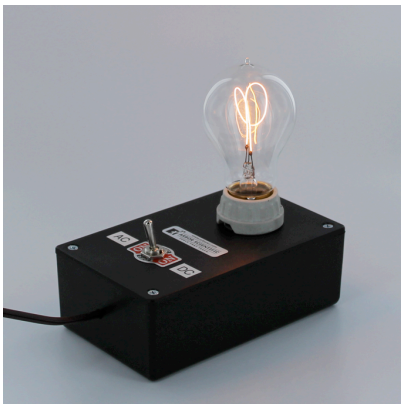

Electricity & Magnetism Light bulb Demo

P6-4000

BACKGROUND:

The link between electricity and magnetism finds its legendary roots back to Hans Christian Ørsted when he supposedly found that electric current affected his compasses during a student lecture. That piece of scientific history may be one of exaggerated legend, but the marriage of electricity with magnetism has been widely known for over a century, later to be given full mathematical explanation by Lord Kelvin and James Clerk Maxwell. The concept of electron movement causing the production of an ensuing magnetic field is a fundamental model used in describing electromagnets, generators, transformers and electric motors. Students can witness the magnetic fields produced by electron movement using compass deflections and observe first-hand the mechanical spin of a solenoid in an electric motor. Using the "Electricity & Magnetism Light Bulb Demo", you will demonstrate to your students the relationship between electricity and magnetism in an amazing and unconventional way, using a light bulb under conditions not normally observed in everyday life. When a wire that carries an electrical current is placed within a magnetic field, each of the moving charges, which comprise the current, experience the Lorentz force, and together they can create a macroscopic force on the wire. The following equation, in the case of a straight, stationary wire is as follows:

$$\mathbf{F} = I\boldsymbol{\ell} \times \mathbf{B}$$

...where $\boldsymbol{\ell}$ is a vector whose magnitude is the length of wire, conventional current flow I, B is the Magnetic Flux Density and F is the force on the wire.

IMPORTANT! The bulb's filament is very fragile. When using the bulb in AC mode, we suggest holding a small neodymium magnet (P8-1123) about 1 inch above the top of the bulb for a very short period of time. Placing a magnet closer than 1 inch to the AC current bulb could break the bulb's filament. Extra bulbs (P6-4000-05) on hand are always a plus, especially if constant use is warranted. Large neodymium magnets can be used for more dramatic demos (see our video) but be careful, the faster it vibrates the more likely it is to break!

IMPORTANT CONCEPTS:

The "Electricity & Magnetism Light Bulb Demo" can clarify several important concepts:

1. Using DC (Direct Current), electrons flow through a bulb's filament in one direction.

2. Using AC (Alternating Current), electrons flow through a bulb's filament in a two directions.

3. A magnetic field is produced when electrons flow through a conductor.

4. When magnets are placed near wires that carry electric current, a force is exerted on the wire. (Technically, the force is on the electrons in the wire. The electrons are "trapped" in the wire therefore causing the wire to move instead of the individual electrons.)

5. When a wire carrying an electrical current is placed in a magnetic field, each of the moving charges (electrons), which comprise the current, experiences the Lorentz force, and together they can create a macroscopic force on the wire itself.

OPERATION:

The "Electricity & Magnetism Light Bulb Demo" box is easy to use and requires no set-up time when you are ready to demonstrate to your students.

1. Place the "Electricity & Magnetism Light Bulb Demo" box on the front teacher lab desk and screw in the included filament bulb. In order to be able to demonstrate the effect of magnetic fields on current-carrying wires (the bulb's filament…), the kit's bulb possesses a special movable filament. Conventional light bulbs will not work for this demonstration since their filaments are supported and secured within the bulb itself.

2. Using a Neodymium magnet, show the students that an unlit bulb's filament is not affected by the presence of a strong magnetic field. Most bulb filaments are made of tungsten which are not ferromagnetic (strongly attracted) nor diamagnetic (strongly repelled) in nature and therefore not attracted nor repelled by the close proximity of a magnet.

3. Plug in the "Electricity & Magnetism Light Bulb Demo" box and explain to students that the light bulb can be illuminated using DC or AC current simply by using the switch on the box. Turn on the light using the DC switch position. Then turn on the bulb using the AC switch position. In both instance, the students will observe that the bulb appears to glow in the same manner of brightness, appearing identical in every way. Explain to them that even though they cannot "see" the current alternating in the AC position, the current nevertheless is alternating at 60 cycles/second, much faster than can be perceived by the human eye.

4. Placing the switch to the DC position, explain to the students that you will now bring the Neodymium magnet close to the bulb and its filament. They will begin to notice the filament bending in one direction, depending on what Pole (North or South) is facing the bulb filament. The filament will bend according to the Magnetism Hand Rule for Force on a wire in a magnetic field and the result is a Lorentz Force exerted on the filament. Turning the magnet to the opposite pole results in the bulb's filament to bend in the other direction according to Magnetism Hand Rules. Students are always astounded that a light bulb can actually be affected by a magnet as you perform this demonstration.

5. Now remove the magnet and turn the switch on the box to the AC position. The bulb glows brightly as in DC as you ask the class what will happen to the filament when bringing the magnet close to the bulb. Even before the experiment, many students will begin to realize that a changing electric current WILL cause a changing magnetic field at 60 times/second!

6. Bring the magnet about 1 inch above the top of the AC current bulb and you will astonish your students with the resulting phenomenon. The bulb's filament vibrates at 60 times/second in the presence of the magnetic field due to the electron movement-magnet interaction. You have essentially made a "light bulb electric motor"!

TEACHER SUGGESTIONS:

A. The “Electricity & Magnetism Light Bulb Demo” box is very durable and will last for years. Store in a cool, dry place over long periods of inactive use.

B. An old decorator light bulb manufactured years ago with blue and red glass had a tiny bar magnet mounted inside the bulb and a flimsy filament which caused the filament to vibrate when screwed into a household socket. It was sold as “Bala-Fire” and used the Electricity-Magnetism principles to exhibit a “flickering flame” when it was turned on. It may be available on eBay or at other antique lighting company outlets.

ACKNOWLEDGEMENTS:

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RELATED PRODUCTS:

Worlds Simplest Motor P8-8300

By building and observing a motor that converts electrical energy into motion, students discover and explore first-hand several key properties of electricity and magnetism.

Neodymium Magnet pair P8-1123

These neodymium-iron-boron magnets are, for their size, the most powerful magnets on earth! Each 1/2" in diameter, 1/4" thick.

Lenz’s Law Apparatus P8-8400

Experience the fundamental principle behind electric motors with this demonstration. Drop the strongly magnetized plug through the copper pipe, and induced currents cause it to fall very slowly.

Homopolar Motor Kit P8-8350

You've seen the World's Simplest Motor. We have a classroom set so you can make one that's even simpler than that.