Chapter 2 Atoms and Elements II

2.3 – 2.5

A little review

- What are the primary substances used for building all others?
- What is the smallest unit characteristic of one of these substances?
- What is a combination of these building blocks in a defined ratio?

Evidence for Atomic Theory

- Law of Conservation of Mass
  - Mass can be neither created or destroyed
  - If matter is made up of indestructible atoms, then any chemical reaction just changes the attachments among atoms, but does not destroy the atoms themselves

- What elements are displayed in the reaction?
Objectives

12. Know the characteristics and locations of the three subatomic particles
13. Know how to calculate the atomic number and mass number of an element
14. Give the definition of an isotope
15. Explain the meaning and origin of the average atomic mass of an element.

Suggested problems: 2.15-2.20, 2.23-2.30, 2.67-2.74

Atomic Structure

- Name the subatomic particles we have mentioned
  - __________
  - __________
  - __________

The Model of the Atom

- Thomson Model
- Rutherford Atomic Model (1911)
- Bohr Model of the Atom (1913)
- (1904)
- (1911)
Atomic Structure Timeline

- 1803 – Dalton – Matter is composed of atoms
- 1897 – Thomson discovers electrons
- 1911 – Rutherford discovers positive, dense nucleus
- 1913, 1914 – Moseley determines charge of nucleus due to protons
- Bohr proposes electrons in specific energy levels
- 1926 – Schrödinger’s electron cloud theory
- 1932 – Chadwick discovers neutron
- 1950s – 70s – quarks and other things

Subatomic Particles

<table>
<thead>
<tr>
<th>Charge</th>
<th>Mass</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton (p)</td>
<td>+1 1.0073 amu</td>
<td>nucleus</td>
</tr>
<tr>
<td>Neutron (n)</td>
<td>0 1.0087 amu</td>
<td>nucleus</td>
</tr>
<tr>
<td>Electron (e−)</td>
<td>-1 0.00055 amu</td>
<td>Outside nucleus</td>
</tr>
</tbody>
</table>

1 amu (atomic mass unit) is defined as 1/12 the mass of the carbon atom with 6 protons and 6 neutrons.

1 amu = 1.7 \times 10^{-24} g

Subatomic Particles

- Convert the masses of each particle to grams. Express in scientific notation.
A Typical Atom

- Protons and neutrons are found in the nucleus, and electrons are found as a cloud outside the nucleus.

Atomic and Mass numbers

- **Atomic number (Z)** –
  - The atomic number identifies an element
  - In a neutral atom, the number of electrons equals the atomic number
- **Mass number (A)** -
  - The number of neutrons for a particular element does not remain constant

Atomic Symbols

- Information on an element is noted in different ways in text and in the periodic table.
Average Atomic Mass

- Which subatomic particle can change without affecting the identity of an element?

- Isotopes – atoms of the same element with different numbers of ____________.

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Average Atomic Mass

- Carbon exists as $^{12}$C, $^{13}$C, and $^{14}$C, all with 6 protons, but 6, 7, and 8 neutrons, respectively.
- We need to average out these atomic masses in order to do calculations with them.

98.9 % is $^{12}$C and 1.1% is $^{13}$C

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Average Atomic Mass

- The periodic table lists the mass of H as 1.00794 amu. Does every H atom have a mass of 1.00794 amu?

- Protium, deuterium, tritium
Separating Isotopes

- Isotopes of an element can be isolated, but it takes considerable effort and expense.

Uranium enrichment is a critical step in transforming natural uranium into nuclear fuel to produce electricity. Uranium is a naturally occurring element containing mostly U-238 and U-235 isotopes. Uranium-235 can be used to make a nuclear bomb.

**Centrifuge Process**

The uranium gas is pumped into the centrifuge at twice the speed of sound. The heavier Uranium-235 is separated from the lighter Uranium-238, increasing the percentage of the centrifuge cylinder.

- The heavier Uranium-235 passes through the separator and enriches the cylinder to over 90%.
- Uranium-238 passes through the separator and remains in the nuclear fuel.

The reactor consumes 1% of the 235,000 kilograms of Uranium-235 to enrich it further. A single centrifuge cylinder is typically six inches in diameter.