Chemistry Lecture #28: History of the Periodic Chart

In the late 1790's Lavoisier compiled a list of 23 known elements. By 1870, there were 70 known elements. Chemist began to notice that some elements had similar properties, and could be grouped by their properties. They also noticed that there was a pattern to the groupings.

In 1829, Johann Wolfgang Dobereiner (1780-1849) placed elements into groups by their chemical properties. Each group had three members. He called these groups "triads." Below are some of the groups he created.

Group 1	Group 2	Group 3	Group 4
Li	Ca	S	Cl
Na	Sr	Se	Br
K	Ba	Te	I (Iodine)

Li, Na, and K are soft metals. They all react with water to produce an alkaline solution. An alkaline solution tastes bitter and feels slippery.

Ca, Sr, and Ba will react with hot water to make an alkaline solution. They also conduct electricity better than Li, Na, and K.

S, Se, and Te all combine with hydrogen to made acidic substances.

Cl, Br, and Iodine all react with metals to form compounds similar to salt.

Dobereiner also noticed that the atomic mass of the second element in a group is close to the average of the first and third elements.

For example, Na has an atomic mass of 22.99 amu. If you take the average of Li (6.941 amu) and K (39.098 amu), you get

$$(6.941 + 39.098)/2 = 23.019$$

which is pretty close to 22.99 amu. Try it with the other groups and see if it works.

In 1864 English chemist John Newlands (1837-1898) listed the elements from lightest to heaviest. In doing so, he noticed that the chemical properties repeated with every 8th element. He called this property the Law of octaves.

Li Be B C N O F Na Mg Al Si P S Cl K
1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8

Li, Na, and K share similar properties. Likewise, C and Si are similar, as are F and Cl.

In 1869 Dmitri Mendeleev (1834-1907) also listed the elements in horizontal rows from lightest to heaviest. He started new rows when properties began to repeat. He also spaced the elements so that elements in vertical columns shared similar properties.

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca	?	?	As	Se	Br
	Sr	In	Sn	Sb	Te	I
	Ba					

Notice that two of Dobereiner's triads (Li, Na, K, and Ca, Sr, Ba) appear in the first two vertical columns.

Spacing the elements so that they fit into the correct vertical columns created gaps in the chart. If you look at the 3rd horizontal column starting with K there are two gaps between Ca and As. Mendeleev believed that the blank spaces represented undiscovered elements. He correctly predicted the properties of gallium, germanium and other elements before their discovery.

Mendeleev's system was not perfect. Listing elements from lightest to heaviest occasionally placed elements into the wrong vertical column.

For example, iodine has an atomic mass of 126.9 amu and tellurium has a mass of 127.80 amu, so iodine should be listed before tellurium. Doing so would put iodine into a column with Se, S, and O, and iodine does not have the same properties as these elements.

Likewise, tellurium's properties do not match those of Br, Cl, and F. Mendeleev put tellurium and iodine in their correct columns and suggested that the atomic mass of tellurium had not been measured correctly (he was wrong - tellurium was indeed heavier than iodine).

Instead of listing elements by atomic mass, another method was needed. In 1914 Henry Moseley (1887-1915) succeeded in using the x-ray spectra of elements to measure their atomic number. Elements could now be listed in order of their atomic number.

Listed by atomic number, tellurium (atomic # 52) could now be listed before iodine (atomic #53), allowing tellurium to be placed below Se, S, and O. Likewise, iodine could now be placed below Br, Cl, and F. Iodine and tellurium were now in columns with other elements that shared the same chemical properties.

The modern periodic chart now lists elements by their atomic number.