Read Section 3.5 before viewing slide show.
Unit 11
The Atomic Nucleus

• Identification of Three Subatomic Particles (3.5)
• Arrangement of Subatomic Particles (3.5)
• Definitions of atomic number, mass number, isotope (3.5)
• Based on the previously considered experimental evidence, in the early 1900’s there were three identified subatomic particles.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Symbol</th>
<th>Mass(u)</th>
<th>Charge</th>
<th>Location in Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>p⁺</td>
<td>1</td>
<td>1⁺</td>
<td>Nucleus</td>
</tr>
<tr>
<td>Neutron</td>
<td>n</td>
<td>1</td>
<td>0</td>
<td>Nucleus</td>
</tr>
<tr>
<td>Electron</td>
<td>e⁻</td>
<td>1/1837</td>
<td>1⁻</td>
<td>Outside nucleus</td>
</tr>
</tbody>
</table>

• The neutron was suspected to exist due to unaccounted mass in the atom, but was not discovered until 1932.
• The masses are relative. The proton and neutron are about the same with the electron with a lot less mass.
A very simple picture of the atom would be like that shown here.
The protons and neutrons are in the nucleus.
The electrons are somehow outside of the nucleus. It is not a simple sort of planetary look.
Definitions of Terms

• The number of protons in the nucleus is called the atomic number \((Z)\) and identifies the element. When looking at the periodic chart you will see an integer in each box which is the atomic number.

• The sum of the protons and neutrons is called the mass number \((A)\) – you will not find this on the periodic chart.

• The number of electrons equals the number of protons in an electrically neutral atom.

• The atom pictured would be boron since there are five protons - its atomic number is five.
Isotopes

• Often an element can exist in multiple forms which vary only in the number of neutrons present in the nucleus. Two atoms of the same element with differing numbers of neutrons are called isotopes.

• Examples:
  • Carbon exists as isotopes with 6 protons and 6, 7, or 8 neutrons (mass numbers of 6+6=12, 6+7=13, or 6+8=14)
  • Chlorine exists as isotopes with 17 protons and either 18 or 20 neutrons (mass numbers of 17+18=35 or 17+20=37)
  • Hydrogen exists as isotopes 1 proton with 0, 1, or 2 neutrons (mass numbers of 1+0=1, 1+1=2, or 1+2=3)
Symbols for Isotopes

• A system is used to represent the various isotopes of elements. The base of the system is:

\[
\text{mass number} \quad \frac{A}{\text{ChemicalSymbol}} \quad \text{or} \quad \frac{A}{Z} X
\]

where \( A \) represents the mass number and \( Z \) the atomic number.

• Consider the examples from the previous page:

\[
\begin{align*}
12^6C & \quad 13^6C & \quad 14^6C \\
35^{17}Cl & \quad 37^{17}Cl \\
1^1H & \quad 2^1H & \quad 3^1H
\end{align*}
\]
Charged Particles (Ions)

• An atom can gain or lose electrons to form charged species called ions.
• Since an electron is negative, a loss of electrons leads to a positive ion referred to as a cation.
• A gain of electrons leads to a negative ion referred to as an anion.
• The charge on an ion is indicated as a superscript to the right of the symbol.
• Examples on next slide.
Examples of Charged Particles (Ions)

• A neutral chlorine (Cl) atom has 17 protons and 18 electrons. If the atom gains an electron it will have a 1\(^-\) charge. If the mass number is 35, the symbol would be \(^{35}_{17}\text{Cl}^-\). Because the ion is negative, it is an example of an anion.

• A neutral barium atom (Ba) has 56 protons and 56 electrons. If the atom loses two electrons it will have a 2\(^+\) charge. If the mass number is 137, the symbol would be \(^{137}_{56}\text{Ba}^{2+}\). Because the ion is positive, it is an example of a cation.
Want Some Practice?

• For practice, you can try the following simulation.
  • Go to [http://phet.colorado.edu/en/simulation/build-an-atom](http://phet.colorado.edu/en/simulation/build-an-atom) and click on either Download or Run Now
  • Hit the “+” signs next to Symbol, Mass Number, and Charge to see the changes as you build various atoms and ions
  • To build atoms and ions drag protons, neutrons, and electrons to the atomic structure
  • You can click the Game tab to check yourself by playing a game building requested species.