Solutions to:
Atoms and Elements Homework Problem Set
Chemistry 145, Chapter 2

1. How many protons, neutrons and electrons are present in the following:
   
   a. $^1\text{H}$
   
   From the information given,
   
   \[
   \text{at}\_\text{number} := 1 \quad \text{at}\_\text{mass} := 1 \quad \text{charge} := 0
   \]
   
   note: The atomic number is from looking up H (hydrogen) on the periodic table, this is usually given above the symbol of the element. The atomic mass is given by the superscript 1 before the H ($^1\text{H}$). The charge is given as a superscript number after the atomic symbol, since none is given it is assumed to be 0.

   Calculations,
   
   \[
   \text{proton} := \text{at}\_\text{number} \quad \text{neutron} := \text{at}\_\text{mass} - \text{at}\_\text{number} \quad \text{electron} := \text{at}\_\text{number} - \text{charge}
   \]
   
   Answers,
   
   proton = 1 \quad neutron = 0 \quad electron = 1
   
   b. $^2\text{H}$
   
   From the information given,
   
   \[
   \text{at}\_\text{number} := 1 \quad \text{at}\_\text{mass} := 2 \quad \text{charge} := 0
   \]

   Calculations,
   
   \[
   \text{proton} := \text{at}\_\text{number} \quad \text{neutron} := \text{at}\_\text{mass} - \text{at}\_\text{number} \quad \text{electron} := \text{at}\_\text{number} - \text{charge}
   \]

   Answers,
   
   proton = 1 \quad neutron = 1 \quad electron = 1
   
   c. $^3\text{H}$
   
   From the information given,
   
   \[
   \text{at}\_\text{number} := 1 \quad \text{at}\_\text{mass} := 3 \quad \text{charge} := 0
   \]

   Calculations,
   
   \[
   \text{proton} := \text{at}\_\text{number} \quad \text{neutron} := \text{at}\_\text{mass} - \text{at}\_\text{number} \quad \text{electron} := \text{at}\_\text{number} - \text{charge}
   \]

   Answers,
   
   proton = 1 \quad neutron = 2 \quad electron = 1
d. $^{13}\text{N}$

From the information given,

\[ \text{at\_number} := 7 \quad \text{at\_mass} := 13 \quad \text{charge} := 0 \]

Calculations,

\[ \text{proton} := \text{at\_number} \quad \text{neutron} := \text{at\_mass} - \text{at\_number} \quad \text{electron} := \text{at\_number} - \text{charge} \]

Answers,

\[ \text{proton} = 7 \quad \text{neutron} = 6 \quad \text{electron} = 7 \]

e. $^{14}\text{N}$

From the information given,

\[ \text{at\_number} := 7 \quad \text{at\_mass} := 14 \quad \text{charge} := 0 \]

Calculations,

\[ \text{proton} := \text{at\_number} \quad \text{neutron} := \text{at\_mass} - \text{at\_number} \quad \text{electron} := \text{at\_number} - \text{charge} \]

Answers,

\[ \text{proton} = 7 \quad \text{neutron} = 7 \quad \text{electron} = 7 \]

f. $^{15}\text{N}$

From the information given,

\[ \text{at\_number} := 7 \quad \text{at\_mass} := 15 \quad \text{charge} := 0 \]

Calculations,

\[ \text{proton} := \text{at\_number} \quad \text{neutron} := \text{at\_mass} - \text{at\_number} \quad \text{electron} := \text{at\_number} - \text{charge} \]

Answers,

\[ \text{proton} = 7 \quad \text{neutron} = 8 \quad \text{electron} = 7 \]

g. $^{79}\text{Br}$

From the information given,

\[ \text{at\_number} := 35 \quad \text{at\_mass} := 79 \quad \text{charge} := 0 \]

Calculations,

\[ \text{proton} := \text{at\_number} \quad \text{neutron} := \text{at\_mass} - \text{at\_number} \quad \text{electron} := \text{at\_number} - \text{charge} \]

Answers,

\[ \text{proton} = 35 \quad \text{neutron} = 44 \quad \text{electron} = 35 \]
h. $^{81}\text{Br}^-$

From the information given,

\[
\begin{align*}
\text{at}_{\text{number}} & := 35 & \text{at}_{\text{mass}} & := 81 & \text{charge} & := -1 \\
\end{align*}
\]

Calculations,

\[
\begin{align*}
\text{proton} & := \text{at}_{\text{number}} & \text{neutron} & := \text{at}_{\text{mass}} - \text{at}_{\text{number}} & \text{electron} & := \text{at}_{\text{number}} - \text{charge} \\
\end{align*}
\]

Answers,

\[
\begin{align*}
\text{proton} & = 35 & \text{neutron} & = 46 & \text{electron} & = 36 \\
\end{align*}
\]

i. $^{262}\text{Bh}$

From the information given,

\[
\begin{align*}
\text{at}_{\text{number}} & := 107 & \text{at}_{\text{mass}} & := 262 & \text{charge} & := 0 \\
\end{align*}
\]

Calculations,

\[
\begin{align*}
\text{proton} & := \text{at}_{\text{number}} & \text{neutron} & := \text{at}_{\text{mass}} - \text{at}_{\text{number}} & \text{electron} & := \text{at}_{\text{number}} - \text{charge} \\
\end{align*}
\]

Answers,

\[
\begin{align*}
\text{proton} & = 107 & \text{neutron} & = 155 & \text{electron} & = 107 \\
\end{align*}
\]

2. What is the Atomic Weight of chlorine given that there are two isotopes and:

The exact mass of $^{35}\text{Cl}$ is 34.9689 and the relative abundance is 75.53 %

The exact mass of $^{37}\text{Cl}$ is 36.9659 and the relative abundance is 24.47 %

Is this the answer that you expected?

The information given,

\[
\begin{align*}
\text{mass }_{35} & := 34.9689 & \text{abundance }_{35} & := 75.53\% & \text{abundance }_{35} & = 0.755 \\
\text{mass }_{37} & := 36.9659 & \text{abundance }_{37} & := 24.47\% & \text{abundance }_{37} & = 0.245 \\
\end{align*}
\]

The average atomic mass (atomic weight)

\[
\begin{align*}
\text{mass }_{35}\text{abundance }_{35} + \text{mass }_{37}\text{abundance }_{37} & = 35.458 \\
\end{align*}
\]

Comparing this result with the value given in the periodic table of 35.4527 agrees to the expected number of significant figures (4).
What is the Atomic Weight of Ruthenium given the following information:

The information given,

<table>
<thead>
<tr>
<th>Mass</th>
<th>Abundance</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>5.54%</td>
<td>0.055</td>
</tr>
<tr>
<td>98</td>
<td>1.87%</td>
<td>0.019</td>
</tr>
<tr>
<td>99</td>
<td>12.76%</td>
<td>0.128</td>
</tr>
<tr>
<td>100</td>
<td>12.60%</td>
<td>0.126</td>
</tr>
<tr>
<td>101</td>
<td>17.06%</td>
<td>0.171</td>
</tr>
<tr>
<td>102</td>
<td>31.55%</td>
<td>0.316</td>
</tr>
<tr>
<td>104</td>
<td>18.62%</td>
<td>0.186</td>
</tr>
</tbody>
</table>

The average atomic mass (atomic weight)

\[
\text{mass}_{96} \times \text{abundance}_{96} + \text{mass}_{98} \times \text{abundance}_{98} + \text{mass}_{99} \times \text{abundance}_{99} + \text{mass}_{100} \times \text{abundance}_{100} + \text{mass}_{101} \times \text{abundance}_{101} + \text{mass}_{102} \times \text{abundance}_{102} + \text{mass}_{104} \times \text{abundance}_{104} = 101.065
\]

Comparing this result (101.07) with the value given in the periodic table of 101.07 agrees to the expected number of significant figures (2). Notice that the atomic weights (average atomic mass) is not known to the same precision for all elements. This is largely because the natural abundance of each isotope varies more for some elements. It is possible to measure the exact mass and the abundance with VERY great precision.
4. Using a blank periodic table, fill in the atomic number, name, atomic symbol, and atomic weight of the first 36 elements. Also label the noble gases, the halogens, the alkali metals, the metals, and the non-metals.

This may be a bit tedious, but you will use these elements frequently throughout the course, and in any future chemistry courses. You need to know the symbols for AT LEAST the first 36 elements from memory and will be responsible for them on future exams, quizzes, and homework.

5. Use the mass spectrum for chromium given below to determine the atomic weight.

For previous problems like this you were given the exact mass and the abundance for each isotope of an element. This information is obtained from the mass spectrum of the element. In this problem, you are given the mass spectrum and need to determine the exact mass and abundance of each isotope. In the mass spectrum the total abundance of each peak is scaled so that the large has a signal of 100.

From the spectrum I obtain the following values (yours may differ slightly, that is OK)

<table>
<thead>
<tr>
<th>Mass</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>49.95</td>
</tr>
<tr>
<td>52</td>
<td>51.95</td>
</tr>
<tr>
<td>53</td>
<td>52.95</td>
</tr>
<tr>
<td>Intensity</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>52</td>
<td>100</td>
</tr>
<tr>
<td>53</td>
<td>10</td>
</tr>
</tbody>
</table>

Next to determine the percent abundance.

\[
\text{Abundance}_{50} = \frac{\text{Intensity}_{50}}{\text{Total Intensity}} = \frac{5}{115.000} = 4.348\%
\]
\[
\text{Abundance}_{52} = \frac{\text{Intensity}_{52}}{\text{Total Intensity}} = \frac{100}{115.000} = 86.957\%
\]
\[
\text{Abundance}_{53} = \frac{\text{Intensity}_{53}}{\text{Total Intensity}} = \frac{10}{115.000} = 8.696\%
\]

Finally, calculate the atomic weight (average atomic mass),

\[
\text{Atomic Weight} = \text{Mass}_{50} \times \text{Abundance}_{50} + \text{Mass}_{52} \times \text{Abundance}_{52} + \text{Mass}_{53} \times \text{Abundance}_{53} = 51.950 + 51.950 + 51.950 = 155.85\%
\]

This is very close to the value given in the periodic table (51.9961). How many significant figures does this solution have?

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