3.4 Bohr Atomic Theory

- Even after Rutherford's gold foil experiment, scientists could not explain electron arrangement.

The Problem with the Rutherford Model

- When an electron is orbiting a nucleus, it is constantly in a state of acceleration since it is constantly changing directions (circular orbit). In the classical theory, the electron should emit electromagnetic radiation and its orbit should degrade until the electron hits the nucleus.
- The classical theory is wrong. The electron does not crash into the nucleus. This caused some scientists to speculate that elections were stationary.

Atomic Spectra

- Spectroscopy: a technique for analyzing spectra; the spectra may be visible light, IR, UV, etc.
- Originally based on the flame test. The light from the flame test produced a bright-line spectrum when it passed through a prism that was unique to the element.
- Bright-line spectrum: a series of bright lines of light produced or emitted by a gas excited by heat or electricity.
- Dark-line spectrum (absorption): a series of dark lines of a continuous spectrum; produced by placing a gas between the continuous spectrum source and the observer. (Can be used to determine the composition of stars.)

Bohr's Model of the Atom

- Bohr originally worked with Thompson to explain electron arrangement. Thompson refused to use the "new" quantum theory proposed by Plank and Einstein. Bohr left Thompson and went to work with Rutherford.
- Bohr and Rutherford used line spectra to explain electron arrangement.
- Bright and dark line spectra means only certain quanta of light can be emitted or absorbed by an atom. In other words, the electron can only have a specific amount of energies (like the gears in a car)

- ***Bohr's First Postulate:*** Electrons do not radiate energy as they orbit the nucleus. Each orbit corresponds to a state of constant energy (a stationary state).
- Using Balmer's formula, Bohr was able to explain how electrons jump from one energy level to another, which he called electron transition. A quanta of energy is absorbed to allow the electron to jump to the next energy level and when it drops back to the ground state it emits light (a quanta of energy).
- ***Bohr's Second Postulate:*** Electrons can change their energy only by undergoing a transition from one stationary state to another.
- Read "Did you know?" On page 177 → jumps only occur in allowed orbits → no partial quantum numbers.

Successes and Failure of the Bohr Model

- Bohr's model made it possible to explain Mendeleev's periodic table. As you go across a period, the number of elements corresponds to the number of electrons in that energy level (orbit). However, electrons do not orbit like planets around a sun, therefore energy-level diagrams are used.
- E.g. $4e^-$
  $2e^-$ No orbits used because we are talking
  $6p^+$ about energy levels, not orbits.
  C
  Carbon atom

- Bohr's Quantum Model explaining spectra only works for hydrogen. Theoretical calculations and observations became worse as the atoms got bigger.

Homework

- Practice 1
- Questions 1,2,3,4,5,6,7,8,9,10