Drawbots

A vibrating machine that scribbles its own art.

GRADES 2 THROUGH 8 | AGES 7 TO 14 | ABOUT 60 MIN

OVERVIEW

Learners build a small vibrating machine with marker legs that makes its own abstract art, then rearrange it to change what it draws. The build connects art and design, English language arts, and science and engineering.

LEARNERS EXPLORE

closing an electric circuit; unbalanced weight and vibration; energy transfer (electrical to mechanical); the engineering design process; iterative redesign









IN EACH LEARNER'S KIT

- 3 primary-colored markers (legs)
- Pre-cut foam sheet with components
- 1 AA battery
- 1 jumbo rubber band
- 1 motor with attached gear and wires
- Instruction sheet
- Resealable storage bag

Educator provides: scissors and markers.

STANDARDS IN THIS GUIDE

NGSS: K-PS2-1, K-2-ETS1-2, 3-5-ETS1-1, 3-5-ETS1-3, MS-PS3-5, MS-ETS1-2

Common Core: RI.K-2.7, SL.K-2.1, RI.3-5.7, W.3-5.2, RST.6-8.7, W.6-8.1, K.MD.A.1, 1.G.A.2, 3.MD.B.4, 4.MD.A.3, 6.RP.A.3, 7.G.A.2

Video walkthrough
8:25 min

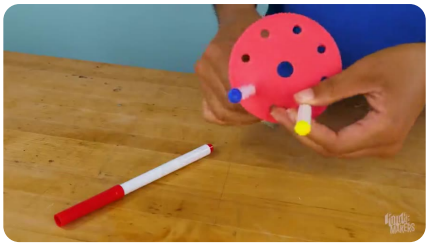
Full guide read online

Step by step, with guiding questions

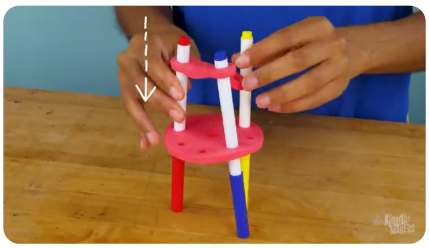
Step 1: Build the Base

Ask: How can you combine a piece and markers to create a body that stands on three legs?

Start with the circular foam base from your kit. Take each marker and gently slide it back-end first, halfway through three different holes on the base. Try to space the markers out as evenly as possible - this will help your Drawbot stay balanced later on.



Step 2: Secure the Markers



Ask: How can you keep the markers connected so they're more stable?

Take the three-hole foam connector and slide the end of each marker through each of its holes. Balance the Drawbot by adjusting the spacing of the markers, the connector, and the base - it should stand on its own. Encourage learners to try other components that have multiple holes as well - they combine well! Pro Tip: Now is a great time to check in with your learners and make sure everyone's Drawbot is standing on its own before moving on.

Step 3: Assemble the Battery Pack

Ask: The motor and the battery will need to connect to make a circuit that makes the motor spin - how can we use the rubber band to hold wires to the ends of it?

First, free-stretch the rubber band several times to loosen up the elastic - this makes it much easier to work with. Hook the band onto the bump of the battery's positive end, then pull it lengthwise over the battery, covering both ends evenly. If the rubber band keeps slipping off, encourage learners to press firmly over the bump while stretching it to the other side. Very small fingers may need help from others. Pro Tip: Stretch the band multiple times before putting it on the battery. Loosening up the elastic first will make it much easier for learners to get it on without frustration.

Step 4: Attach the Battery to the Base

Ask: Where can we attach the battery to our Drawbot body so it's held firmly in place?

Gently slide the battery pack through the large center hole on the base. The battery can also be placed elsewhere using other foam components to hold it in place - ask learners: where else could it go?

Step 5: Build the Motor Assembly

Ask: Where can we insert the motor so it's held firmly in place, and it can spin?

Find the two foam components that have a large rectangular hole - one is short and straight, the other is shaped like the letter L. Take your motor and feed the gear through the rectangular hole on one piece, then slide the foam down until it's wrapped around the metal body of the motor. Do the same with the second piece. Overlap the pieces to align the rectangular holes and form a Y-shape. The motor should be firmly held in place without keeping the gear from turning. Insert the tabs of the motor assembly into holes on the circular base, between the markers.

Step 6: Create the Unbalanced Weight

Ask: What parts can we add to the end of the motor to make the motor vibrate?

Find the unbalanced weight components - any combination could work, but start with the ones that have notches. Gently press the notches on the foam components and connect them together to create an off-center shape that adds weight. Insert the motor's gear into one end of the unbalanced weight. Line up the foam with the top of the gear so that it's flat across the top.

Step 7: Connect the Circuit

Ask: How can we connect the motor wires to the battery so the motor spins?

Note: The colors of wires are not important right now - you can experiment with where which color wire goes later and see what changes! Gently slide one motor wire between the rubber band and the battery's positive end, being sure to touch the metal bump. The wire might bend, so take your time and go slowly - if it bends, you can unbend it! Insert the other wire under the rubber band on the other end of the battery. The motor should start spinning and your Drawbot should start vibrating! If it doesn't, check the troubleshooting tips: make sure the unbalanced weight isn't bumping into anything, isn't pushed too far down past the gear, and that wires are carefully connected to each end of the battery.

Step 8: Make It Draw!

Ask: What will your Drawbot create?

Let's find out! Flip over your Drawbot build guide sheet and use that as a Drawbot dance floor, or place your Drawbot on a large piece of paper on a flat work surface. Take the caps off the markers and let it go! If you're working on a desk, be prepared to gently nudge the Drawbot back towards the center so it doesn't fall over the edge.

Step 9: Iterate!

Ask: How could you rebuild it?

This is just one iteration of a Drawbot! Encourage your learners to redesign using the same components Adjust the weight and placement to change speed Use fewer parts, or Modify the structure to create different drawing patterns like lines, circles, and random squiggles. Remind learners that it's okay to fail and try again! Post-Activity Questions 2nd - 3rd Grade What happened when you changed where the markers or the weight were placed? If you could rebuild your Drawbot, what is one thing you would do differently and why? Did anyone else's Drawbot move differently than yours? What was different about how they built it? 4th - 8th Grade How did the position and fit of the motor, battery, and unbalanced weight affect your Drawbot's movement pattern? Real engineers test and rebuild their designs many times. What did you learn from rebuilding that you couldn't have learned from the first version?

Troubleshooting

Motor is not moving	Check wire connections - each metal end must touch an opposite end of the battery. Make sure the wires are carefully slid under the rubber band on each end.
Motor moves, but bot doesn't move	Adjust foam weights, reposition the motor, or change marker angles. Most importantly - is anything keeping the unbalanced weight on the motor from spinning? Is it stuck on something like a marker?
Bot falls over	Adjust leg positioning, length, and angle or shift components for balance. The motor and battery are heavy - where can they be moved to keep things stable?
Weight isn't spinning, or Drawbot isn't moving much	Check three things: First, make sure the unbalanced weight isn't bumping into anything like the markers. Second, make sure the weight isn't pushed too far down past the gear. Finally, ensure the foam weight is correctly attached and the motor is held tightly to the body - motors that are tight to the body make bots that vibrate and move more!