

Three-dimensional magnetic field in a bottle

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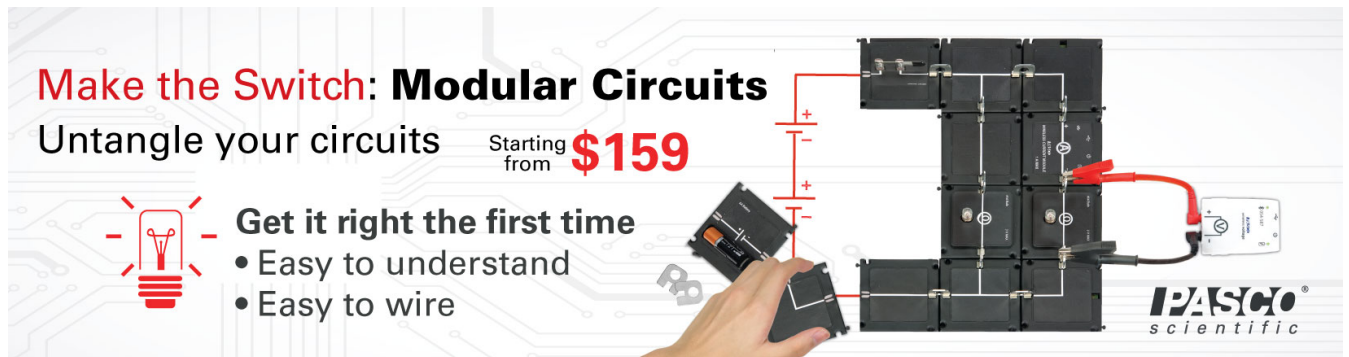
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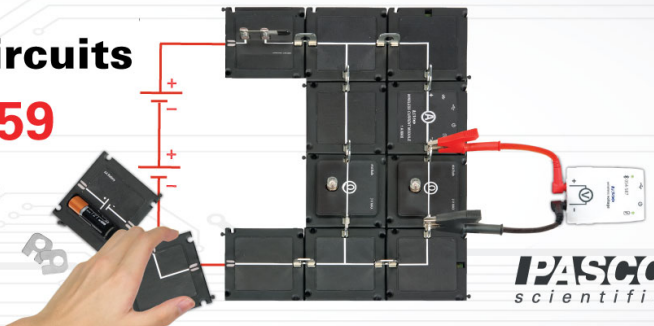
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Three-Dimensional Magnetic Field in a Bottle

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There are several devices for making magnetic fields visible in two dimensions on an overhead projector. Recently a few companies have been offering an apparatus that exhibits magnetic fields of small magnets in three dimensions, but these commercial devices cost about \$60 each.

An equivalent apparatus can be constructed using material found in most physics and chemistry laboratories, plus a "cow magnet" available at most farm stores for under \$3. The cow magnet is a stainless steel cylinder 7.5 cm long and 1.5 cm in diameter. The type that is rounded at the end works best. (These magnets are used to hold ingested scrap metal in the rumens of grazing cattle, and thus keep the metal from passing into the cows' more sensitive intestines.) The other materials required are a standard 250-ml gas bottle, a 15-cm-long test tube, a #12 cork stopper, a 1 × 0.5-cm piece of clear tubing, and about 25 g of coarse iron filings.

Cut a hole 16 mm in diameter in the cork and insert the test tube until the top is flush with the cork. Place the iron filings in the gas bottle and put the cork-test tube assembly in the mouth of the bottle. Place the small piece of tubing in the bottom of the test tube to absorb the shock of the magnet when it is dropped into the tube (Fig. 1). Put the magnet inside the tube and shake it gently. A reasonably good three-dimensional field will form around the test tube and magnet (Fig. 2).

For class viewing, placing the assembly on an overhead projector will

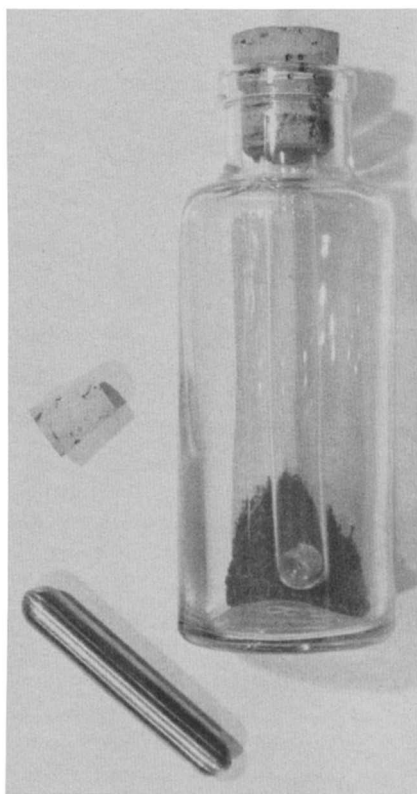


Fig. 1. Materials used in construction.

work, but refraction through the round glass bottle distorts the image. The bottle is simple and rugged; put a small stopper in the top of the test tube and let the students pass it around.

I tried variations by mixing iron filings with mineral oil and other viscose liquids to hold the shape of the pattern, but found the added materials messy, and they did not appreciably improve the field. In other words—the simpler the better.



Fig. 2. A three-dimensional magnetic field. Note: The filings line up at points near the ends of the magnet.