615-0310 (10-149) Lenz' Law Demonstration Kit

Warranty and Parts:

We replace all missing or defective parts free of charge. Additional parts may be ordered . All products are guaranteed free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear.

Theory:

The Law of Conservation of Energy states that a change cannot propagate itself - nature does not give you something for nothing. To generate a current (and thus produce heat) you must do work to overcome an opposing force. **Lenz' Law,** named after the Russian scientist who discovered it, is really a statement of the law of conservation of energy as applied to electricity. It states that *whenever there is an induced electromotive force (emf) in a conductive material, it is always in such a direction that the current it produces would oppose the change which causes the induced emf.* The current produced has been dubbed "Eddy Current."

Lenz' Law can be demonstrated effectively by dropping a strong magnet through a vertically positioned copper or aluminum tube. Instead of dropping instantly to the table via the force of gravity, the neodymium magnet induces a strong opposing electromotive force in the conductor, thus markedly slowing the downward motion of the magnet. Induced eddy currents slow the descent of the magnet, reducing its acceleration to zero. The terminal velocity reached by a strong magnet is proportional to its weight and to the resistivity of the tube and also depends upon the pipe's diameter and wall thickness.

A magnet dropped down a conducting pipe induces eddy currents whose magnitude depend on the magnet's speed and strength. A strong magnet does not have to accelerate to a high speed before the induced eddy currents create enough magnetic force to balance the magnet's weight. At this point the magnet falls at a constant terminal velocity, as it would if acted on by air resistance.

Always ask forScience First itrems when considering physics products.

How to Use:

1. Hold tube(s) in upright position in front of your class.
2. Drop penny and neodymium magnet through copper tube.
3. Time the rate of fall.
4. Discuss your results.
5. Let students experiment on their own.

Experiment 1:

Drop the penny down the copper tube from a fixed location. Time how long it takes.

Drop the magnet, which is much heavier, from the same location. Time how long it takes.

What happens? Why?

Discussion: *The magnet slowly falls down the copper tube due to the eddy currents it induces in the nonmagnetic conductive copper.*

Experiment 2:

Try taping a nonmagnetic disc of equal mass to the magnet, thereby doubling mass while keeping strength of magnet constant. This should double the magnet's terminal velocity.

Experiment 3:

Look down the copper tube as the magnet falls through.

The magnet always reorients itself in a predictable fashion no matter how it starts at the top. Why?

Optional Experiment:

Materials Needed:

- *Brass Plate*
- *Lead Weight*
- *Alnico Magnet*
- *Neodymium Magnet from this kit*

Put brass plate at a 45° angle and slide the lead weight down it.

Slide the neodymium magnet down the brass incline. Compare.

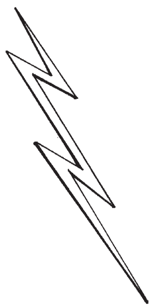
Lay brass plate flat on the table. Slide an alnico magnet across it. Slide the neodymium magnet across and you will feel a definite drag due to eddy currents.

Safety Note:

As neodymium magnets are strong but at the same time brittle, special care needs to be taken with them. They are powerful enough to leap from distances up to 6" (150 mm) and can easily chip or shatter from the force of their impacts.

P/N 24-1149

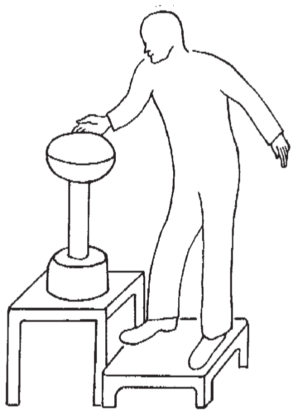
615-3130 Large Van de Graaf Generator Kit - ***One hot machine!***
New and improved. Double the output - up to 10 microamps. Make your own lightning with up to 12" arcs. 400,000 v potential, 90 cm high. 35 cm globe, rectangular metallic housing with on/off switch, butyrate column for minimal static, 16-page instructions. Uses 110v 60 cycle AC. Fully assembled.



Specifications:
- Works in humidities up to 90%
- 90 cm high, 35 cm globe
- 1/30 hp motor
- Blue enamel housing with on/off switch
- Two belts, 2" x 45"
- Globe 25 cm high, 35 cm diameter (14")
- Upper brush that clips on
- Transparent butyrate column

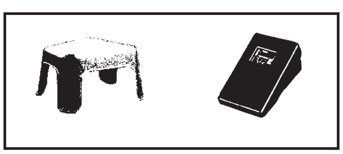
615-3100 Small Van de Graaf - Raise hair instantly - no shock hazard. Astound your friends with 5" sparks. Neoprene belt, spare included. Plastic molded base & housing, 18cm globe, PVC column, ground terminal, 16-page instructions. 200.000 v potentials in humidities to 90%.

Specifications:
- works in humidities to 90°
- 45 cm high, 18 cm dia globe
- with spare belt
- teflon lower pulley
- motor with more starting torque



Van de Graaff Accessories:

615-3120 Footstool - Insulate yourself for hair raising demonstrations. Stand on stool with hand on globe, have helper turn on machine.



615-3125 Footswitch - Start and stop your machine at a distance to reduce the likelihood of sparks. Good for hair-raising demonstrations. 110 volt operation only.

615-3116 Mylar Foil - 6 strands. Tape to globe, watch them fly.

Pith Balls
Balsa wood balls for electrostatic experiments, 3/8 inch in diameter. With or without attached threads.
615-3045- 6 pack, threaded
615-3050 - 6 pack, unthreaded
615-3055 - 6 pack, threaded, graphite coated

615-3115 Discharge Wand - Discharge your Van de Graaf at a comfortable distance. Good way to demonstrate lightning in front of a group. Contains 7" diameter aluminum globe on PVC column. Attached ground terminal connects to terminal on either 615-3100 or 615-3130. Instructions.

615-3085 Electrostatic Demonstration Kit - All you need to charge electroscopes, show electrostatic attraction, duplicate Faraday's ice pail experiment, display surface distribution of a charge, and more. Includes: 2 electroscopes with flasks; 2 ball and disc terminals; Faraday cage; 6 friction rods, labeled; electrophorus with charge plate; neon lamp; ice pair; acetate cloth; polyethylene film; charge transfer ball; electrically conducting ball; 12 pith balls; mounted point, instructions.

615-3090 Electrostatic Demonstration Kit - Make electricity by friction; store and transfer it. Experiment with electrostatic attraction and repulsion. Demonstrate the principles of electrophorus and proof plane *Includes:* electrophorus with plate; 6 friction rods; acetate cloth; polyethylene film; proof plane; neon lamp; graphite ball with hook; 12 pith balls; instructions.

A complete kit for middle school science.

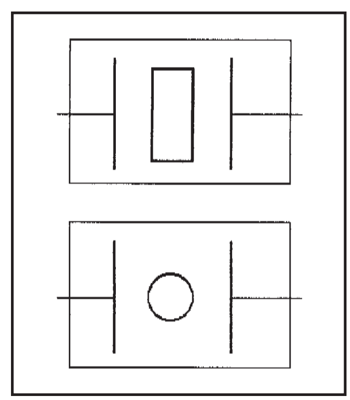
615-3075 Electroscopes Kit -Detect and identify electrical charges. Study electrostatic induction, attraction and repulsion and special effects. Includes: 2 foil leaf electroscopes with 2 pair die cut leaves and 2 250 ml flasks, 2 ball terminals; aluminum ice pail , 2 disc terminals; instructions.

615-3015 Friction Rod Kit - Contains hard rubber, glass and acrylic rod; silk, cotton and faux fur pads. With instructions.

615-0310 Lenz' Law Demonstration Kit - New! Drop the included incredibly strong neodymium magnet down our 2-foot copper tube. Does the magnet fall as quickly as you would expect it to? Why not? Kit contains: 2-foot tube, 3/4 in diameter: copper ; neodymium magnet; penny for contrast; instructions.

A class-sized demo and instant hands-on lab!

615-3195 Electric Field Map Kit - Plot, compare electric fields. Contains everything for a complete lab, *including:* cork board cover; 25 sheets conductive paper with grid; 100 sheets graph paper; template; conductive pen; 4 clip leads; instructions. *You need 12 volt AC power supply or 1 1/2 volt battery; digital volt meter (10 megohms +).* [Please note: conductive pen has shelf life of 6 months.]



Sample electrode configurations

Good group project for high school electricity labs!

615-3095 Faraday Cage Kit - Demonstrate that charge cannot exist inside a conductor cage. Study the lightning rod effect. *Includes*: Faraday Cage with stand and cover; mounted point; instructions.