

First, gently cut the speaker cone from the speaker basket (the metal frame) and lift to show students what is inside. It will not come completely apart until you cut the spider from the frame.



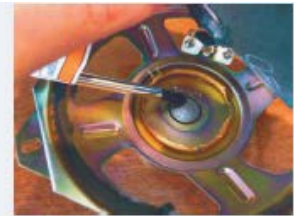
Second, gently cut the spider from the speaker basket. The spider's main function is to hold the center voice coil in place.



Lift the spider/voice coil from inside the speaker. Allow students time to make observations of the tiny coil of wire.



Using a metal tool, like a screwdriver, tap on the center magnet in the speaker basket. It's difficult to remove the magnet and sufficient to show students that it is a magnet without removing it. Your screwdriver should stick to the magnet, which is a good way to show students the magnet.



Lay out the important parts of the speaker, including the voice coil (coil of wire), the magnet/basket combination, and the paper speaker cone.



Discuss variations to speaker designs. Ask students to review the questions they answered in the previous lesson. Elicit from 2 or 3 students their written explanations to the questions. Pause to reflect on the ways speakers are designed using certain materials and particular parts that together make a system. Use **slide A** if needed to guide the discussion.

- Why do speaker manufacturers design the coil of wire and magnet to have such a small air gap between them?
- How would increasing the gap between the coil of wire and magnet affect the strength of the pushes and pulls they exert on each other?
- Speaker cones are usually made of thin materials that are lightweight. Why would designers do this? How might a heavier material respond differently if the magnetic forces on them stayed the same?

Say, "We've learned a lot about magnetic forces and magnetic fields to help us explain how speaker vibrations are caused by forces between a permanent magnet and an electromagnet. Each part of the speaker has an important role in the whole system. If one part breaks or doesn't work right, then the whole system is affected. Designers and engineers are always looking for better ways to build these devices. Now that you know more about the parts of the system and how they work together, let's think about how those parts are designed to achieve good sound quality and see if we can test our ideas about that."

Generate a list of speaker parts that we could change to affect sound. Remind students that their original homemade cup speakers from Lesson 1 worked OK, but that the sound was not reliable on some of speakers and sometimes the lyrics were hard to hear. Display **slide B** to give students an illustration of the homemade cup speaker. In a public space, with chart paper or a whiteboard, facilitate a brainstorming discussion to elicit and record students' ideas about where the speaker could be enhanced by changing a part of the homemade cup speaker. The illustration may cue students into the various factors they could change. Students may identify the following parts:

- magnet
 - shape
 - size
 - strength
- coil of wire
 - type of wire (thicker/thinner)
 - number of coils
 - diameter of the coil
- speaker cone, or membrane
 - type of material
 - size of the cone
- distance between the magnets