





Chapter 4 Atomic Structure

4.1 Defining the Atom

4.2 Structure of the Nuclear Atom

4.3 Distinguishing Among Atoms

4.1 Defining the Atom > CHEMISTRY & YOU

How do you study something that you cannot see it?

Similar to how you might study a giftwrapped present, scientists often study things that cannot be seen with the naked eye.





Early Models of the Atom

How did the concept of the atom change from the time of Democritus to the time of John Dalton?



- An <u>atom</u> is the smallest particle of an element that retains its identity in a chemical reaction.
- Although early philosophers and scientists could not observe individual atoms, they were still able to propose ideas about the structure of atoms.



Democritus's Atomic Philosophy

The Greek philosopher Democritus (460 BC –370 BC) was among the first to suggest the existence of atoms.



Democritus's Atomic Philosophy

Democritus reasoned that atoms were indivisible and indestructible.



Democritus's Atomic Philosophy

- Democritus reasoned that atoms were indivisible and indestructible.
 - Although, Democritus's ideas agreed with later scientific theory, they did not explain chemical behavior
 - They also lacked experimental support because Democritus's approach was not based on the scientific method.



Dalton's Atomic Theory

The modern process of discovery regarding atoms began with John Dalton (1766–1864), an English chemist and schoolteacher.



Dalton's Atomic Theory

By using experimental methods, Dalton transformed Democritus's ideas on atoms into a scientific theory.



Dalton's Atomic Theory

Dalton studied the ratios in which elements combine in chemical reactions.

 The result of his work is known as Dalton's atomic theory.



Dalton's Atomic Theory

1. All elements are composed of tiny indivisible particles called atoms.



Atoms of element A

Dalton's Atomic Theory

 Atoms of the same element are identical. The atoms of any one element are different from those of any other element.



Dalton's Atomic Theory

3. Atoms of different elements can physically mix together or can chemically combine in simple whole-number ratios to form compounds.



Mixture of atoms of elements A and B

Dalton's Atomic Theory

4. Chemical reactions occur when atoms are separated from each other, joined, or rearranged in different combinations. Atoms of one element are never changed into atoms of another element as a result of a chemical reaction.



Compound made by chemically combining atoms of elements A and B



4.1 Defining the Atom > CHEMISTRY & YOU

How was Jon Dalton able to study atoms even though he couldn't observe them directly? What evidence did he use to formulate his atomic theory?





How was Jon Dalton able to study atoms even though he couldn't observe them directly? What evidence did he use to formulate his atomic theory?

Dalton studied the ratios in which elements combine in chemical reactions. He observed that when atoms mix, they maintain their own identity unless they combine in a chemical reaction.





How was Democritus's idea of the atom different from Dalton's?





How was Democritus's idea of the atom different from Dalton's?

Democritus's idea did not explain chemical behavior and was not a scientific theory because it lacked experimental support. Using experimental support, Dalton transformed Democritus's ideas about atoms into a scientific theory that explained chemical behavior.



Sizing up the Atom

What instruments are used to observe individual atoms?



This liquid mercury illustrates Dalton's concept of the atom.

- Every drop, no matter its size has the same properties.
- Even if you could make a drop the size of one atom, it would still have the chemical properties of mercury.





If you were to grind a copper coin into a fine dust, each speck in the small pile of shiny red dust would still have the properties of copper.

- If you could continue to make the copper dust smaller, you would eventually come upon a particle of copper that could no longer be divided and still have the chemical properties of copper.
- This final particle is an atom.

Atoms are very small.

• A pure copper coin the size of a penny contains about 2.4×10^{22} atoms.



Atoms are very small.

- A pure copper coin the size of a penny contains about 2.4×10^{22} atoms.
- By comparison, Earth's population is only about 7×10^9 people.
- If you could line up 100,000,000 copper atoms side by side, they would produce a line only 1 cm long!



4.1 Defining the Atom > Sizing up the Atom Image: Despite their small size, individual atoms are observable with instruments such as scanning

electron microscopes.

- Despite their small size, individual atoms are observable with instruments such as scanning electron microscopes.
 - In scanning electron microscopes, a beam of electrons is focused on the sample.



- Despite their small size, individual atoms are observable with instruments such as scanning electron microscopes.
 - In scanning electron microscopes, a beam of electrons is focused on the sample.
 - Electron microscopes are capable of much higher magnifications than light microscopes.



With the help of electron microscopes, individual atoms can even be moved around and arranged in patterns.

 The ability to move individual atoms holds future promise for the creation of atomicsized electronic devices, such as circuits and computer chips.

An example of a device made from individual atoms is the nanocar shown here.

 This atomic-scale, or "nanoscale," technology could become essential to future applications in medicine, communications, solar energy, and space exploration.



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If an atom has a radius of 1×10^{-10} m, how many of these atoms must be lined up in a row to produce a line 1 cm long?





If an atom has a radius of 1×10^{-10} m, how many of these atoms must be lined up in a row to produce a line 1 m long?

 1×10^{10} (10,000,000,000) atoms of radius 1×10^{-10} m would need to be lined up in a row to produce a line 1 m long.



4.1 Defining the Atom > Key Concepts

Democritus reasoned that atoms were indivisible and indestructible. By using experimental methods, Dalton transformed Democritus's ideas on atoms into a scientific theory.

Scientists can observe individual atoms by using instruments such as scanning electron microscopes.

4.1 Defining the Atom > Glossary Definitions

- <u>atom</u>: the smallest particle of an element that retains its identity in a chemical reaction
- Dalton's atomic theory: the first theory to relate chemical changes to events at the atomic level



4.1 Defining the Atom > BIG IDEA

Electrons and the Structure of Atoms

Atoms are the smallest particles of an element that still have the chemical properties of that element.



4.1 Defining the Atom >

END OF 4.1



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