

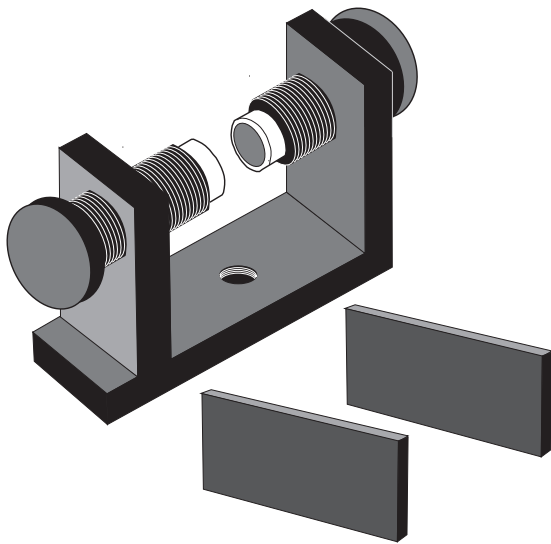
**Instruction Manual and
Experiment Guide for the
PASCO scientific Model
EM-8641 and EM-8642A**

012-04615C

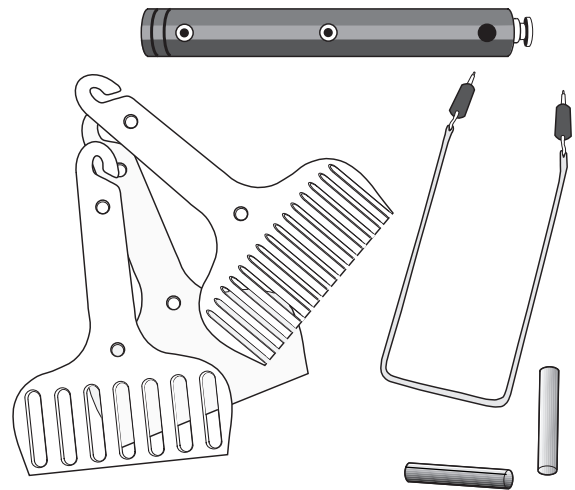
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VARIABLE GAP MAGNET

WITH MAGNETIC FORCE ACCESSORY



EM-8641 Variable Gap Magnet



EM-8642A Magnetic Force Accessory

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\$7.50

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Copyright, Warranty and Equipment Return

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Credits

Authors: Ann and Jon Hanks
Editor: Sunny Bishop

Equipment Return

Should the product have to be returned to PASCO scientific for any reason, notify PASCO scientific by letter or phone BEFORE returning the product. Upon notification, the return authorization and shipping instructions will be promptly issued.

► **NOTE:** NO EQUIPMENT WILL BE ACCEPTED FOR RETURN WITHOUT AN AUTHORIZATION.

When returning equipment for repair, the units must be packed properly. Carriers will not accept responsibility for damage caused by improper packing. To be certain the unit will not be damaged in shipment, observe the following rules:

- ① The carton must be strong enough for the item shipped.
- ② Make certain there are at least two inches of packing material between any point on the apparatus and the inside walls of the carton.
- ③ Make certain that the packing material cannot shift in the box or become compressed, thus allowing the instrument come in contact with the edge of the box.

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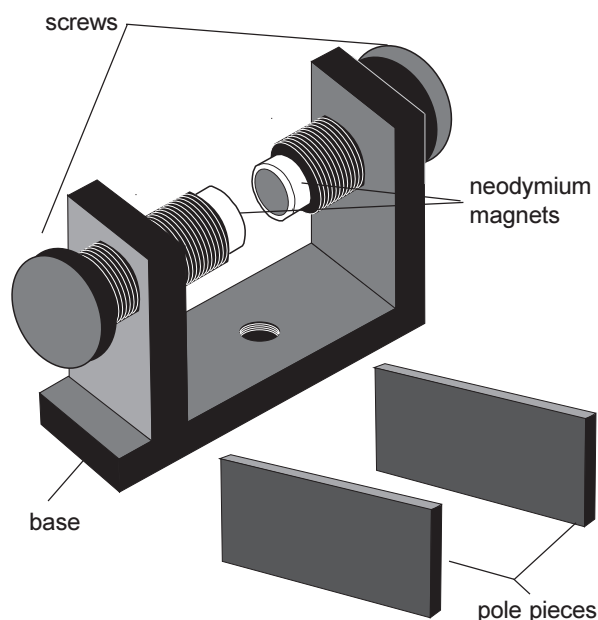
email: techsupp@PASCO.com

Introduction

The PASCO Model EM-8641 Variable Gap Magnet and the Model EM-8642A Magnetic Force Accessory facilitate the teaching of the concepts of magnetic induction,

diamagnetism, paramagnetism, and magnetic force on a current-carrying wire.

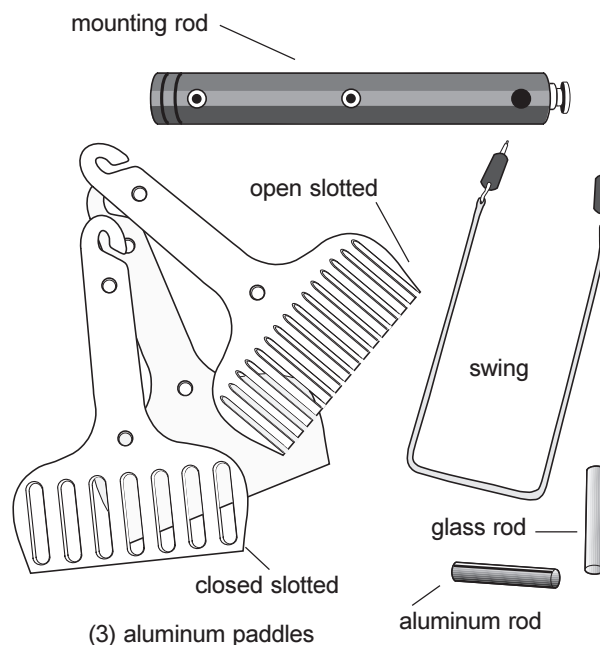
Equipment



EM-8641 Variable Gap Magnet

The Variable Gap Lab Magnet consists of two 3/4 inch diameter neodymium magnets on an iron base. Two flat pole pieces are supplied to provide a uniform field when needed. The gap may be varied from 0.5 cm to 8.9 cm by turning the screws. The magnetic field strength (without the flat poles) varies approximately as shown on Table 1.1. The magnet will not have a great effect on its surroundings because the field drops off to about 30 Gauss at the outside edges of the magnet.

► **NOTE:** If you are having trouble and the magnetic field strength seems too small, check the polarity of the neodymium magnets. If like poles are facing each other, the field will be essentially zero. See “Magnet Installation” on page 2.



EM-8642A Magnetic Force Accessory

The Magnetic Force Accessory consists of five components (see Figure):

- Set of three aluminum paddles (solid, closed slotted, and open slotted) for demonstrating induction and magnetic damping.
- Swing for demonstrating the magnetic force on a current-carrying wire.
- Mounting rod.
- Paramagnetic material (aluminum)
- Diamagnetic material (glass)

Table 1. Strength of the Magnetic Field with Various Gap Sizes between the Poles

Gap (cm)	Magnetic Field at Poles (Tesla/Gauss)	Magnetic Field at Midpoint between Poles (Tesla/Gauss)
0.5	0.75/7500	0.75/7500
1.0	0.60/6000	0.50/5000
8.9	0.40/4000	0.007/70

Installation

The Variable Gap Magnet is shipped with the neodymium magnets installed. The neodymium magnets are attached only by magnetic attraction to the iron. If the magnets are removed for any reason, follow these instructions carefully to re-install them.

► **CAUTION:** Be extremely careful when handling the neodymium magnets. The two magnets can snap together violently; any part of your body that is caught between the magnets may be severely injured.

- ① Screw the iron poles back, widening the gap to about 7 cm. This will separate the poles so there is less chance of the magnets hitting together during installation.
- ② When a magnet is brought near to the iron pole, it will be strongly attracted to it so you will have to hold the magnet back as you approach the iron pole. Carefully put one magnet on the end of either one of the iron screw poles.
- ③ Take the second magnet firmly in your hand (see Figure 1) and test the polarity of this magnet by bringing one side of it near to the magnet you've already installed. When installed, the second magnet must be oriented so it is attracted to the first magnet, thus assuring that one pole of the assembled magnet is a

North pole and the other pole is a South pole. Once polarity has been correctly established, carefully put the second magnet on the remaining screw pole, completing the assembly.

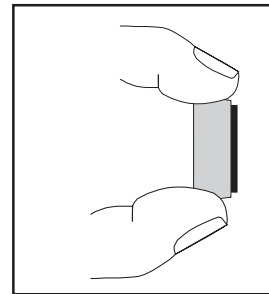


Figure 1: Method for Holding the Neodymium Magnets to Install Them on the Base

Use of the Flat Iron Pole Pieces

The flat iron pole pieces are used to spread the magnetic field over a wider region. This will reduce the field while making it more uniform. The pole pieces are attached only by magnetic attraction.

► Try to prevent the pole pieces from striking hard against the neodymium magnets because this may break or chip the magnets.

Equipment Positioning

The Variable Gap Magnet may be used in four different free-standing positions (Figure 2) as well as on a stand (Figure 3). The following diagrams illustrate the various positions. A threaded hole in the magnet base allows a standard 1/2" rod to be used to attach the magnet to a stand.

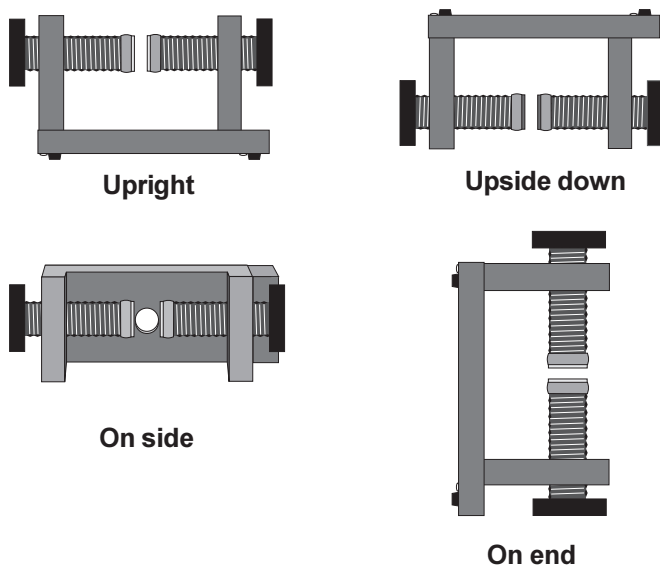


Figure 2. Free-standing positions for the Variable Gap Magnet

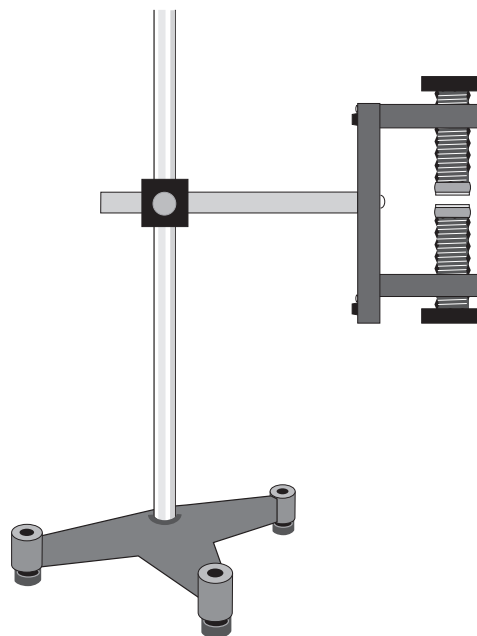


Figure 3. Variable Gap Magnet on a Stand

Demonstration 1: Magnetic Induction

EQUIPMENT NEEDED

- Variable Gap Magnet
- Magnetic Forces Accessory

- Base and Support Rod (ME-9355)

Setup

- ① Slide the support rod through the hole on the mounting rod and tighten the set screw to hold it in place.
- ② Hang the solid paddle on the end of the black bar by placing the hooked end of the paddle in the slot in the black bar (Figure 4).
- ③ Adjust the magnet poles so the gap between the poles is just wide enough to allow the paddle to fit without touching.

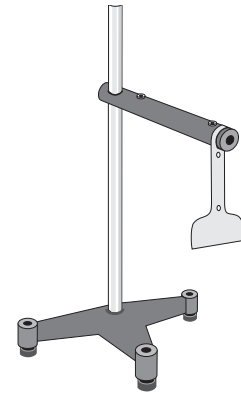


Figure 4

Procedure

- ① Keeping the magnet away from the solid paddle, swing the paddle to show that it swings freely.

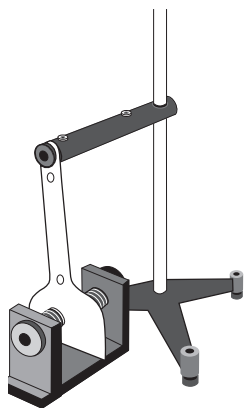


Figure 5

- ② Slowly bring the magnet into position so that the paddle hangs between the poles of the magnet (Figure 5). (If the magnet is moved into position too quickly, the paddle will move). Point out to the class that the paddles are made of aluminum, which is not a ferromagnetic material and is not attracted to magnets.

- ③ With the magnet in place, swing the paddle (Figure 6) to show that the oscillations are now damped because of the induced eddy currents in the moving paddle.

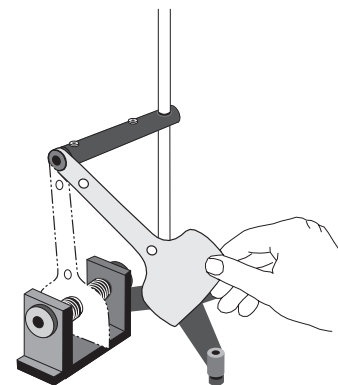


Figure 6

- ④ Repeat Steps 1 through 3 using the other two paddles. The open slotted paddle is only slightly damped (Figure 7). The closed slotted paddle is very damped, although it is less damped than the solid paddle.

► **NOTE:** There are two slots in the black rod so two paddles may be used at the same time.

► **NOTE:** If you drop or bend one of the paddles, it may no longer swing freely in the slot. To fix, simply bend the hooked end back into shape and file both sides of the paddle to eliminate any kinks in the aluminum. Then the paddle will swing freely once again.

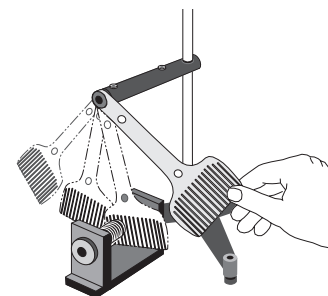


Figure 7

Demonstration 2: Magnetic Force on a Current-Carrying Wire Swing

EQUIPMENT NEEDED	
<ul style="list-style-type: none"> • Variable Gap Magnet • Magnetic Forces Accessory 	<ul style="list-style-type: none"> • Base and Support Rod (ME-9355) • (2) patch cords (SE-9415)
<ul style="list-style-type: none"> • 12 volt DC power supply, or hand-held generator 	

Setup

- ① Slide the support rod through the hole on the mounting rod and tighten the set screw to hold it in place.
- ② Plug the swing into the two holes in the mounting rod (Figure 8).
- ③ Place the Variable Gap Magnet (with the flat pole pieces installed) on its end so the magnetic field between the poles is vertical. Position the magnet so the horizontal wire of the swing is between the poles of the magnet. Adjust the poles of the magnet so the gap is just large enough for the swing to swing freely between the poles.

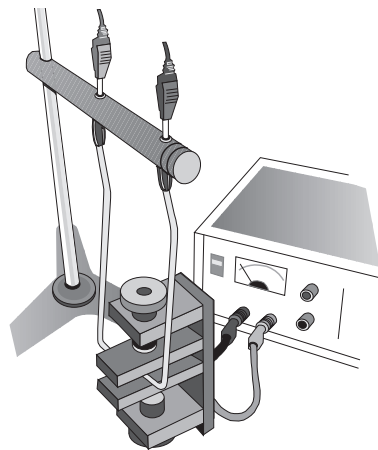


Figure 9

- ④ Connect a power supply (12 V, 6 A) to the top banana jacks on the bar (Figure 9).

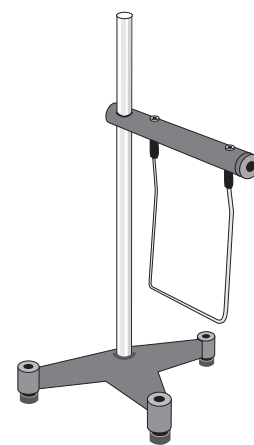


Figure 8

Procedure

- ① Switch the current on. The swing will move out of the magnet. The direction the swing moves depends on the direction of the current ($\mathbf{F} = q\mathbf{v} \times \mathbf{B}$).
- ② Reverse the position of the patch cord connections on the mounting rod. The swing will move in the opposite direction. (You can also demonstrate the dependence of the direction of swing movement on current direction if you include a double-pole, double-throw switch (DPDT) in the circuit.

► **NOTE:** It is possible to use the PASCO hand-held Mini Generator (SE-8645) as the power source in this demonstration. Then it is easy to reverse the current by simply reversing the direction that the Mini Generator is cranked.

Demonstration 3: Diamagnetism and Paramagnetism

EQUIPMENT NEEDED

- Variable Gap Magnet
- Magnetic Forces Accessory

- Base and Support Rod (ME-9355)

Introduction

Compared to ferromagnetism, diamagnetism and paramagnetism are weak effects. However, when a diamagnetic material is placed in a strong magnetic field, it is possible to see that the material is repelled by the magnetic field. On the other hand, paramagnetic materials submerged in a strong magnetic field will be noticeably attracted to the magnetic field.

Setup

- ① Tie pieces of thread (supplied with set) around the glass rod and the aluminum tube and secure the thread with a small piece of tape to prevent the sample from slipping out of the thread loop.
- ② Hang the glass (diamagnetic) sample from a stand so it is at the same level as the Variable Gap Magnet when the magnet is placed on its side (Figure 10).
- ③ For large class viewing, put the magnet and the stand with the sample on an overhead projector and focus the projector on the sample. The stand will not obstruct the view because it is out of focus.

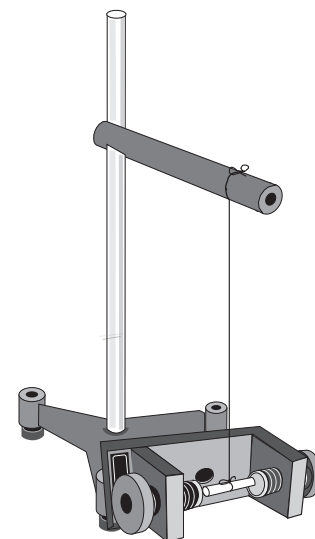


Figure 10

Procedure

- ① For the glass sample, show that when you place the glass rod parallel to the magnetic field lines, the rod rotates and oscillates about an equilibrium position which is perpendicular to the magnetic field lines of the magnet (Figure 11). Eventually the glass rod will come to rest in this equilibrium position but it takes longer than you will want to wait. So, using your hand, stop the glass rod in the equilibrium position. Then, to show that the rod is held in this position by the magnet, gently rotate the magnet about the axis formed by the thread. The glass rod will also rotate, always keeping perpendicular to the magnetic field lines.

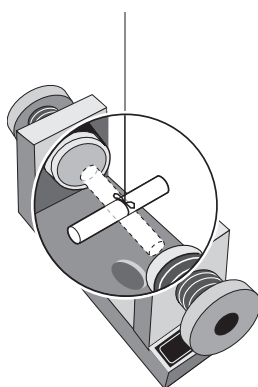


Figure 11

② Follow the same procedure for the aluminum (paramagnetic) sample except, instead of initially aligning the tube with the magnetic field, put the aluminum tube perpendicular to the field at the beginning of the demonstration to show that it will rotate into the equilibrium position which is parallel to the magnet's field lines (Figure 12). Then rotate the magnet to show that the aluminum is locked into the equilibrium position, aligned with the poles of the magnet.

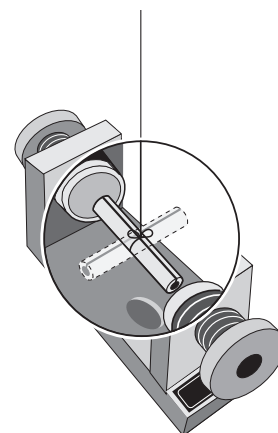


Figure 12

► **NOTE:** The slot in the aluminum sample is necessary to reduce the damping effects due to eddy currents induced in the aluminum as the tube rotates in the magnetic field.

Technical Support

Feedback

If you have any comments about the product or manual, please let us know. If you have any suggestions on alternate experiments or find a problem in the manual, please tell us. PASCO appreciates any customer feedback. Your input helps us evaluate and improve our product.

To Reach PASCO

For technical support, call us at 1-800-772-8700 (toll-free within the U.S.) or (916) 786-3800.

fax: (916) 786-3292

e-mail: techsupp@pasco.com

web: www.pasco.com

Contacting Technical Support

Before you call the PASCO Technical Support staff, it would be helpful to prepare the following information:

- ▶ If your problem is with the PASCO apparatus, note:
 - Title and model number (usually listed on the label);
 - Approximate age of apparatus;
 - A detailed description of the problem/sequence of events (in case you can't call PASCO right away, you won't lose valuable data);
 - If possible, have the apparatus within reach when calling to facilitate description of individual parts.
- ▶ If your problem relates to the instruction manual, note:
 - Part number and revision (listed by month and year on the front cover);
 - Have the manual at hand to discuss your questions.

