

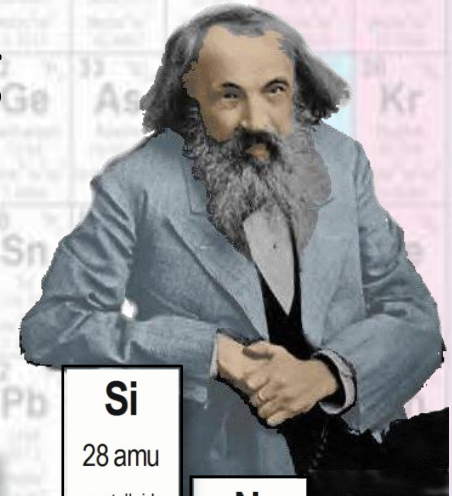
Development of the Periodic Table

Mendeleev
vs

Moseley

Mendeleev

- Dmitri Mendeleev (1869) prepared a card for each of the known elements listing
 - the symbol,
 - the atomic mass,
 - and the chemical properties.



Be
9 amu
active metal

S
32 amu
active nonmetal

Li
7 amu
very active metal

Al
27 amu
metal

P
31 amu
nonmetal

C
12 amu
metalloid

Cl
35 amu
very active nonmetal

O
16 amu
active nonmetal

F
19 amu
very active nonmetal

Mg
24 amu
active metal

Na
23 amu
very active metal

Si
28 amu
metalloid

N
14 amu
nonmetal

B
11 amu
metal

More Mendeleev

- Mendeleev arranged the cards in order of increasing atomic mass.
- He noticed a pattern.

Li 7 amu very active metal	Be 9 amu active metal	B 11 amu metal	C 12 amu metalloid	N 14 amu nonmetal	O 16 amu active nonmetal	F 19 amu very active nonmetal	Na 23 amu very active metal	Mg 24 amu active metal	Al 27 amu metal	Si 28 amu metalloid	P 31 amu nonmetal	S 32 amu active nonmetal	Cl 35 amu very active nonmetal
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- The properties repeated regularly.

Even More Mendeleev

- Mendeleev moved the cards, keeping them in order of mass, so the first one with repeating properties was under the one similar to it.

Li 7 amu very active metal	Be 9 amu active metal	B 11 amu metal	C 12 amu metalloid	N 14 amu nonmetal	O 16 amu active nonmetal	F 19 amu very active nonmetal
Na 23 amu very active metal	Mg 24 amu active metal	Al 27 amu metal	Si 28 amu metalloid	P 31 amu nonmetal	S 32 amu active nonmetal	Cl 35 amu very active nonmetal

- The cards thus arranged formed groups or families with similar properties.
- This arrangement forms the basis for the first Periodic Table.

Mendeleev's Periodic Law

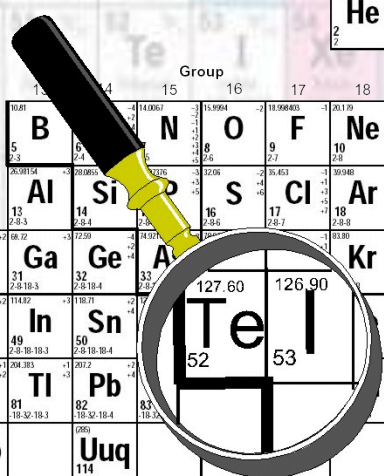
- Based on his observations, Mendeleev concluded:

When the elements are arranged in increasing order of atomic mass, the chemical properties repeat periodically.

- This is known as the ***Periodic Law***.

Could Mendeleev be Wrong?

- Look through the Periodic Table. Are all the elements in order with respect to mass? **No**
- Which elements are out of order with respect to mass? **Ar–K; Co–Ni; Te–I; Th–Pa; U–Np; Pu–Am**
- Mendeleev was aware of some of these discrepancies.
 - He knew that if tellurium and iodine were in the right family, they were out of order with respect to mass.
 - He believed that when scientists improved techniques for measuring atomic mass, these discrepancies would disappear.



11		12		13		14		15		16		17		18	
Cu		Zn		Ga		Ge		As		Se		Br		Kr	
63.546 29 2-8-18-1	65.39 30 2-8-18-2	69.72 31 2-8-18-3	72.63 32 2-8-18-4	74.921 33 2-8-18-5	75.94 34 2-8-18-6	78.96 35 2-8-18-7	81.904 36 2-8-18-8	85.463 37 2-8-18-9	89.904 38 2-8-18-10	91.904 39 2-8-18-11	95.94 40 2-8-18-12	101.07 41 2-8-18-13	106.905 42 2-8-18-14	112.905 43 2-8-18-15	118.905 44 2-8-18-16
107.868 47 2-8-18-18-1	112.411 48 2-8-18-18-2	114.818 49 2-8-18-18-3	118.710 50 2-8-18-18-4	127.60 52 2-8-18-18-6	126.90 53 2-8-18-18-7	178.48 81 2-8-18-18-13	208.98 82 2-8-18-18-14	208.97 83 2-8-18-18-15	208.97 84 2-8-18-18-16	208.97 85 2-8-18-18-17	208.97 86 2-8-18-18-18	208.97 87 2-8-18-18-19	208.97 88 2-8-18-18-20	208.97 89 2-8-18-18-21	208.97 90 2-8-18-18-22
196.967 79 2-8-18-32-1	200.59 80 2-8-18-32-2	200.59 81 2-8-18-32-3	208.97 82 2-8-18-32-4	208.97 83 2-8-18-32-5	208.97 84 2-8-18-32-6	208.97 85 2-8-18-32-7	208.97 86 2-8-18-32-8	208.97 87 2-8-18-32-9	208.97 88 2-8-18-32-10	208.97 89 2-8-18-32-11	208.97 90 2-8-18-32-12	208.97 91 2-8-18-32-13	208.97 92 2-8-18-32-14	208.97 93 2-8-18-32-15	208.97 94 2-8-18-32-16
111 111 1-11-1	112 112 1-11-1	113 113 1-11-1	114 114 1-11-1	115 115 1-11-1	116 116 1-11-1	117 117 1-11-1	118 118 1-11-1	119 119 1-11-1	120 120 1-11-1	121 121 1-11-1	122 122 1-11-1	123 123 1-11-1	124 124 1-11-1	125 125 1-11-1	126 126 1-11-1

He was wrong!!

Did Mendeleev Make Sense?

- Mendeleev found an important pattern – repetition of properties. But does it make sense to think that the pattern is caused by mass?
- What parts of an atom affect its mass?
protons and neutrons
- What parts of an atom affect its properties?
protons and electrons
- Today we know that different isotopes of the same element have the same properties, but have different masses because of neutrons which affect the mass, but not the properties.
- **Mendeleev does not make sense. Mass does not cause chemical properties.**

Moseley

- When the elements were ordered so each was in the correct family some were out of order with respect to mass.
- When the elements are placed in the proper order, they are numbered sequentially. This number is called the **atomic number**.
- By using a technique called X-ray diffraction, Henry Moseley (1913) showed that the atomic number was the nuclear charge or the number of protons.



The Real Periodic Law

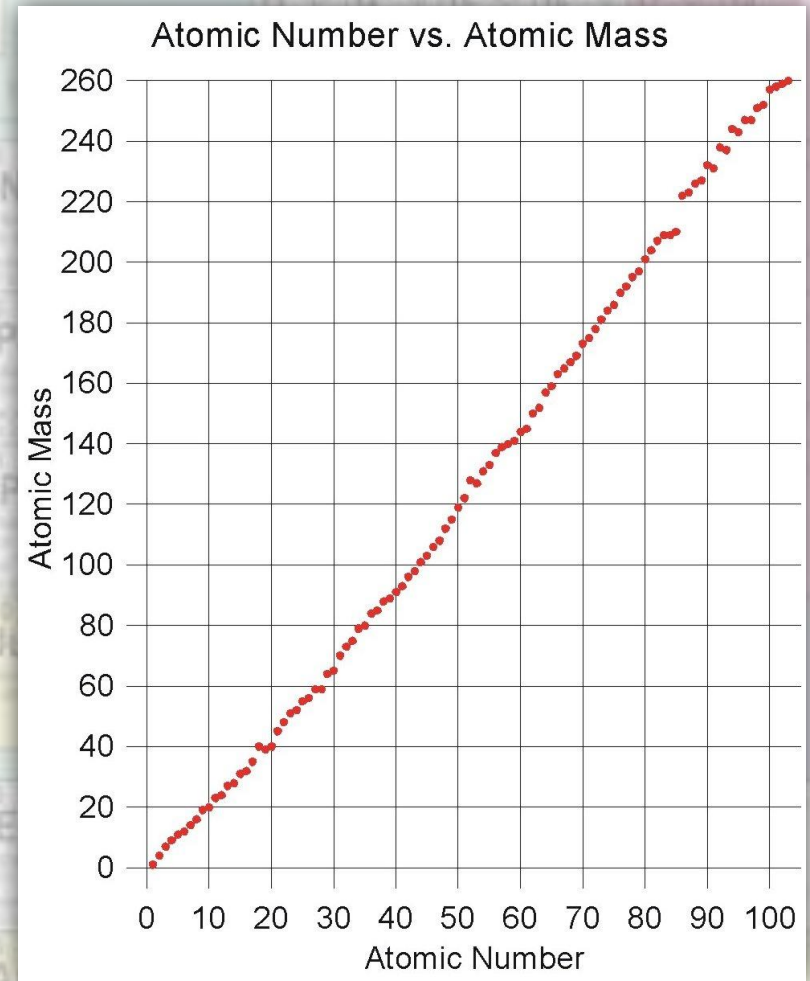
- Moseley showed that when the elements are arranged in order of atomic number (as measured by X-ray diffraction), the discrepancies in Mendeleev's Periodic Table disappear.
- Moseley corrected the *Periodic Law*:

When the elements are arranged in increasing order of atomic number, the chemical properties repeat periodically.

- This is the basis for the modern Periodic Table.

How did Mendeleev Succeed (even though he was wrong)?

- When Mendeleev arranged the elements in order of increasing mass, he inadvertently arranged them in order of atomic number, with few exceptions.
- The graph to the right shows that there is a direct relationship between atomic mass and atomic number.



What Information is on the Periodic Table?

- Each element has its own box on the *Periodic Table* with a lot of information in it.
- There is a key to tell you what information in each box means. Although Periodic Tables differ, most have the same basic information.
- Starting from the top of the box, the information on the key to the right is as follows:

KEY

Atomic Mass	12.0111	-4
Common Oxidation States		+2 +4
Symbol	C	
Atomic Number	6	
Electron Configuration	2-4	

- [1] **atomic mass** - weighted average of the mass of the common isotopes of the element;
- [2] **common oxidation states** - tells number of electrons lost, gained or shared during bonding;
- [3] **symbol** - one, two, or three letters related to the name with the first letter capitalized and other letters lower case. The three letter symbols are systematic names that represent the atomic numbers of unnamed elements;
- [4] **atomic number** - number of protons; and
- [5] **electron configuration** - arrangement of electrons in energy levels