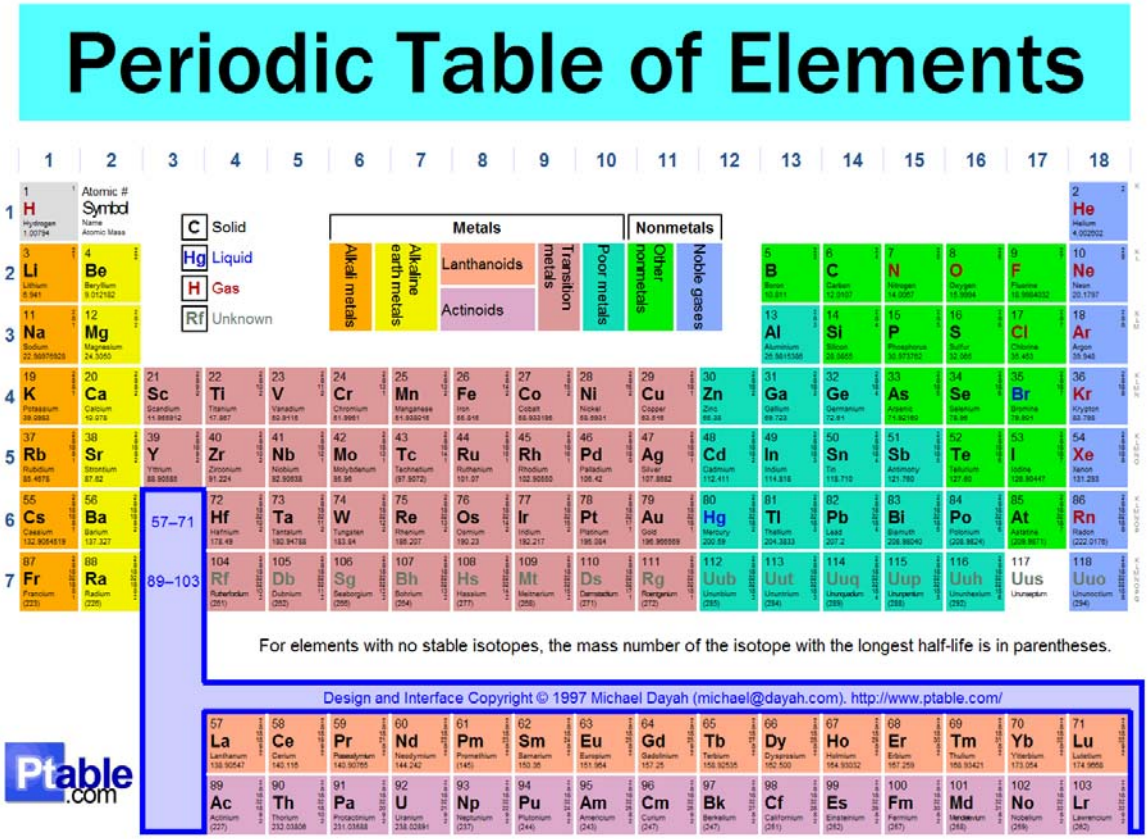
Science of Electricity and Electronics
Cornerstone Electronics Technology and Robotics I Week 1

- **Administration:**
  - Prayer
  - Bible Verse
  - Handout textbooks and study guides
  - Order safety glasses
- **Introduction:** Unlike mechanical systems where you are familiar with the quantities like friction, springs, mass, speed, etc., electricity and electronics are based upon unfamiliar quantities like current, voltage, resistance, capacitance, etc. This makes it more difficult to relate to and understand. You will have to work with these electrical quantities before you will gain some comfort with them.
  In this session, we will start with a look at the micro, i.e. the small details of matter and then work with the macro, i.e. dealing with the large scale behavior of electrostatics.
- **Electricity and Electronics, Section 1.1, The Nature of Matter:**
  - **Matter:** Anything that has mass and occupies space or may be thought of as what all things are made up of.
  - **Element**: A substance that can not be changed into a simpler substance under normal laboratory conditions. Examples of elements are hydrogen, oxygen, copper, and sodium. (There are 94 different naturally occurring elements and 24 man-made elements that do not occur in nature.)
    - Periodic Table of Elements:



        - See periodic table applet: http://www.dartmouth.edu/~chemlab/info/resources/p_table/Periodic.html
        - See element games at: http://education.jlab.org/indexpages/elementgames.php
    - **Atom**: The smallest form of an element is known as the atom.
    - **Compound**: If two or more elements are chemically mixed together, a compound is created. For example, water is a compound made up of the two elements hydrogen and oxygen (H_2O). Salt is a compound of sodium and chlorine (NaCl).
    - **Molecule**: A molecule is the smallest part of a compound that still retains all the characteristics of that compound.
        - Demonstration: Models of molecules
    - **Summary:** The smallest particle **a** compound can be divided and still retain its properties is **a** molecule. The smallest particle **an** element can be divided and still retain its properties is **an** atom.
    - **Atomic Structure**:
        - **Introduction**: We will use the Bohr model of atomic structure. The model which was developed by Danish scientist Niels Bohr states that an atom consists of a nucleus at the center and electrons orbiting around the nucleus much like the planets orbit around the sun. Another model of atomic structure is the quantum mechanical model which will not be covered here. See Bohr model applet: http://www.germane-software.com/~dcaley/atom/Atom.html
        - **Nucleus**: The nucleus is the center of the atom which contains the protons and neutrons. See: http://education.jlab.org/atomtour/listofparticles.html
        - **Protons**: Protons are positively charged particles contained in the nucleus. The mass of a proton is about 1800 times that of an electron.
            - **Atomic Number**: The atomic number equals the number of protons in the nucleus.
        - **Neutrons**: Neutrons are uncharged particles contained in the nucleus. The mass of a neutron is about the same as a proton.
        - **Electrons**: Electrons are the basic particles of negative charge that whirl in orbits around the nucleus. Sometimes the orbits are called rings or shells. See applet: http://www.lon-capa.org/~mmp/applist/coulomb/orbit.htm
            - In an atom, the number of electrons in orbit equals the number of protons in the nucleus; therefore the number of negative charges equals the number of positive charges. In this state, the atom is electrically balanced or neutral.
            - See: http://www.colorado.edu/physics/2000/applets/a2.html
            - **Ionization**: The *removal* or addition of an electron *from* or to a neutral atom so that the resulting atom

(called an ion) has a *positive* (+) or negative charge (-). An ion is an atom that is not electrically neutral. A positive ion has had an electron removed, while a negative ion has gained an electron.
- In electricity and electronics, the most important part of an atom is the electrons because they can be stripped off an atom to produce electricity.
- Electronics is about controlling electrons with components such as resistors, diodes, capacitors, transistors and integrated circuits to produce the result we want, which in our case is controlling the behavior of robots.

- **Electricity and Electronics, Section 1.2, Static Electricity:**
  - Terms and definitions:
    - **Static:** Static means at rest.
    - **Static Electricity**: Static electricity deals with the accumulation of charge rather than charge in motion. Static electricity is a charge that stays on a nonconductive material. Static electricity deals with electrical happenings which involve HIGH VOLTAGE at low current.
      - Balloon and salt and pepper demonstration
      - Fur and a plastic rod: By rubbing fur on a plastic rod, the friction strips electrons from the fur and deposits them on the plastic rod. The rod acts as a charged body since it has more electrons than when it is in its neutral state.
      - Electrostatic experiments do not work well in the humid Florida climate.
    - **Law of Charges**: Like charges repel each other and unlike charges attract each other.
    - **Coulomb**: A coulomb is the unit of electrical charge and it represents approximately 6,240,000,000,000,000,000 electrons or 6.24×10^{18} electrons.
      - Quick review of scientific notation:
        - Scientific notation to describe large or small numbers.
        - Example 1:
          - $7310 = 7.31 \times 1000$
          - $7310 = 7.31 \times 10 \times 10 \times 10$
          - $7310 = 7.31 \times 10^{1} \times 10^{1} \times 10^{1}$
          - $7310 = 7.31 \times 10^{3}$
        - Example 2:
          - $0.0059 = 5.9 \times 1/1{,}000$
          - $0.0059 = 5.9 \times 1/10 \times 1/10 \times 1/10$
          - $0.0059 = 5.9 \times 10^{-1} \times 10^{-1} \times 10^{-1}$
          - $0.0059 = 5.9 \times 10^{-3}$
        - See: http://www.ieer.org/clssroom/scinote.html
        - Applet:http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

- **Electrostatic Field**: The force field surrounding a charged body is called the electrostatic field. An electrostatic field is like a magnetic field except the forces in the field are created by charges not magnetism. The field is made up of imaginary lines coming from charges which represent lines of force.
    - Drawing with lines of force
    - Lines point from positive to negative
    - See: http://www.falstad.com/emstatic/
- **Conduction:**
    - Conduction is the transfer of charge by direct contact.
    - Conduction occurs when a charged object directly contacts an object with a different charge. There must be a conductive path between the two objects.
- **Induction**: Transferring a charge by bring a charged object near another object.
- **Electrostatic Game:**
    - See: http://mw.concord.org/modeler1.3/mirror/electrostatics/mazegame.html

o Student Activity Sheet 1-2.

o Static protection when working with some electronic components
- Wrist strap
- Anti-static bags
- Anti-static DIP tubes

o Van der Graaf demonstration
- The highest potential sustained by a Van de Graaff accelerator is 25.5 MV.
- A rule of thumb for breakdown potential of air is about 20,000 volts per inch.
    - The breakdown potential of paper is about 350,000 volts per inch.
    - The breakdown potential of a vacuum is infinite volts per inch.
- See: http://www.magnet.fsu.edu/education/tutorials/java/vandegraaff/index.html

- Related web sites:
  - http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=4&DocID=234
  - http://www.sciencemadesimple.com/static.html
  - http://en.wikipedia.org/wiki/Van_de_Graaff_generator
  - http://www.school-for-champions.com/science/static.htm

- **Robot Building for Beginners, Chapter 1:**
  - Four Disciplines of Robotics:
    - Electrical Engineering:
      - Circuits
      - Sensors
    - Mechanical Engineering
      - Body
      - Gearing
      - Moving parts
    - Computer Science:
      - Pseudo-intelligent behavior, decision making
    - Arts:
      - Style
      - Expression

- Parts of a Robot:
  - Electric Power:
    - Power source
    - Power regulation
  - Brains:
    - Robots without brains
      - Remote control
      - Joystick
    - Microcontroller chip
      - Top choice for brains
  - Sensors:
    - Touch sensor demonstration
    - Light sensor demonstration
    - Temperature probe demonstration
    - Infrared detection demonstration
    - Sonar demonstration
  - Action and Feedback:
    - Movement with motors and wheels or legs
    - Indicator lights and sounds so operator can view status of robot
  - Body
    - Frame for robot
- Sandwich web site:
    - http://www.robotroom.com/Sandwich.html