

Demonstrations by Jim Ferrara at the NJ Science Convention Demo Den on 10-15-08

### Electromagnetic Induction – Faraday’s & Lenz Law

Two air-core solenoids (approx 500 windings each) placed vertically about 0.5 m apart each under an individual ring stand. Hanging from each ring stand above each solenoid, is a cow-magnet (any strong magnet will do - even bar magnets work fine) which is magnetically attached to a paper-clip (tape is also optional) which is in turn hung from a large spring (a Hookean spring from any catalogue will do). It is important that the two magnet set-ups are not mechanically connected to each other. The two solenoids are then electrically connected by 2 alligator clipped wires. One wire connecting the two top connections and the other two bottom connections on the respective solenoids.

Put ONE of the magnets in motion by pulling it down a bit into the solenoid and releasing it. It will begin to oscillate. The other magnet will very quickly join in the same motion, either in phase or out of phase depending on the orientation of the other magnet (N/S) and/or the order of the connecting wires (top-top or top-bottom).

The principle is the movement of the magnet in a loop of wire will create a current in the loop. The current flows through both solenoids and creates an alternating (N/S) magnetic field in the other solenoid – which in turn repels & attracts the other magnet.

### Magnetic Fields around Current Carrying Wires – The Jumping Wire

A loop (3-4 turns) of loose, light wire (~16 gauge) is placed around a strong horseshoe magnet. The both ends of the wire is connected to a power supply (or any other source of large current – several amps). Old car batteries work very well also. Be sure to include a telegraph or other similar switch so that the current can be briefly switched on. When the switch is closed, the wire will “jump” out of the magnet. Sometimes you might have to turn the loop 180° to get the loop to jump out instead of inward.

The principle is the current sets up a magnetic field in the wire that is repelled by the large magnet and the wire “jumps” out of the magnet due to the repelling force.

### Forces Between Current Carrying Wires

Two long, straight light wires (~16 gauge – I used magnetic wire, but any wires work fine) are hung physically parallel from an insulated arm connected to a ring stand (or lab rigging). Each wire is connected to a high current DC power source – a car battery works very well! (I used a motorcycle/boat battery) via a telegraph (or similar) switch (very important!!) The wires are connected electrically in parallel by alligator wires and when the switch is briefly closed, the wires will attract. Then reverse the connections on one of the wires to make anti-parallel currents. The wires will then repel when current is passed through. CAUTION: Only close the switch BRIEFLY as this is essentially a short of the power supply and the wires will rapidly heat. The battery can be damaged if the circuit is closed for too long.

The principle is the magnetic fields developed in each wire when there is a current in the wire will cause forces on the moving charges in the adjacent wire. When currents are parallel the forces are attractive, when anti-parallel they mutually repel each other.

### Electromagnetic Induction – “Floating” Magnet

A copper pipe (1/2” diameter) is held vertically while a Neodymium alloy magnet is dropped and let fall the length of the copper tube. When compared with an ordinary object (e.g. small regular magnet), the Neodymium magnet falls dramatically more slowly. Green nickle-based “magnetic tape” can be applied to the side of the tube which then allows students to “see” the magnetic field as the magnet passes down the copper tube.

The principle is the moving magnetic field of the magnet sets up a circular current in the copper tube which in turn creates its own magnetic field with an opposite polarity thus creating an upward force on the magnet which slows its fall. Be sure the tube’s diameter is large enough to accommodate the magnet’s diameter. The magnets come in many sizes. Any size will work.