

## Review

- Bohr Diagrams
- E.g.: silicon ( $^{28}_{14}\text{Si}$ )

## 1.2 Developing a Model of the Atom

- All scientific knowledge can be classified as either empirical (observable) or theoretical (non-observable)
- The sun will rise in the morning (assuming no major catastrophes) is empirical knowledge. Theoretical knowledge is how we explain the “why?” of empirical knowledge.
  - It was once theorized that the Earth was the center of the universe and everything revolved around it, including the sun. This belief was held for 2000 years. In the 1600’s Copernicus collected data that explained that the sun was the center of our solar system and that we were part of a larger body of stars (our galaxy). It was not until we were able to measure the motion of the stars that we could change our theoretical explanation of the sunrise to an empirical explanation.
- Empirical Knowledge: The universe is made of matter.
- Theoretical Knowledge: Matter is made of atoms.
- How do we explain matter: Use models such as the atomic model of the atom. We also use analogy to say that the electrons orbit the nucleus much like a planet orbiting a star.
- We also use simple theories that are used to describe, explain, and predict observations.

### Definitions to Know

- |                         |                               |
|-------------------------|-------------------------------|
| • Empirical knowledge   | • Quantitative                |
| • Theoretical knowledge | • Law of conservation of mass |
| • Model                 | • Law of constant composition |
| • Analogy               | • Electron                    |
| • Theory                | • Nucleus                     |
| • Atom                  | • Proton                      |
| • Alchemy               | • Neutron                     |

### Demo: Activity 1.2.1

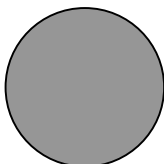
- Will be done in class

### Early Greek Theories of Matter

- Empedocles proposes 4-element theory of matter in 6<sup>th</sup> century BC.
- Democritus proposes atomic theory in the 5<sup>th</sup> century BC. In his theory all matter is made up of tiny indivisible particles that are unique to each element. The particles were dynamic and nothing existed between the particles (a void).
- Aristotle defends Empedocles model and we use the 4-element model for the next 2000 years.
- Alchemy relied on the 4-element model.
- Not until 18<sup>th</sup> century do we see quantitative studies that support Democritus’s theory.

### Dalton’s Atomic Theory

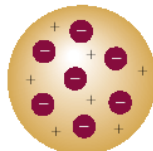
- Dalton gave us the Billiard Ball Theory.



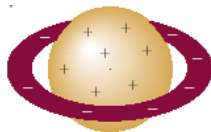
- His theory contained the following statements:
  - All matter is composed of tiny, indivisible particles called atoms.
  - All atoms of an element have identical properties
  - Atoms of different elements have different properties.
  - Atoms of two or more elements can combine in constant ratios to form new substances. (Law of constant composition)
  - In chemical reactions, atoms join together or separate from each other but are not destroyed. (Law of conservation of mass)

### Development of Atomic Theory from 1803 to 1920

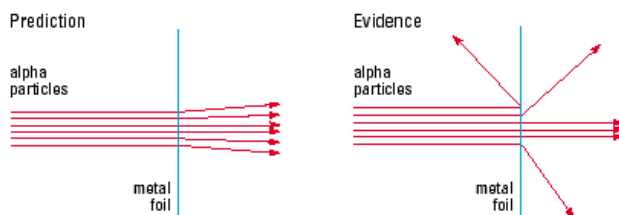
- Invention of the cathode ray tube leads to the discovery of the electron.
- J.J. Thompson incorporates the electron into Dalton's model to create the Raisin Bun Model. In this model the electrons are uniformly dispersed inside a nearly empty positive sphere.



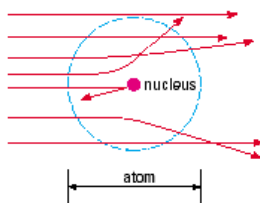
- Hantaro Nagaoka had a different idea to incorporate the new electron. He developed the solar system model.



- In 1911, Ernest Rutherford did an experiment where he shot positive  $\alpha$ -particles (He nucleus) at a thin gold foil. He speculated that if Thompson were right, then the  $\alpha$ -particles would pass through the uniformly charged atom with little deflection.



- What Rutherford found out was that a few  $\alpha$ -particles were deflected and reflected. This meant that Thompson was wrong. Rutherford's theory was that an atom contained a small, dense, positive nucleus. Most of the  $\alpha$ -particles passed right through the empty space but some were deflected or reflected by the dense positive nucleus.



- In 1932, James Chadwick discovered neutrons. This gave us our modern understanding of the sub-atomic particles.
  - Proton ( $p^+$ )
  - Neutron ( $n^0$ )
  - Electron ( $e^-$ )

### Homework

- Bohr Diagrams for the first 20 elements
- Activity 1.2.1 done in class.
- Practice Questions: 1-5