

**Apparatus Competition**  
**2009 AAPT Summer Meeting**  
**Ann Arbor, MI**

## **Musical Paper**

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(Sponsored by AAPT Member Michael Meyer, same address)

### **Abstract**

A working audio speaker is constructed with a piece of paper, some wire, and glue. This can be done as a demonstration, as part of a lab, or as a simple project. The speaker clearly illustrates the Laplace force ( $I \times B$ ) in an entertaining way.

### **Construction of Apparatus:**

A coil of thin wire is glued to a regular piece of paper. Audio signals from a radio, tape player, or other device are applied to the coil. When a permanent magnet is brought into the vicinity of the coil, the audio can be heard.

The coil should be a few centimetres in diameter, made from very thin wire, with a length to get a total resistance of a few ohms. We have had success with coils which are approximately 25 turns of AWG 36 wire in a coil about 10 cm in diameter. The coil can be wound on any convenient form (e.g. the bottom of some coffee mugs, or other similar containers). For our coils, after about 25 turns, the coil is removed and one final turn is wrapped around the others to hold them in shape.

The coil is glued to a regular piece of paper. We used fast curing epoxy. First a few dots of glue are applied around the circumference and allowed to dry. Then a thin layer is applied around the entire circumference.

You can use bared coil leads with alligator clips, or for a more “permanent” setup, you can make connection points on the edge of the paper using copper tape.

The paper is hung from a ring stand and is connected to the audio source. A magnet is brought near the coil to hear audio. The magnet can be conveniently stuck to another (steel) ring stand for longer term demonstrations. For public displays, tape can be used to secure the magnet to ensure it does not wonder off.

The larger and stronger the magnet, the more sound will be produced. A large ferrite magnet is quite inexpensive and works well. A large rare earth magnet works even better though there are practical concerns if students will be handling the apparatus.

### **Use of Apparatus:**

The paper speaker is attached to an audio source, such as a radio. A magnet is brought near the coil of the speaker and the audio can be heard. Further exploration can involve turning the magnet around, trying the magnet on the opposite side of the paper, a d.c. current can be applied to demonstrate the forces involved, etc.

### **Cost:**

The paper speaker:

Piece of paper (if not from recycling bin): \$0.02

Thin Wire (if not available surplus): \$0.01

Few dabs of Glue: < \$1.00

2 small pieces of copper tape (optional): \$0.01

Magnet (2 x 2 x 1 ferrite used here): \$4.00

(magnet was already present, price is for similar from [www.magnet4less.com](http://www.magnet4less.com))

Other components used for this presentation:

Audio source (radio, from 2<sup>nd</sup> hand shop): \$3.50

Audio connector (from old broken headphones): scrap

Total cost is less than \$10.