Historical Development of the Periodic Table

http://www.privatehand.com/flash/elements.html

Mr. Shields Regents Chemistry U08 L01 1

John Dalton & Atomic Theory 1803

Check out some Of the names

30 elements were known in 1803

- Dalton came up with the first table of atomic weights.
  - Atoms of different elements have different weights.

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Berzelius - 1828

- Published a much better table of atomic masses than Dalton's
  - Ex. Based on H = 1 Oxygen was equal to 16.
  - Introduced the use of <u>LETTERS</u> to symbolize the elements
    - Replaced use of alchemist symbols
- Approximately 51 elements known up to this time

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Johann Dobereiner (1780-1849)- triads

- 1817: Dobreiner grouped elements based on <u>similarities</u>.
- Ca (atomic mass 40), Sr (atomic mass 88), and Ba (atomic mass 137) possess <u>similar chemical properties</u>.
- When grouped together as a triad physical properties could be predicted
  - Examples: Atomic weight, BP, MP, Density

This was known as the <u>Theory of Triads</u>

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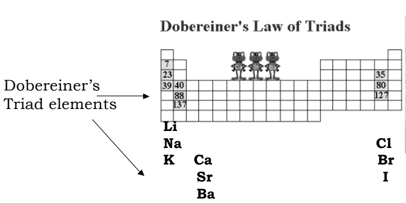
Johann Dobereiner - triads



Using triads you would <u>predict</u> the atomic weight of strontium
Should be <u>midway</u> between the weights of calcium and barium

Sr = (40 + 137) ÷ 2 = <u>88.5</u> (actual = <u>87.6</u>)
a <u>little</u> off, but not too bad!

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Triads

Triads could not only be used to estimate <u>mass</u> but Also worked reasonably well with other properties Such as <u>mp</u> or <u>density:</u>

$$\frac{A + C}{2} = B$$

Problem: Density of Ca = 1.55g/cm^3 & Ba = 3.5g/cm^3

Calculate the density of Strontium?

Ans: (1.55 + 3.5)/2 = 2.52;

Actual Sr density = 2.6g/cm^3

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Johann Dobereiner - triads

Soon other scientists found chemical relationships extended beyond Dobereiner's triads.

Fluorine (F) was added to Cl/Br/I group.

Oxygen, sulfur, selenium and tellurium were grouped into a family.

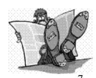
Nitrogen, phosphorus, arsenic, antimony, and bismuth were classified as another group.

Well, not perfect but it was a start!

F
Cl
Br
I

O
S
Se
Te

N
P
As
Sb
Bi



John Newlands - Octaves

John Newlands – 1837- 1898

When ordering the elements by atomic weight he noticed the properties of the 8th element were like the 1st

Li Be B C N O F
Na Mg (Noble gases were not then known)

And the properties of the 2nd element were similar to the 9th and so on.

Hence he named this the Law of Octaves (7 Feb 1863).

John Newlands - Octaves

Newland's octave arrangement of the elements was ridiculed by the English Chemical Society who refused to Publish his paper.

But Newlands was on the right track!

Belatedly in 1887 (15 years after his discovery) The Royal Society awarded Newlands the Prestigeous Davy Award.

Dmitri Mendeleev (1834-1907)

In the late 1860s (after Newlands), Mendeleev began working on trying to organize the elements by their properties.

In 1869 he achieved his goal by arranging all of the 63 Known elements by their properties and their atomic weights.

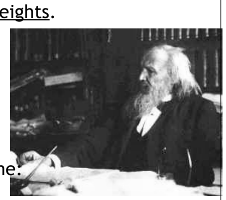
Dmitri Mendeleev (1834-1907)

Dmitri Mendeleev

Elements were organize into GROUPS having similar Chemical properties.

In 1869 Medeleev arranged all of the 63 known elements by their properties and their atomic weights.

Where a gap existed in the table, Mendeleev predicted a new element would one day be found!



He was right! Three predicted missing elements were found during his Lifetime.

Gallium (Ga), scandium (Sc), and germanium (Ge).

How did Mendeleev know the element below Al should have a mass of 44?

Predicted elements Sc, Ga, Ge

TABELLE II

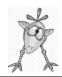
REIHEN	GRUPPE I. — R^2O	GRUPPE II. — RO	GRUPPE III. — R^2O^3	GRUPPE IV. RH^4 RO^2	GRUPPE V. RH^3 R^2O^5	GRUPPE VI. RH^2 RO^3	GRUPPE VII. RH R^2O^7	GRUPPE VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

Notice the missing Noble gase

Figure 2.5 Dmitri Mendeleev's 1872 periodic table. The spaces marked with blank lines represent elements that Mendeleev deduced existed but were unknown at the time, so he left places for them in the table. The symbols at the top of the columns (e.g., R^2O and RH^4) are molecular formulas written in the style of the 19th century.

The noble gases were not discovered until the late 1890's

Mendeleev's prediction of the element Germanium along with it's properties



Properties of Element 32

Property	Eka-silicon (Predicted in 1871)		Germanium (Discovered in 1886)
Atomic Weight	72		72.6
Density (g/cm^3)	5.5	⟷	5.47
Melting Pt. (°C)	High	NOT BAD!	947
Formula of Oxide	RO_2		GeO_2
Density of Oxide (g/cm^3)	4.7		4.703

☞ The Periodic Law

The PERIODIC LAW forms the basis for the organization of the Periodic Table.

" When elements are arranged in order of Increasing **atomic number** *(mass during Mendeleev's time)* their physical and Chemical properties show a **predictable periodic pattern**"

i.e. the properties of yet undiscovered elements can be predicted based on their apparent location in the Periodic table.

Atomic Weights

- Between 1860 and 1905, more refined measurements of atomic weights were made.
- Additional elements were discovered
  - Total in 1905 = 84
  - Including all the noble gases between 1895-1905
- Element with the lowest atomic weight is hydrogen. For a while, H was used as the standard for 1 atomic mass.

  - Today C-12 is the standard (12.000 amu).

Moseley: Atomic Number (1913)

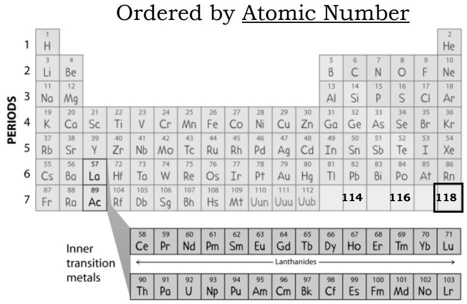
- While experimenting with the creation of x-rays he discovered the wavelength of x-rays varied by an integer value (n) from one metal to another according to the equation: $(\text{frequency})^{1/2} = n$
- interpreted "n" to be the positive charge on the nucleus.
- He suggested that the size of the nuclear charge increased by 1 with each step up the Periodic Table
  - He called "n" the atomic number

Henry G. J. Moseley (1887_1915)

- Based on Moseley's discovery, the periodic table was reordered by increasing *Atomic Number* instead of by mass.
- This Solved certain problems with Mendeleev's atomic mass sequence in which some elements seemed to be out of order
  - for example Co/Ni; Te/I

The Modern Periodic Table

Ordered by Atomic Number



How Can you Predict the BP of This new Element?

BP:

Xe 166
Rn 211
118 x?

(166 + x)/2 = 211 x=256K