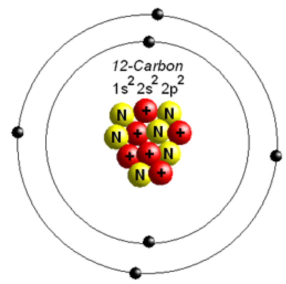
<u>EDUCATIONAL ASSIGNMENT for JOSEPH JOHN WUNDERLICH</u> for his 3rd trimester of 10th grade
This assignment covers the following Educational Objectives (Subjects marked with a "■" are the main subject, and those marked with an "☐" are secondary subjects):

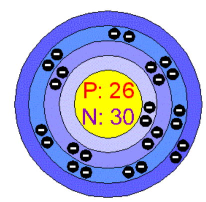
☐ 1. READING (ENGLISH)
☐ 2. WRITING (ENGLISH)
 3. ALGEBRA 2
■ 4. CHEMISTRY
☐ 5. WORLD HISTORY
 6. LATIN II
☐ 7. WORLD CULTURAL ARTS
 8. PHYSICAL EDUCATION

<u>ASSIGNMENT</u>: Recall your father's lecture on Atoms, Molecules, Crystal Lattice Structures, and Semiconductors (excerpt attached to the end of this document), and other teachings on Chemistry & Physical Science, then research and write about how Carbon, Iron, and other elements are combined to make different Steel <u>Alloys</u>

<u>JOSEPH'S WORK</u>:

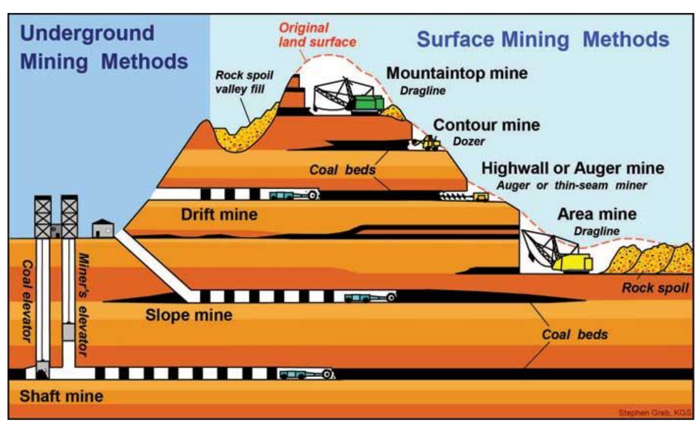


Carbon is an atom that bonds easily with other atoms, over 10 million compounds in fact can be made with carbon. It makes up graphite and diamond, one being one of the weakest substances, but the latter being one of the strongest. In the production of steel and other alloys, carbon content determines the strength and flexibility of the alloy.



Iron is an element used as a main ingredient in most metal production around the world. Steels and low carbon iron alloys along with other metals (alloy steels) are by far the most common metals in industrial use.

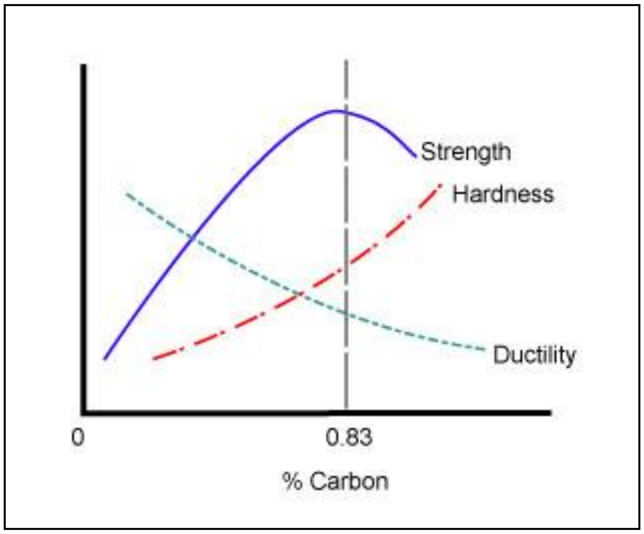
Steel is an alloy made primarily from Iron and Carbon. Other elements such as Chromium increase rust resistance and Nickel for ductility (flexibility).
The ingredients used in steel must be dug out of the ground through mines. One of which is coal, a largely exported good in Pennsylvania. A surface coal mine is shown below to the left. Though this form of mining is safer, it leaves a large toll on the ground. Other methods of mining are shown below to the right.



Once materials are acquired, the process of combining the elements includes both chemistry and manufacturing. The chemistry includes balancing equations and understanding PV=nRT. The Manufacturing requires melting, forging, folding, casting, quenching, cutting, rolling, and drawing through a dye.

The types of Steel I'm studying are for architectural metal accents and beams, weaponry such as firearms and swords, and plumbing.

For architectural beams and columns the variables are strength, ductility, and corrosion resistance. Kinds of strengths are compression, tensile, sheer, and flexural. The carbon content is the most important ingredient for determining the type of strength the steel will have.



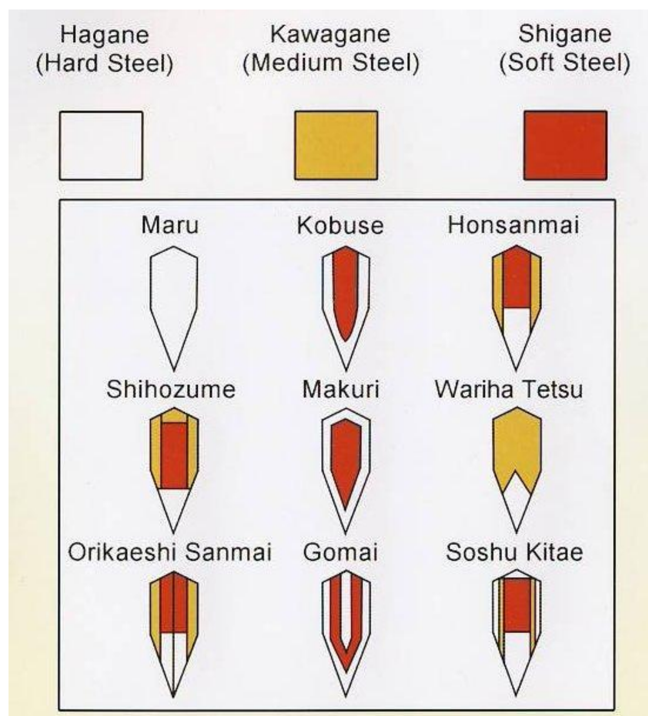
This graph shows an ideal amount of carbon for maximum strength at 0.83% and how ductility is lost for the price of hardness and strength to a point.

Adding Nickel increases Ductility

A katana is a balance of strength, precision, and balance of weight. The Japanese smelting furnace for katanas is called a tatara. Local iron sand has less impurities such as sulfur and phosphorous then typical iron ores. A katana never becomes completely molten. A precise amount of carbon content is there at an atomic level to aid in shock absorption. The steel is folded over 5000 layers per I cm of steel. These layers make a wavelike pattern. The harder steel is wrapped around a softer core in the sword made in this video: https://www.youtube.com/watch?v=VE_4zHNcieM

Shown to the right are the different types of layering used in most katanas

The harder steel is 0.7% carbon. The stronger steel can be sharpened.

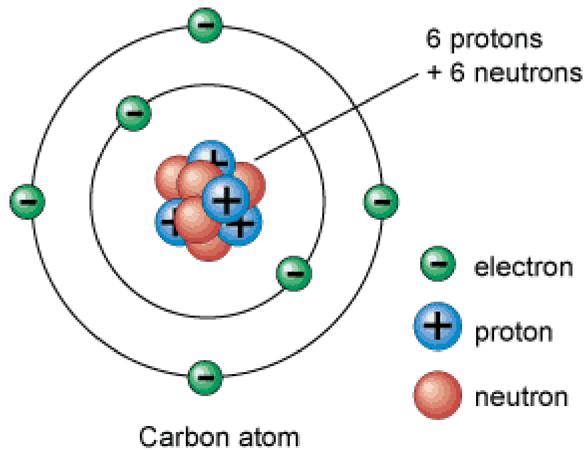


Maru	not laminated; poorest method
Honsanmai	most common lamination method
Kobuse	method used on swords from WW2 period
Soshu Kitae	seven layers method; used by famous sword smith, Masamune

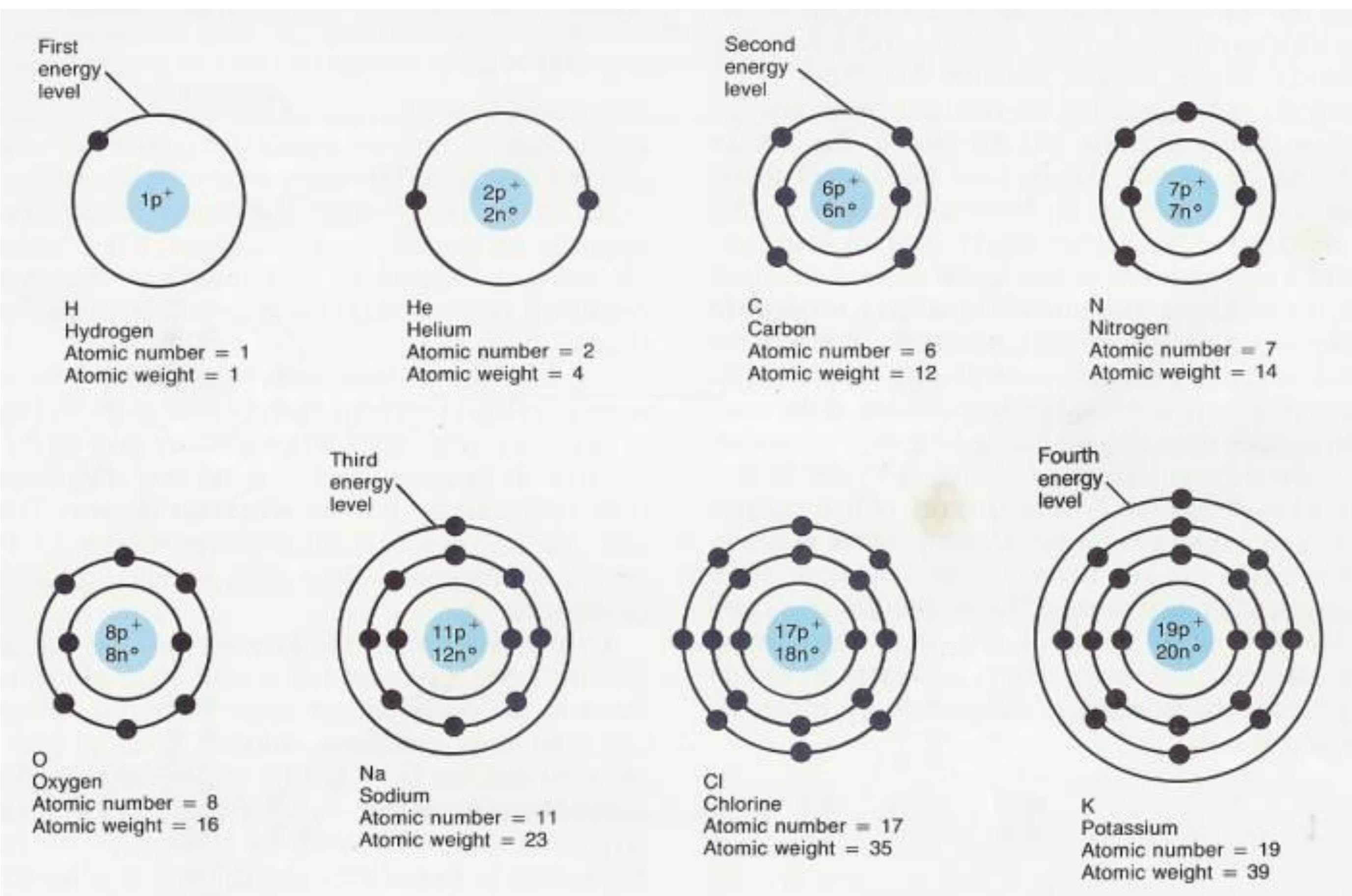
Dad’s Lecture at Elizabethtown College:

ATOM:

The smallest particle of a substance that can exist by itself or be combined with other atoms to form a molecule. An atom is typically modeled as **ELECTRONS** circling a **NUCLEUS** which contains **protons** and **neutrons**.



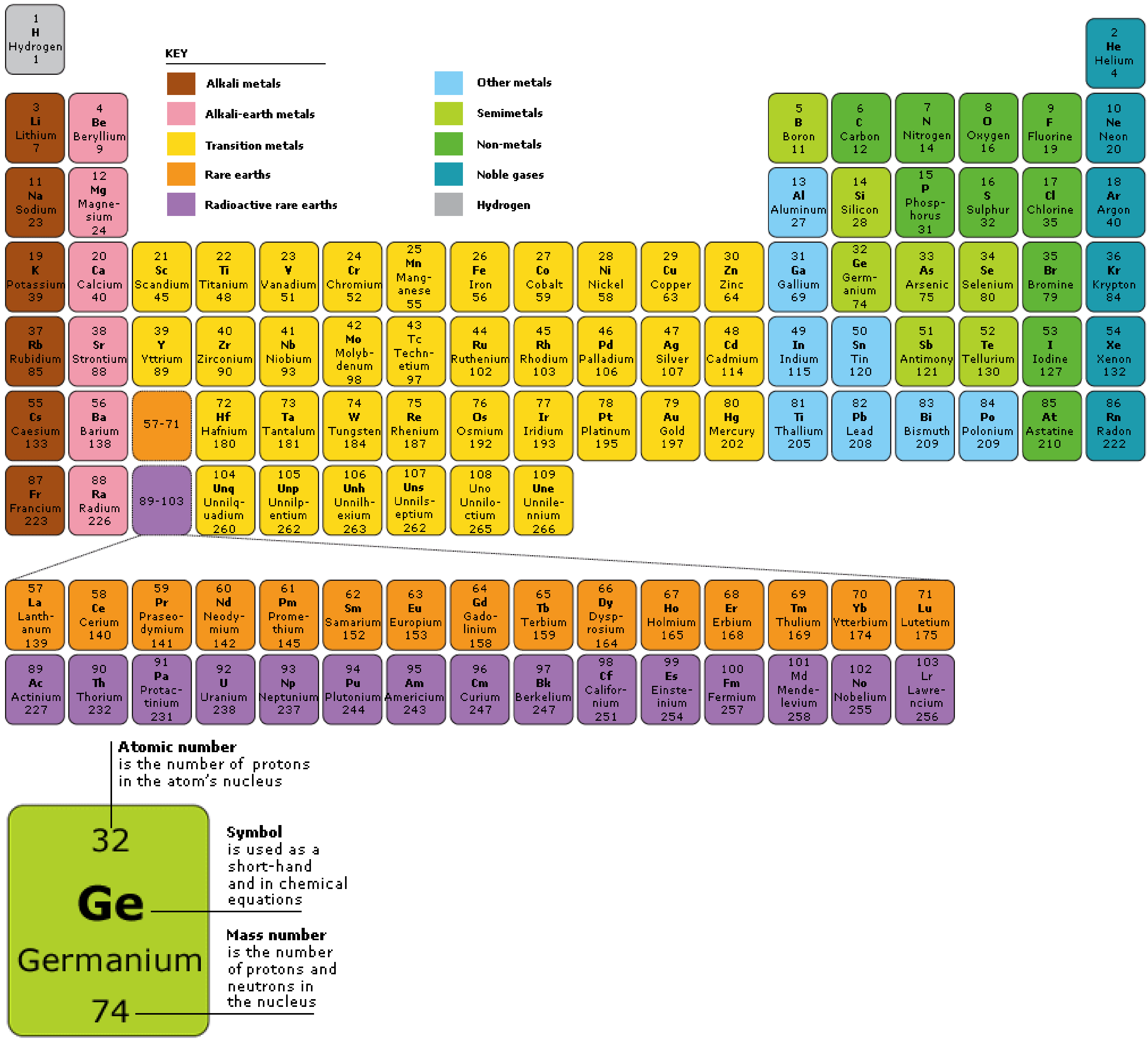
Electrons are in shells around a nucleus, with a certain number of electrons that fit into each shell. The outer shell is called the valance shell. *From: http://www.merriam-webster.com/dictionary/atom, http://www.freethought-forum.com/forum/showthread.php?t=24978&garpg=2*



From: http://www.anatomyfacts.com/muscle/anatomy.htm

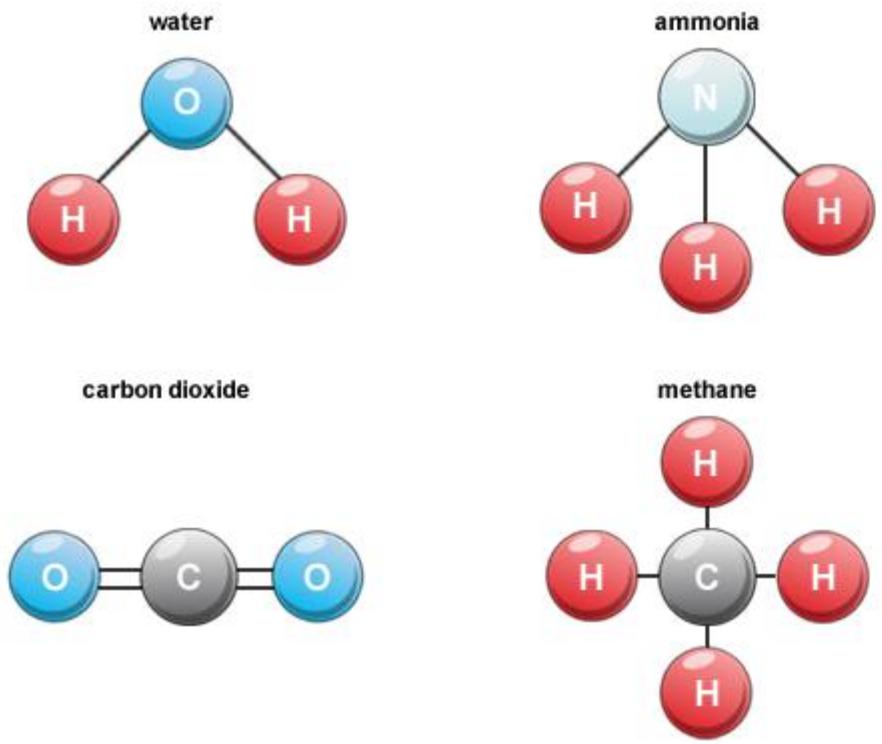
PERIODIC TABLE

A grid of every element that exists, arranged in order of atomic number, the number of protons each atom has in its nucleus. The rows are called_PERIODS and all have the same number of shells; and the columns called_GROUPS which all have the same number of electrons in their outermost shell. Hydrogen (**H**) is the first element because it has just one proton in its nucleus. Helium (**He**) is second, because it has two. As you go across a period, atoms get heavier, but also get smaller because the number of electron shells stays the same across the period, but the number of protons in the nucleus increases. The stronger, attractive force from the positively charged protons sucks the negatively charged electrons tighter into the center.



From <http://www.infoplease.com/dk/science/encyclopedia/periodic-table.html>

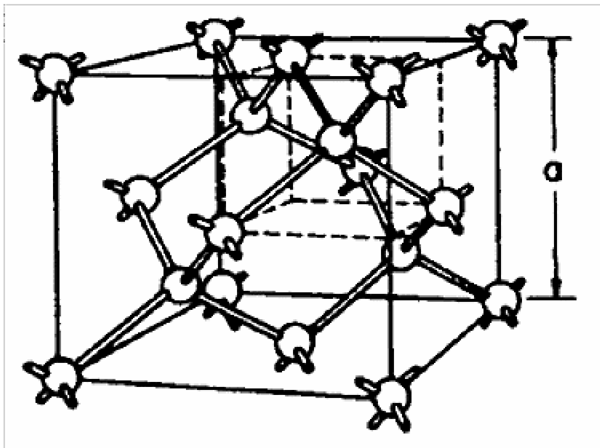
MOLECULE
Smallest particle of a substance that retains all properties of the substance and is composed of one or more atoms (Typically at least two atoms bonded together).



From: *http://www.merriam-webster.com/dictionary/atom*, http://www.bbc.co.uk/bitesize/standard/chemistry/images/covalent_molecules.gif

CRYSTAL LATTICE STRUCTURE
A unique arrangement of atoms or molecules in a crystalline liquid or solid. A crystal structure describes a highly ordered structure, occurring due to the intrinsic nature of molecules to form symmetrical patterns. A crystal structure can be thought of as an infinitely repeating array of 3D 'boxes', known as unit-cells.

Crystal Lattice Structure for Silicon (**Si**):



From: http://en.wikipedia.org/wiki/Crystal_structure http://www.irf.com/technical-info/guide/semi.html

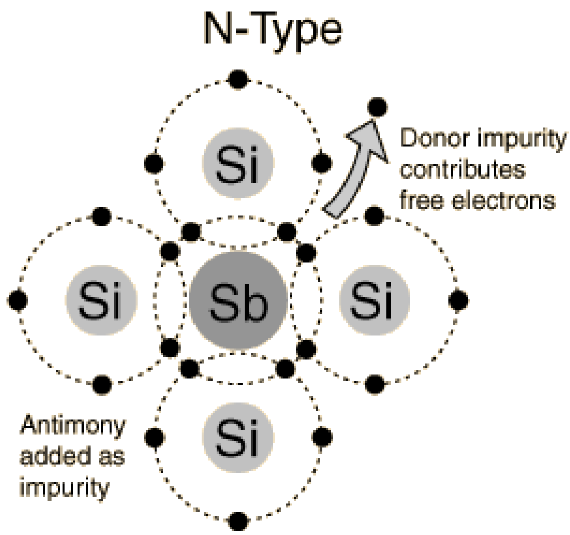
A **SEMICONDUCTOR** *can be either a single element like Silicon (**Si**), or a **Molecular** compound like Gallium Arsenide, (**GaAs**). Semiconductors are not conductors of electricity like gold (**Au**) (a metal), and not an insulator which prevents electricity from flowing. Semiconductors are useful because they can be "doped" to control electrical properties and to make transistors, the basic building blocks of computers.*

DOPING OF SEMICONDUCTORS

The addition of a small percentage of foreign atoms in the regular crystal lattice of silicon or germanium produces dramatic changes in their electrical properties, producing n-type and p-type semiconductors. Impurity atoms with 5 valence electrons produce n-type semiconductors by contributing extra electrons.

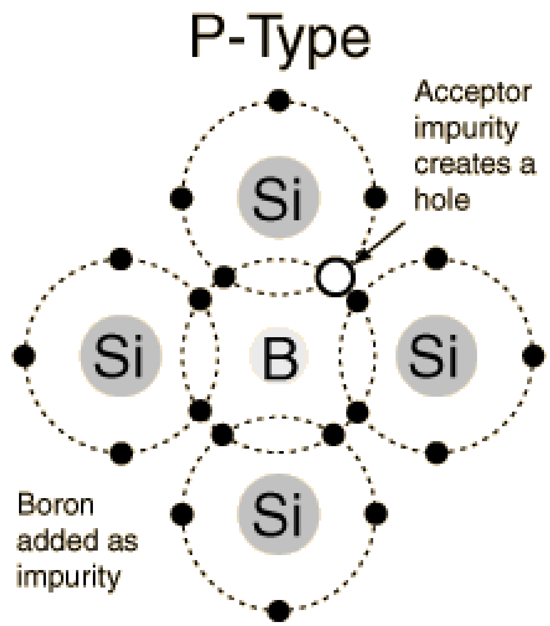
N-Type Semiconductor

The addition of atoms such as antimony (**Sb**), arsenic (**As**), or phosphorous (**P**) to a semiconductor like silicon (**Si**) contributes free electrons, greatly increasing the conductivity of the semiconductor.



P-Type Semiconductor

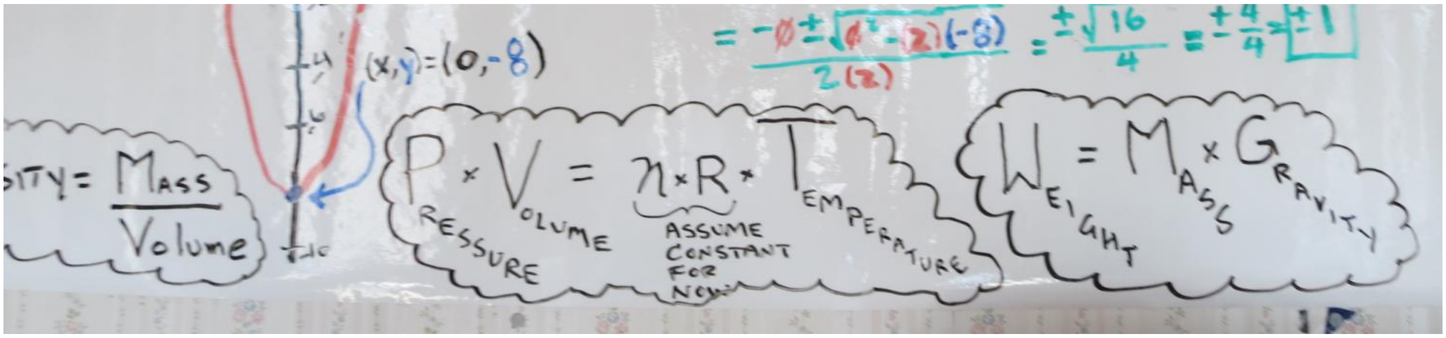
The addition of atoms such as boron (**B**), aluminum (**Al**) or gallium (**Ga**) to a semiconductor like silicon (**Si**) creates deficiencies of valence electrons, called "holes" – these holes attract electrons.



From: http://hyperphysics.phy-astr.gsu.edu/hbase/solids/dope.html#c3

Computers are made from Logic Gates which are made from Transistors which are made by - combining N and P type semiconductors to create the flow of electricity at controlled times.

Parts of another Dad lecture -- on bedroom wall:



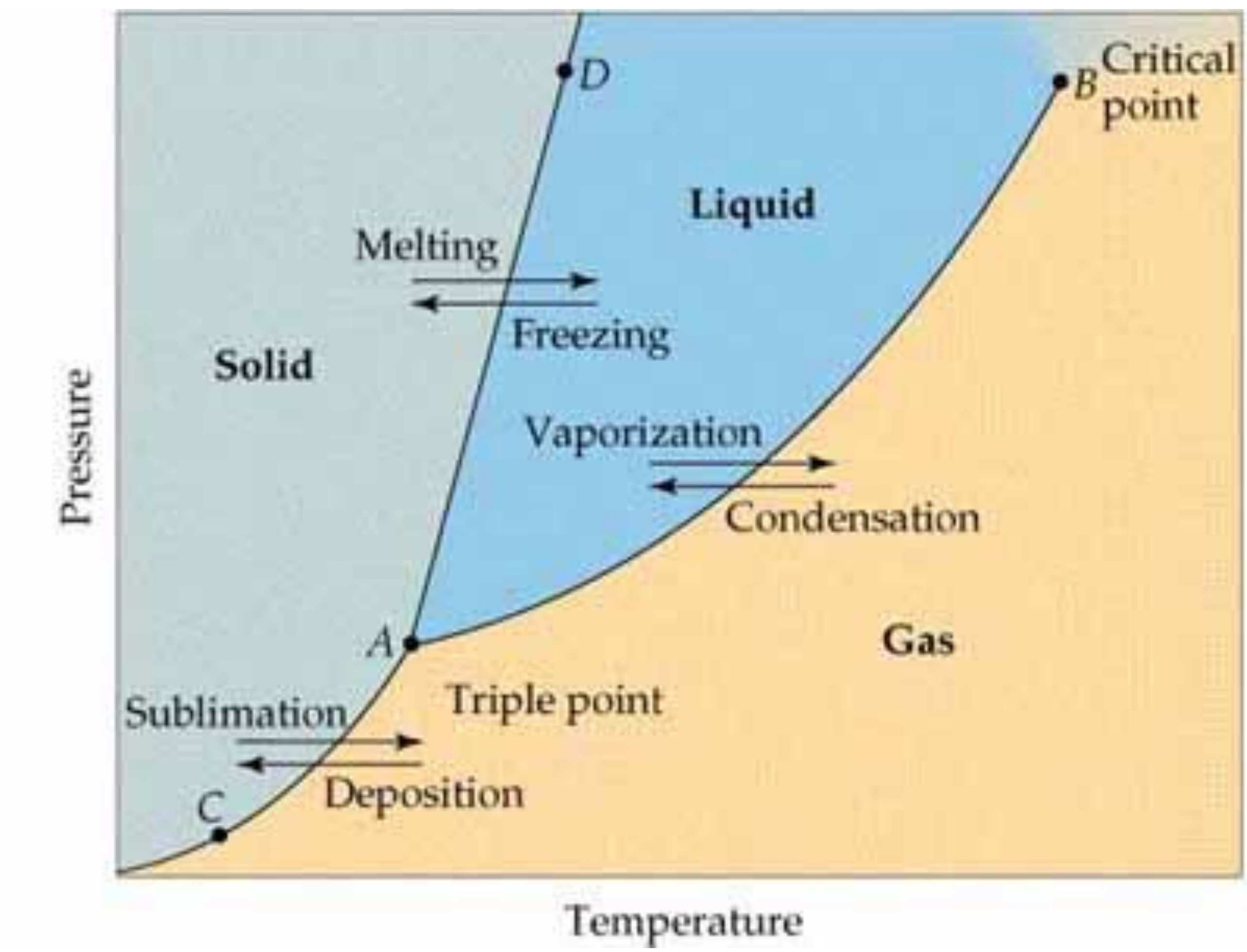


Image from: http://wps.prenhall.com/wps/media/objects/3311/3391416/imag1106/AAAUAZO0.JPG