4-1: Introduction to Atoms

8th Grade Physical Sciences
Development of Atomic Theory

• Figuring out what matter is made of is not simple since the particles are too small to see.
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Development of Atomic Theory

- Around 430 BC a Greek philosopher named Democritus proposed the idea that matter is made of stuff that can’t be cut apart.

“atomos = uncuttable”
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Development of Atomic Theory

- He just had ideas and didn’t do experiments.
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Development of Atomic Theory

- 2000 years later in the 1600s, this idea of “atomos” came around again – but this time they did experiments.
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Development of Atomic Theory

- Atoms are the smallest particle of an element.
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Development of Atomic Theory

- Atomic theory grew as a series of models were developed from experiments.
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Development of Atomic Theory

• These models would change as more experimental evidence was found.
Dalton’s Theory

- An Englishman named **Dalton** proposed a model where the atoms were solid particles like round spheres – unique for each element.
Thomson’s Theory

- Around 1900, another English scientist named Thomson discovered atoms have negatively charged particles.

Plum Pudding Model
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Thomson’s Theory

- If true, there must also be a positive particle since atoms have no charge – they must cancel each other.

Plum Pudding Model
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Thomson’s Theory

- The negatively charged particles later became known as electrons.

Plum Pudding Model
In 1911, one of Thomson’s students, named Rutherford, proved Thomson’s model was inaccurate.
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Rutherford’s Theory

- He concluded the positive charges were clustered in the very middle – not spread out.
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Rutherford’s Theory

- Scientists already knew that electrons had almost no mass.

- So an atoms mass must be in the positive particles.
Rutherford’s Theory

• Rutherford called the positive particles **protons**.
Bohr’s Theory

- In 1913, Danish scientist Bohr concluded electrons have different energy levels, based on distance from the nucleus, the center of the atom.
Later Theories

• In the 1920’s, scientists concluded that electrons don’t orbit the center like planets around the sun.
Later Theories

- Electrons form a **cloud** where they may or may not exist at any one time.
In 1932 English scientist Chadwick discovered another particle in the nucleus – called the Neutron.
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Later Theories

- The Neutron has about the same mass as a proton, but has no charge, making it hard to detect.
Final Theory

- All this research concludes the following:

The atom is mostly empty space with a massive nucleus containing protons and neutrons and a cloud of electrons flying around in different energy shells.
1. Each negative electron has a corresponding positive proton so atoms are neutral.

2. It takes about 2000 electrons to equal the mass of a proton.

3. Protons and neutrons have almost the same mass.
Isotopes

- Unlike protons, elements may have a different number of neutrons.
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Isotopes

- Atoms of the same element, but different number of neutrons, are called isotopes.
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Isotopes

- $^{12}\text{C}$: 6 protons, 6 neutrons (light)
- $^{13}\text{C}$: 6 protons, 7 neutrons (heavy)
- $^{14}\text{C}$: 6 protons, 8 neutrons (unstable)
Isotopes

- Isotopes are identified by their mass number – the sum of the protons and neutrons.
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Isotopes

- The most common form of carbon has a mass number of $6 + 6 = 12$. 
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More isotope examples

- **Uranium-238**
  - 92 protons
  - 146 neutrons
  - Extra neutrons - heavier

- **Uranium-235**
  - 92 protons
  - 143 neutrons
  - Tighter and more active
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Unstable Isotopes
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Summary

• Atomic theory has developed over centuries.
• Old models were discarded or updated to incorporate new information.
• Today’s model of the atom has a small, heavy nucleus with protons and neutrons – surrounded by a cloud of electrons.
• The number of protons determines which element it is – differing neutrons create isotopes but don’t change what the element is.