**The Periodic Table Module**

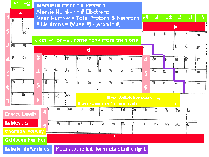
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| Student Objectives | | |
| * Know the history of the development of the periodic table. * Know the chemical symbols and names of the 50 most commonly used elements. * Use atomic numbers and mass numbers to determine the number of electrons, protons, and neutrons in an atom. * Read the following information directly from the periodic table:   + Whether an element occurs naturally or is man-made.   + The physical state of an element at room temperature.   + Whether and element is a metal or nonmetal.   + How the chemical activity of one element relates to another element.   + The members of each family of elements.   + The oxidation number of an atom.   + Electron energy levels, sublevels, and orbitals.   + The electron configuration of an atom. |  |  |

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|  | **The 1954 Periodic Table**  **showing elements 1-98**  **The 1964 edition added elements 99-103**  **The 1994 edition added elements 104-109** |

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| **3 new elements discovered in 1999!!** | **168 elements??** |

Review the **development of the periodic table**.   
The table is based on current atomic theory. Review how the **atomic theory has changed**.   
Another website with a **history of the periodic table**.



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| |  | | --- | | **The periodic table is your most important chemistry tool !** | |

The periodic table contains a wealth of chemistry information, if you know how to read it. Freshman physical science students begin learning to read the periodic table. Chemistry students must expand their understanding of the information on the table. Your science facilitator will provide a periodic table that may be used in any way you wish.

*Make notes on the front and back and use it at any time to make your life easier this year. This paper table and the class wall table are the only ones that are always available for use during class...*

**Two more periodic tables** links



**Each element is represented by a square providing information about it.**

* **Element name:**



Many periodic tables do not have the name of the elements in each square. For this reason you should be familiar with the names and symbols of the most commonly used elements.

* **Chemical symbol:**



The one or two letter symbol. The first letter always capital case, the second letter always small case.

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|  | *Do not be sloppy as you write chemical symbols*. |

* **Atomic number:**



The whole number in every square.

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|  | *There is no standard for the location of the information in each square. Different periodic tables may have a different arrangement.* |

* **Mass number:**

The number with a decimal fraction in most sqares. In most squares, this number represents the average of all isotopes. If the number is a whole number, it represents the most stable isotope.

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|  | *In our class, always round off the decimal fraction to the nearest whole number for any question about the mass number of an element.* |

* **Number of protons in atom:**

Always equal to the atomic number. *If the number of protons change, the element becomes another element.*

* **Number of electrons in atom:**

Equal to the atomic number in a normal atom. *The numbers of electrons are easily changed within an atom. If the chemical symbol is written with a charge, representing an ion, the charge indicates the number of electrons that have been added or removed.*

* **Number of neutrons in atom:**

Subtract the atomic number from the mass number to find the number of neutrons. *To do this calculation in our class, round off the average mass number to the nearest whole number before doing the subtraction. There is never a fraction of a neutron in an atom.*

* Review the **quark model of subatomic particles**



The actual mass of subatomic particles is so small that it is usually expressed in a unit known as electron volts. An **electron volt** is a measure of energy equal to the energy gained by a single electron when it is accelerated across an electric potential difference of 1 volt: 1 eV = 1.602 X 10 -19 joules. Because this unit is so small, it is commonly expressed as keV (thousand), MeV (million), or GeV (billion).

Since Einstein showed that mass and energy are interchangeable, dividing electron volts by the square of the speed of light gives a mass. By substituting 1 for the constant speed of light, electron volts becomes a mass. While this substitution may seem odd, it is commonly done with constants (natural units) in complicated calculations. The exact numbers can be replaced at the end of the calculation to give a numerical value to the final answer.

The mass of an average sized person would be 4 X 10 31 MeV, which is another way of saying that the average person is made up of about 4 X 10 28 baryons.

* + The mass of an electron is 0.5110 MeV.
  + The mass of a proton is 938.2796 MeV.
  + The mass of a neutron is 939.5729 MeV.

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|  | The vertical columns on all periodic tables are numbered at the top. However, different tables may have different numbering systems. **The periodic table on the wall in our classroom numbers the columns 1 to 18, from left to right. We will refer to the columns using these numbers.** Some tables also have the older system using Roman numerals and letters. We will not use that system. |  |

**The following information can be read directly from many periodic tables.**

* **Natural and manmade elements:**

There are different colors of chemical symbols on *some* periodic tables. Our class wall table shows manmade elements with a white (black outline) chemical symbol. All other elements are naturally occuring elements.

* **Physical state of the element at room temperature:**

There are different colors of chemical symbols on *some* periodic tables. Our class wall table shows solid elements with black chemical symbols, liquid elements with blue chemical symbols, and gas elements with red chemical symbols.

* **Metals and nonmetals:** *Some* periodic tables have a **line dividing these two**, . The dividing line begins between boron and aluminum and stair-steps down and to the right, one square at a time. Metals are left of the line, nonmetals are to the right.



* **Chemical activity:**
  + Metals increase in chemical activity as you go from right to left on a horizontal row and from top to bottom in a vertical column.
  + Nonmetals increase in chemical activity as you go from left to right on a horizontal row and from bottom to top in a vertical column.
  + The elements in the far right-hand column on the periodic table are chemically inert.

  **Families of elements:**



Families contain elements with similar characteristics, usually determined by the number of electrons in the outer electron energy level. Families on the periodic table are in vertical columns called "groups". Some resources will identify 10 families. We will recognize only 9 families in this class. The difference involves the placement of the Lanthanoid Series (elements 57 - 71) and Actinoid Series (elements 89 - 103). Some references will place these two series in a family known as the "Rare-earth Metals". We will consider them as part of the "Transition Metal Family".

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| **Group #** | **Family Name & Notes** | **Elements in the Family** |
| 1 | Alkali Metals | H, Li, Na, K, Rb, Cs, Fr |
| 2 | Alkaline Earth Metals | Be, Mg, Ca, Sr, Ba, Ra |
| 3 - 12 | Transition Metals  Including the Lanthanoid and Actinoid Series (Rare Earth Metals) | See this periodic table |
| 13 | Boron Group | B, Al, Ga, In, Tl |
| 14 | Carbon Group | C, Si, Ge, Sn, Pb |
| 15 | Nitrogen Group | N, P, As, Sb, Bi |
| 16 | Oxygen Group | O, S, Se, Te, Po |
| 17 | Halogens | F, Cl, Br, I, At |
| 18 | Noble Gases | He, Ne, Ar, Kr, Xe, Rn |

* **Oxidation number:**

The table below shows the elements and oxidation numbers that can be read from the periodic table.

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| **Column #** | **Elements** | **Oxidation #** |
| 1 | All | + 1 |
| 2 | All | + 2 |
| 3 - 12 | Silver | + 1 |
| 13 | Aluminum | + 3 |
| 14 | Carbon & Silicon | + or - 4 |
| 15 | Nitrogen & Phosphorus | - 3 |
| 16 | Oxygen & Sulfur | - 2 |
| 17 | All | - 1 |
| 18 | All | 0 |

*An element's oxidation number, sometimes called valence, is the number of electrons gained or lost by an atom when forming compounds. This characteristic is controlled by the electrons in the outer energy level.*



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|  | *Atoms gain or lose electrons to get* ***eight electrons in their outer shell****.* |

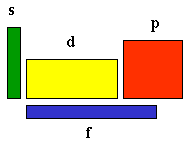
*Elements with a positive oxidation number (usually metals) lose electrons when forming compounds. Elements with a negative oxidation number (usually nonmetals) gain electrons when forming compounds.*

* **Electron energy levels:**

The number of electron energy levels in an atom is indicated by the horizontal row on which the element is found on the periodic table. The horizontal rows are **numbered 1 to 7**, at the extreme left of the table.



* **Electron energy sublevels:**



The shape of the periodic table makes the **four sublevels** easy to see.

* + **s sublevel** - the two tall columns on the left.

*Helium is at the far right because it is inert. For the purpose of reading sublevels, it should be thought of as sitting in the second column beside hydrogen.*

* + **p sublevel** - the six tall columns on the right, *without helium*.
  + **d sublevel** - the ten short columns in the middle of the table.
  + **f sublevel** - the fourteen columns of two below the body of the table.

One thing that does not show on the periodic table is the overlap of some sublevels. Both the d and f sublevels overlap the s sublevel of the next lowest electron energy level.

* + Even though the first elements in the d sublevel on the periodic table are on the fourth row, the first electron energy level to have a d sublevel is the third energy level.
  + Even though the first elements in the f sublevel on the periodic table are on the fifth row, the first electron energy level to have an f sublevel is the fourth energy level.
* **Orbitals within sublevels:**

An orbital can hold two electrons. Within an electron energy sublevel on the periodic table, each orbital is represented by two element squares.

* **Electron configuration:**

**Electron configurations** can be read directly from the periodic table. This concept will be covered in detail **next week**.



* **Element name:**

Many periodic tables do not have element names on them. You already know many element names and you will learn more as you use them this year. However, you might find it worth your time to write the names into the element squares on your paper periodic table.

**Research Links:**

* [**A Periodic Table**](http://ull.chemistry.uakron.edu/genobc/periodic/) **- Quick and Easy**
* [**A Periodic Table**](http://environmentalchemistry.com/yogi/periodic/) **- Lots of display options**
* [**A Periodic Table**](http://www.ucc.ie/ucc/depts/chem/dolchem/html/elements.html) **- Elements, Compounds & Dictionary**
* [**A Periodic Table**](http://chemlab.pc.maricopa.edu/periodic/periodic.html) **- With Pictures of the Elements**
* [**Interactive Periodic Table**](http://www.chemicalelements.com/) **- Chemical Elements.Com**
* [**Fill in a blank table**](http://www.ilpi.com/genchem/periodicquiz.html) **- University of Kentucky**
* [**1001 Periodic Table Quiz Questions**](http://www.1001-periodic-table-quiz-questions.com/)