**Interactive Java Tutorials magnetism and electricity**

**http://micro.magnet.fsu.edu/index.html**

[**Mag Lab U: Learning about Electricity and Magnetism**](http://www.magnet.fsu.edu/education/tutorials/electricitymagnetism.html) - Visit our sister website for more interactive Java tutorials, a timeline of historical events, a museum of antique devices, and articles on topics related to electricity and magnetism.

[**Russian Abacus**](http://micro.magnet.fsu.edu/electromag/java/abacus/index.html) - This tutorial explores how the Russian abacus was once used to do simple arithmetic. By moving a set of beads back and forth across a set of framed wires, the visitor can do use this tutorial to do simple addition and subtraction.

[**Atomic Orbitals**](http://micro.magnet.fsu.edu/electromag/java/atomicorbitals/index.html) - Electrons are distributed around an atom according to probability density distributions. Visitors can use this interactive Java tutorial to observe how combinations of atomic orbitals combine to create an electronic "shell" surrounding the atom.

[**Factors Affecting Capacitance**](http://micro.magnet.fsu.edu/electromag/java/capacitance/index.html) - Capacitors are simple devices designed to store electric charges. This tutorial explores how variations in capacitor plate area, separation distance, and the dielectric insulator work together to change the overall capacity of the capacitor.

[**Charging And Discharging A Capacitor**](http://micro.magnet.fsu.edu/electromag/java/capacitor/index.html) - Examine how electrons flow within a circuit consisting of a capacitor and battery using this tutorial. Visitors can throw a virtual switch to connect the circuit and observe the battery charge the capacitor. Once the capacitor is fully charged, the switch can be reversed to discharge the capacitor.

[**How A Compact Disc Works**](http://micro.magnet.fsu.edu/electromag/java/cd/index.html) - This tutorial explores how a laser beam is focused onto the surface of a spinning compact disc, and how variations between pits and lands on the disc surface affect how light is either scattered by the disc surface or reflected back into a detector.

[**Magnetic Fields and Compass Orientation**](http://micro.magnet.fsu.edu/electromag/java/compass/index.html) - Explore the effects of induced electromagnetic fields on the orientation of a compass. A virtual switch is provided to start and stop current flow from a battery through a coil of wire. Visitors can turn the switch on and off to observe the effects on the compass needle orientation.

[**Crookes Tube: Cathode Rays**](http://micro.magnet.fsu.edu/electromag/java/crookestube/index.html) - The first cathode ray tube was created British scientist Sir William Crookes. This tutorial demonstrates how the electrons create ionizing effects from residual gas, which results in the visibility of cathode rays.

[**How A Metal Detector Works**](http://micro.magnet.fsu.edu/electromag/java/detector/index.html) - The operation of metal detectors is based upon the principle of electromagnetic induction. Metal detectors contain one or more inductor coils, and this tutorial demonstrates how a single-coil detector operates.

[**Vacuum Tube Diodes**](http://micro.magnet.fsu.edu/electromag/java/diode1/index.html) - Current flowing from the cathode to the plate of a vacuum tube diode changes the nature of the current from alternating current (AC) to direct current (DC).

[**Electrophoresis**](http://micro.magnet.fsu.edu/electromag/java/electrophoresis/index.html) - Explore how electrical potential can cause migration and separation of macromolecules according to size in a cross-linked gel.

[**Faraday's Electromagnetic Induction Experiment**](http://micro.magnet.fsu.edu/electromag/java/faraday/index.html) - In 1831, Michael Faraday made his discovery of electromagnetic induction with an experiment using two coils of wire wound around opposite sides of a ring of soft iron similar to the experiment setup below. This tutorial explores that discovery and demonstrates how his experiment worked.

[**Another Faraday Experiment**](http://micro.magnet.fsu.edu/electromag/java/faraday2/index.html) - After discovering electromagnetic induction, Faraday began to test a hypothesis on magnetic fields and energy currents, which is demonstrated in this tutorial showing a galvanometer connected to a wire wrapped paper cylinder.

[**Resistance at the Molecular Level**](http://micro.magnet.fsu.edu/electromag/java/filamentresistance/index.html) - This tutorial explains how resistance to current flow occurs at the molecular level, and shows how an electric conductor consists of electrons floating freely around atoms.

[**AC Generator Action**](http://micro.magnet.fsu.edu/electromag/java/generator/ac.html) - The AC generator tutorial demonstrates how varying the frequency of an alternating current can affect both the voltage produced by the generator, as well as the speed in which the coil rotates.

[**DC Generator Action**](http://micro.magnet.fsu.edu/electromag/java/generator/dc.html) - Similar to the AC generator tutorial, this tutorial also shows the effect on coil rotation speed and voltage by increasing and decreasing the frequency in a direct current generator.

[**How A Hard Drive Works**](http://micro.magnet.fsu.edu/electromag/java/harddrive/index.html) - Have you ever wondered how the storage system inside your computer works? Well, this tutorial illustrates how a hard drive is constructed and how it actually works internally. It also demonstrates how a read/write head floating over a magnetically coated platter can result in binary data being sent to the computer.

[**Lenz's Law**](http://micro.magnet.fsu.edu/electromag/java/lenzlaw/index.html) - This interactive tutorial illustrates the directional relationships between induced magnetic fields, voltage, and current when a conductor is passed within the lines of force of a magnetic field.

[**Lightning: An Example Of A Natural Capacitor**](http://micro.magnet.fsu.edu/electromag/java/lightning/index.html) - Clouds and the ground can act in unison to mimic a huge natural capacitor. This tutorial shows how the collisions of dust with ionizing radiation can cause electrons to be knocked off of particles, creating a charge separation in the clouds, resulting in lightning.

[**Magnetic Field Lines**](http://micro.magnet.fsu.edu/electromag/java/magneticlines/index.html) - This tutorial illustrates the forces of magnetic attraction and repulsion, and how they can be seen as lines of force.

[**Attraction and Repulsion By Magnet Poles**](http://micro.magnet.fsu.edu/electromag/java/magneticlines2/index.html) - Similar to the Magnetic Field Lines tutorial, this applet is used to illustrate how the magnetic fields surrounding a magnet cause attraction and repulsion on a surface of iron filings.

[**Condenser Microphone**](http://micro.magnet.fsu.edu/electromag/java/microphone/index.html) - The diaphragm of a condenser microphone is the negatively charged plate of a capacitor. This interactive tutorial shows a cross section of the diaphragm, and how sound waves cause the diaphragm to vibrate at the same frequency as the sound waves.

[**Mitosis**](http://micro.magnet.fsu.edu/electromag/java/mitosis/index.html) - We know this is not about electricity and magnetism, but have placed the tutorial here for demonstration purposes. This tutorial demonstrates the process of a nuclei splitting into two separate daughter cells with a complete set of chromosomes during cellular division. This, coupled with cytokinesis, occurs in all multicellular plants and animals to permit growth of the organism.

[**NMR: The AB (I=S=1/2) Spectrum**](http://micro.magnet.fsu.edu/electromag/java/nmr/abspectrum/index.html) - This tutorial demonstrates the primary effects of scalar coupling. Strong coupling influences both the transition intensities and the observed splittings, often making spectral interpretation more difficult.

[**NMR: The ABX Spectrum**](http://micro.magnet.fsu.edu/electromag/java/nmr/abxspectrum/index.html) - Like the AB (I=S=1/2) Spectrum tutorial, this tutorial also illustrates the effects demonstrated by scalar coupling. Spectral interpretation is made more difficult by the influence on transition intensities and observed splittings.

[**NMR: Dipolar Powder Patterns**](http://micro.magnet.fsu.edu/electromag/java/nmr/dipolar/index.html) - The observed NMR spectrum of a solid powder is the summed signal from crystallites over all possible orientations relative to the applied field. By changing the orientation, one can visualize how an individual crystallite contributes to the powder pattern.

[**NMR: Spin Populations**](http://micro.magnet.fsu.edu/electromag/java/nmr/populations/index.html) - This tutorial details the relative populations of spin up *versus*spin down states in spin I=1/2 particles. For most spin species under typical fields and temperatures there are almost an equal number of each, making detection in NMR somewhat insensitive.

[**NMR: Lorentzian Lineshapes**](http://micro.magnet.fsu.edu/electromag/java/nmr/lorentzian/index.html) - This tutorial shows the Fourier relationship between a damped oscillating exponential (a detected FT-NMR transition) and a Lorenzian function (the displayed transition in an NMR spectrum).

[**NMR: Quadrupolar Powder Pattern**](http://micro.magnet.fsu.edu/electromag/java/nmr/quadrupolar/index.html) - This tutorial is very similar to the Dipolar Powder Patterns tutorial, in that is illustrates the observed spectrum of a solid powder. The main difference between the two is that this NMR spectrum consists of four poles rather than two, causing increased interaction pertaining to spin.

[**Structure Determination Using NMR**](http://micro.magnet.fsu.edu/electromag/java/nmr/spectra/index.html) - There are three basic aspects of an NMR spectrum which help chemists determine the chemical structure a substance. This tutorial illustrates how each hydrogen atom in the chemical equation of various samples contribute to the associated spectrum.

[**Ohm's Law**](http://micro.magnet.fsu.edu/electromag/java/ohmslaw/index.html) - This illustration of a circuit is used to demonstrate how the current in a circuit is directly proportional to the applied voltage and inversely proportional to the resistance of the circuit, according to Ohm's Law.

[**Pulsed Magnets**](http://micro.magnet.fsu.edu/electromag/java/pulsedmagnet/index.html) - Pulsed magnets are among the strongest magnets in the world, and come in two forms: destructive and non-destructive. Of these two, non-destructive magnets are more suited towards scientific research. This tutorial demonstrates how a non-destructive short pulse magnet works, and shows the relative field strengths generated.

[**Tuning A Radio Receiver**](http://micro.magnet.fsu.edu/electromag/java/radio/index.html) - This tutorial demonstrates how variable capacitors are used with inductor coils in tuning circuits of radios, television sets, and a number of other devices that must isolate electromagnetic radiation of selected frequencies.

[**Resistor Color Codes**](http://micro.magnet.fsu.edu/electromag/java/resistor/index.html) - Composition resistors are color coded to indicate the resistance values of resistors in ohms as well as the tolerance rating of resistors. This tutorial allows you to change the resistance and tolerance values, which in turns generates a differing color code.

[**The Rutherford Experiment**](http://micro.magnet.fsu.edu/electromag/java/rutherford/index.html) - This classic diffraction experiment was originally created by Ernest Rutherford in 1911, and can be used to explore how Rutherford discovered that the majority of an atom is empty space.

[**Creating A Silicon Seascape**](http://micro.magnet.fsu.edu/electromag/java/siliconcreature/sailboat.html) - This interactive Java tutorial explores the steps necessary to construct a miniature rendition of a natural seascape on the surface of a silicon wafer.

[**Creating A Silicon Yin Yang**](http://micro.magnet.fsu.edu/electromag/java/siliconcreature/yinyang.html) - This unique method of fabricating silicon creatures was developed by Hewlett-Packard's CPU design team in Fort Collins, Colorado, and is the safest technique yet devised for patterning these silicon doodlings.

[**How A Speaker Works**](http://micro.magnet.fsu.edu/electromag/java/speaker/index.html) - Most loud speakers consist of a circular permanent magnet surrounding a freely moving coil. The coil is attached to a cone shaped diaphragm that is moved back and forth to produce accoustical waves (sound). In this tutorial, the circular magnet is cutaway so that visitors can observe how the speaker operates.

[**RC Time Constant**](http://micro.magnet.fsu.edu/electromag/java/timeconstant/index.html) - The resistive-capacitive (RC) time constant is the time required to charge a capacitor. This tutorial illustrates how the amount time required to charge and discharge a capacitor is a very important factor in the design of electrical circuits.

[**How a Transformer Works**](http://micro.magnet.fsu.edu/electromag/java/transformer/index.html) - This tutorial explores how transformers are used to increase or decrease AC voltages and currents in circuits, and how the operation of transformers is based on the principal of mutual inductance.

[**Building A Transistor**](http://micro.magnet.fsu.edu/electromag/java/transistor/index.html) - Explore how an individual Field Effect (FET) transistor is fabricated on a silicon wafer simultaneously with millions of its neighbors.

[**Variable Capacitor**](http://micro.magnet.fsu.edu/electromag/java/varcapacitor/index.html) - Explore how the plates of a variable capacitor move in relation to one another to produce changes in capacitance.

#### Electricity and Magnetism

[**Timeline of Electricity and Magnetism**](http://micro.magnet.fsu.edu/electromag/timeline/index.html) - Our timeline guides you through the highlights of electricity and magnetism across the globe, from the first compasses in China to the invention of magnetic core computer memory at the Massachusetts Institute of Technology and beyond.

[**Pioneers in Electricity and Magnetism**](http://micro.magnet.fsu.edu/electromag/pioneers/index.html) - Ampere, Celsius, Kelvin, Hertz, Tesla: These terms are familiar to all science students. Behind them is a group of scientists who went down in history for their groundbreaking work in magnetism and electricity. Who were these brilliant inventors, physicists and chemists, and what lasting contributions did they make to their fields – and to our lives? Get to know these pioneers by visiting this section.

[**Museum of Electricity and Magnetism**](http://micro.magnet.fsu.edu/electromag/museum/index.html) - From the world's first "south-pointer" (an early compass) to modern instruments such as the magnetic force microscope, the Museum of Electricity and Magnetism on our sister website at the National High Magnetic Field Laboratory will introduce you to a variety of instruments, tools and machines devised over the centuries.

[**History of the Compact Disc**](http://micro.magnet.fsu.edu/electromag/computers/compactdiscs/cd.html) - During the mid to late 1980's, compact discs began to take over both the audio and computer program market. By following specific standards in production known as the "Color Books," compact discs could be developed to the current technology.

[**How a Writable CD-R Works**](http://micro.magnet.fsu.edu/electromag/computers/compactdiscs/writable/cdwriter.html) - After compact disc technology became mainstream for audio recordings, the use of compact discs as a storage medium for computers rose during the late 1980's. These discs are created by writable CD-R drives containing a write head, which sends a low-energy laser beam to the surface of the disc, recording data.

[**How a Digital Video Drive Works**](http://micro.magnet.fsu.edu/electromag/computers/digitalvideodiscs/dvd.html) - The next evolution in compact discs, digital video disks are the result of four companies, Philips, Sony, Time-Warner, and Toshiba, collaborating on the standards for a dual-layered, high-density disk. Similar to CD-ROM drives, DVD players use light beams to read the information from the surface of a disc.

[**Capacitance**](http://micro.magnet.fsu.edu/electromag/electricity/capacitance.html) - Discovered around 1745 independently by Ewald Christian von Kliest and Pieter van Musschenbroek, capacitance is the property of an electric conductor that allows the storage of an electric charge. Capacitance is the foundation for storing energy in an electric field between two conducting bodies.

[**Inductance**](http://micro.magnet.fsu.edu/electromag/electricity/inductance.html) - Defined as the property of an electric circuit by which a changing magnetic field creates an electromotive force in that circuit or a nearby circuit. Inductance is the basic principle for the operation of electric generators.

[**Resistance**](http://micro.magnet.fsu.edu/electromag/electricity/resistance.html) - Resistance is the property of a substance at the molecular level that hinders the flow of electric current through it. High resistance to electric flow is a requisite for insulators, while conductors require a low resistance.

[**Batteries**](http://micro.magnet.fsu.edu/electromag/electricity/batteries/index.html) - Consisting of two or more connected cells, batteries provide a direct current by converting chemical energy to electrical energy. The different types of batteries we use require different components for production and operation.

[**Generators and Motors**](http://micro.magnet.fsu.edu/electromag/electricity/generators/index.html) - Generators and motors are two devices, which function almost oppositely; generators turn rotary mechanical energy into electrical energy, while motors change electric energy into mechanical energy.

[**Interactive Java Tutorials**](http://micro.magnet.fsu.edu/electromag/java/index.html) - Our interactive Java tutorials have been developed in order to assist with the understanding of the principles, physics, and devices used in electricity and magnetism, such as transformers, electrophoresis, and lightning.

[**Mag Lab U: Learning about Electricity and Magnetism**](http://www.magnet.fsu.edu/education/tutorials/electricitymagnetism.html) - Visit our sister website for more interactive Java tutorials, a timeline of historical events, a museum of antique devices, and articles on topics related to electricity and magnetism.