Unit 2: Atomic Structures and Properties

3.1 Early Atomic Theories

Ancient History

- 300 BC Democritus hypothesized an indivisible particle that he called an atom after the Greek word *atomos.*
- Democritus's theory ignored for over 2000 years because Aristotle argued that the 4-element model was correct (earth, fire, air, water) and everyone believed him.

Dalton

- The Billiard Ball Model
- In 1805 John Dalton reintroduces Democritus's theory and applies 3 important scientific laws:
    a) Law of definite composition (have a combining capacity)
    b) Law of multiple proportions (one or more combining capacity)
    c) Law of conservation of mass (cannot be created or destroyed)

Thompson

- The Raisin Bun Model
- Faraday, Arrhenius, and Crookes research showed that components of matter contained electrical charges.
- The first particle to be measured was the electron by Millikan with his famous charged oil drop experiment.
- In this theory the following discoveries were incorporated:
    a) Atoms gain or lose electron to form ions
    b) Atoms gain or lose a specific number of electrons
    c) Electrons are negatively charged particles
    d) Electrons are a component of all matter
    e) Electrons have a fixed electric charge

Rutherford

- In combination with Bohr developed the Solar System Model.
- Rutherford was from New Zealand but did his research at McGill in Montreal.
- The famous gold foil experiment:

a) Fired alpha particles at a thin sheet of gold (α particle = He nucleus)
b) Predicted that the beam of particles should pass through the gold because if Thompson's model was correct there would be equal distribution of charge throughout the gold foil and it would not affect the positive alpha particle
c) Observed many deflected alpha particles which lead to conclusion that an atom is mostly empty space with electrons flying around a very small, very dense positive nucleus
d) To explain the existence of a nucleus, very strong nuclear forces had to be introduced to create a stable nucleus

Protons, Isotopes, and Neutrons

- Protons → positive charge (equal and opposite to that of an electron), found in nucleus, has a mass about 2000 times greater than an electron, the number of protons determine the element, an element has equal number of protons and electrons
- Isotopes → invention of mass spectrometer leads to the discovery that elements can exist in different forms (different mass, same number of protons, therefore still the same element, just different), some isotopes are unstable and will decay (radioactive isotopes can emit alpha particles, beta particles, and gamma particles)
- Neutrons → neutral particles found in the nucleus with the same mass as a proton but does not have a charge, different number of neutrons create isotopes (e.g. ${}^{12}_{6}C$ and ${}^{14}_{6}C$)

Homework

- Questions 1,2,3,4,5