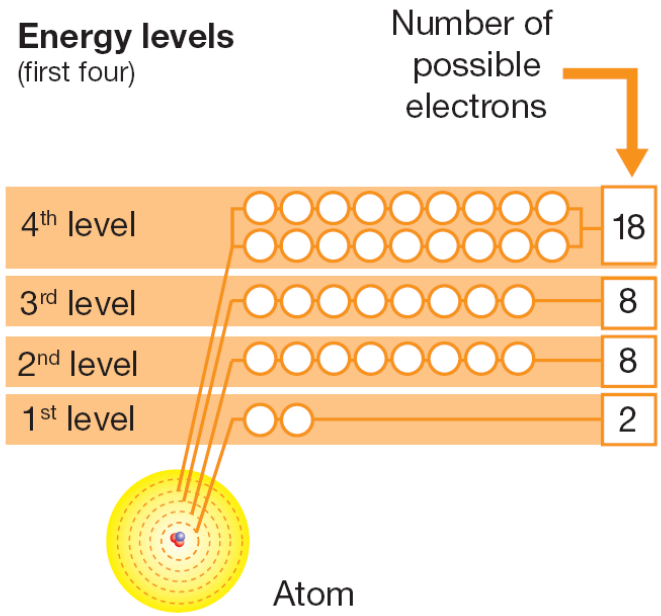
12.2 Energy levels



- In the Bohr model of the atom, the first energy level can accept up to two electrons.
- The second and third energy levels hold up to eight electrons each.
- The fourth and fifth energy levels hold 18 electrons.

Electron Energy Levels



12.2 Electrons and energy levels

- The first energy level can accept up to two electrons.
- The second energy levels hold up to eight electrons.