

RAFT IDEAS

Topics: Sound, hearing, anatomy of the ear

Materials List

- ✓ 3 sports bottle caps
- ✓ 2-2' long tubes
- ✓ Latex glove
- ✓ Tape
- ✓ Utility knife
- ✓ Glue (optional)

This activity can be used to teach:

CO Science Standard 1:
Physical Science

- Sound Waves

Grades: 4, 8

CO Science Standard 2:
Life Science

- Human Body Systems

Grades: 2, 3, 4, 5, 7



Bottle Cap Acoustic Booster

Boost your hearing power!



Assembly

1. Open the mouth pieces of the sports bottle caps.
2. Remove the center tab of each mouthpiece by twisting a utility knife through the center. Set two caps aside.



3. Widen the hole in one bottle cap so that the two tubes fit snugly together inside. Glue can be added around the tubes to ensure an air-tight seal.
4. Remove the thumb from a latex glove and stretch taut over the open end of the bottle cap. Secure with a rubber band.
5. Fit the other end of each tube into the mouthpiece of a bottle cap. If the tube does not fit snugly, add tape around the tube.

To Do and Notice

Press the cap with the latex stretched across against what you want to hear magnified and apply the other caps to your ears (they should fit around the ears). The cap with the latex must be touching what you want magnified.

The Science Behind the Activity

Sound is caused by vibrations that travel in compression waves through the air (the medium) and into the ear, hitting the eardrum. The waves cause the eardrum to move back and forth, sending the waves into the inner ear. However, the cochlea in the inner ear conducts sound through a fluid, instead of through air. This fluid has a much higher inertia than air -- that is, it is harder to move (think of pushing air versus pushing water). The small force felt at the eardrum is not strong enough to move this fluid. Before the sound passes on to the inner ear, the total pressure (force per unit of area) must be amplified. This is the job of the ossicles, a group of tiny bones in the middle ear. The ossicles are actually the smallest bones in your body. They include: the malleus, commonly called the hammer, the incus, commonly called the anvil and the stapes, commonly called the stirrup. The main amplification comes from the size difference between the eardrum and the stirrup. The eardrum has a surface area of approximately 55 square millimeters, while the faceplate of the stapes has a surface area of about 3.2 square millimeters. Sound waves apply force to every square inch of the eardrum, and the eardrum transfers all this energy to the stapes. When you concentrate this energy over a smaller surface area, the pressure (force per unit of volume) is much greater. The Acoustic Booster works in much the same way. The sound waves entering the latex covered cap are concentrated through the tubes rather than through open air, and are therefore amplified. (Reference: <http://science.howstuffworks.com/environmental/life/human-biology/hearing3.htm>)