

EQUIPMENT BUILD PLAN SOUND & WAVES

Toy Motor Speaker

Instead of a coil and magnet, this speaker uses an ordinary toy DC motor as its driver. The music signal makes the motor's shaft twitch back and forth, and a short dowel carries those tiny movements to the middle of a foam plate, which pushes on the air. Bruce gives two builds, an easy cardboard version and a sturdier wooden one, plus a 'bite stick' that lets you hear music through your jawbone.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.



<div>DIFFICULTY</div> <div>Beginner</div>	<div>BUILD TIME</div> <div>30 minutes (cardboard) to 1-2 hours (wood)</div>
<div>COST</div> <div>About \$5-10, plus an amplifier</div>	<div>SAFETY</div> <div>Everyday care</div>
<div>GOOD FOR</div> <div>Teachers, Families, Makers</div>	

What it shows

A cheap toy motor already has a coil and magnets inside, so hook it to an amplifier and it will play music through a foam dinner plate.

Key ideas: sound waves, vibration, electromagnetism, motors, speakers, bone conduction

Safety (Everyday care). Hot glue can burn, so younger builders need a grown-up with the glue gun; an adult should do any drilling. Use a ready-made amplifier or stereo and connect only to its speaker outputs; do not open

up mains-powered equipment. For the bite stick, give each person a fresh straw sleeve over the dowel and keep the volume low.

CONSTRUCTION

Build it

Materials

- ☐ **Toy DC motor** · 1
The kind that spins when connected to a D cell
- ☐ **Foam dinner plate** · 1
About 9 in
- ☐ **Wooden dowel, 3 in long** · 1
Or a short wooden pencil with an eraser
- ☐ **Stiff cardboard** · 1 piece
Cardboard version: a square about the size of the plate plus two 3 in tabs
- ☐ **Wood base, 4 × 8 in, a 2 in high wood block, and two 7 in dowels** · 1 set
Wood version only
- ☐ **Eye screws or small bolts** · 2
Optional terminals for the amplifier wires
- ☐ **Speaker wire with alligator clips** · 1 pair
- ☐ **Amplifier or stereo with speaker outputs** · 1
A headphone jack does not supply enough power

Tools

Hot glue gun

Drill with a small bit sized to the motor shaft

Scissors or box cutter (cardboard version)

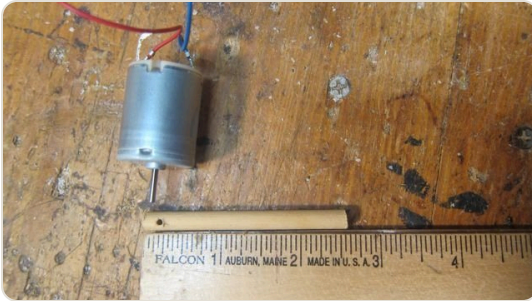
Saw and screwdriver (wood version)

Ruler and marker

1

Fit the dowel to the motor

Drill a small hole in one end of the 3 in dowel so it pushes tightly onto the motor shaft. If you use a pencil instead, twist a small drill bit or nail into the eraser by hand to make a pilot hole first, or the eraser will split.



2

Test the driver

Connect the motor to the amplifier and play some music. You will hear faint sound from the motor. Hold the motor and touch the end of the dowel to the bottom of a plastic cup, and the music becomes clearly audible.



3

Cardboard version: cut the base

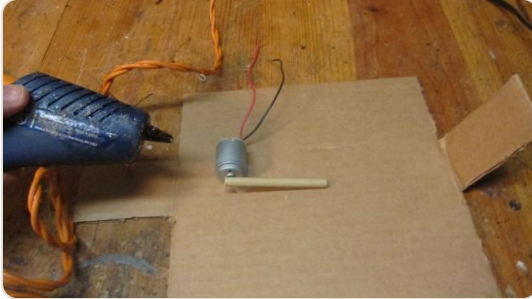
Cut a cardboard square about the size of the plate, with a 3 in tab sticking out from two opposite sides. The tabs will fold up to hold the plate.



4

Glue down the motor

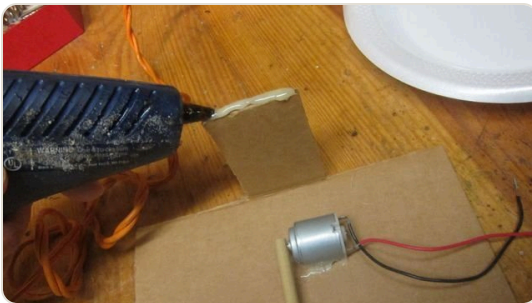
Place the motor so the end of its dowel sits near the center of the cardboard, angled up toward where the plate will be, and hot glue the motor down.



5

Attach the plate to the tabs

Fold up one tab, put hot glue on its top edge and quickly press one side of the plate into it. Repeat with the other tab. Use only a little glue, since too much will melt the foam. It is fine if the plate wobbles now.



6

Glue the dowel to the plate

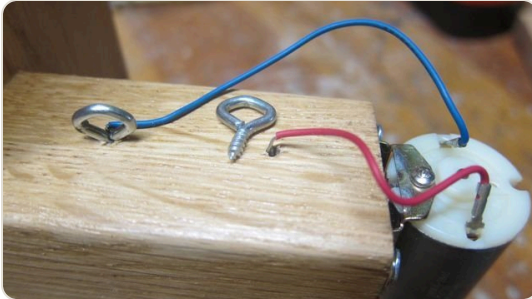
Turn the assembly over so the dowel rests against the middle of the back of the plate. Straighten everything, put a dab of hot glue on the plate and press the end of the dowel into it. Once the glue sets, the plate is stable.



7

Wood version: mount the motor

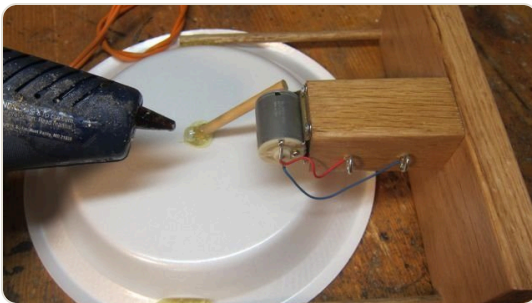
Center the 2 in block on the 4 × 8 in base so the motor's dowel will reach the middle of the plate, mark it, and glue or screw it down from below. Hot glue the motor on top of the block, or use its mounting bracket. Fasten the motor leads to two eye screws in the side of the block as terminals.



8

Wood version: add the plate supports

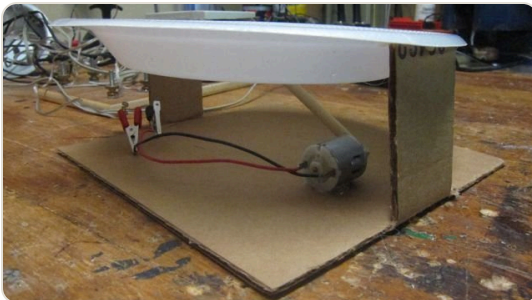
Drill holes for the two 7 in dowels so they hold the plate up with its center level with the motor's dowel. Lay the plate face down, glue the support dowels to its back, then glue the motor's dowel to the center of the plate at an angle of roughly 20-30 degrees.



9

Connect and listen

Clip the speaker wires to the motor leads (or terminals) and to the speaker outputs of the amplifier. Start with the volume low and turn it up gradually.

**THE PHYSICS****How it works**

Inside a toy motor, the spinning part (the armature) is wrapped with coils of wire, and permanent magnets surround it. A music signal is an electric current that changes direction and strength hundreds or thousands of times a second.

Each change in the current makes the armature's coils push or pull against the magnets, giving the shaft a tiny twist one way or the other. The shaft never gets a chance to spin; it just twitches in time with the music.

The dowel carries those twitches to the center of the foam plate. The large, light plate pushes and pulls on a lot of air, creating the pressure waves we hear as sound. The motor alone moves too little air to be heard well, which is why the plate makes such a difference.

The sound is not high-fidelity; Bruce compares it to an old tube radio. The motor is designed to spin, not to vibrate evenly across all frequencies.

Using it

- Play music through the bare motor, then touch its dowel to a cup, a box, a tabletop or a window. Ask: which surfaces make it loudest, and why?
- Compare the toy-motor speaker with the coil-and-magnet foam plate speaker.
- Bite stick: push the dowel or pencil onto the motor shaft, slip a fresh drinking straw over it, and gently bite down on the straw while music plays at low volume. The sound travels through your jaw and skull to your inner ear, bypassing the eardrum, and people next to you can barely hear it. Some hearing aids use the same bone-conduction idea.
- Ask students to explain how a device built to make motion can also make sound, and whether a speaker could work as a microphone or generator in reverse.

GO FURTHER

Variations

- Use a short pencil instead of the dowel, pushing the motor shaft into the eraser.
- Experiment with the angle between the dowel and the plate; Bruce found roughly 20-30 degrees worked best.
- Try paper plates, plastic cups, or a foam bowl as the cone.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

Very faint sound

TRY THIS

Use the amplifier's speaker outputs, not a headphone jack; headphone outputs are too weak to drive a speaker.

IF THIS HAPPENS

Sound is distorted or buzzy

TRY THIS

Turn the volume down; this speaker works best at moderate levels. Make sure the dowel is firmly glued to the plate.

IF THIS HAPPENS

Plate melted where it was glued

TRY THIS

Use less hot glue, or let it cool slightly before pressing the foam into it.

IF THIS HAPPENS

Dowel slips on the shaft

TRY THIS

Drill a smaller hole, or add a drop of glue to the joint.