# Drawbots

A vibrating machine that scribbles its own art.

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

These are the standards listed in the Drawbots educator guide. Under each one is where you will see it in the activity.

## Next Generation Science Standards (NGSS)

| CODE | WHAT IT COVERS |
|---|---|
| **K-PS2-1** | Plan and Conduct an Investigation of Forces |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **compare what happens when they place the unbalanced weight close to the motor's center versus out on the gear's farthest notch** - feeling a gentle wobble from a push near center and a strong shove from a push far off-center - directly comparing how different strengths of push change the Drawbot's motion across the table. | |
| **K-2-ETS1-2** | Develop a Simple Model or Prototype |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **sketch where they will place the unbalanced weight on the motor gear before attaching it**, treating the sketch as a simple physical model, then rebuild it during the Iterate step - moving the weight to a different notch and reshaping the marker legs - to test whether their model needs to change. | |
| **3-5-ETS1-1** | Define a simple design problem with criteria for success and constraints |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **define their own design problem for the Pattern Challenge** - build a Drawbot whose marker draws mostly circles instead of straight lines - naming the constraint that they can only use the components already in the kit, no new materials. | |
| **3-5-ETS1-3** | Plan and Carry Out Fair Tests |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **run the Speed Challenge as a fair test**, changing only the unbalanced weight's position on the gear while keeping the same three markers, spacing, and battery in place, to isolate whether weight placement alone - and not some other factor - is what changes the Drawbot's speed. | |
| **MS-PS3-5** | Construct an Explanation of Energy Transfer |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **trace the energy chain in their Drawbot** - chemical energy in the AA battery converts to electrical energy in the wires, then mechanical energy as the motor spins the off-center gear weight, then kinetic energy as the whole structure vibrates - and predict which link in the chain stops first when they disconnect one wire from under the rubber band. | |
| **MS-ETS1-2** | Evaluate Competing Design Solutions |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **run the Collaboration Challenge, combining their Drawbot with a partner's into one larger machine**, then evaluate the combined design against each of their original solo builds using the criteria of speed and how controlled the resulting pattern is - deciding together which original component arrangement to keep and which to abandon. | |

## Common Core State Standards (Math and ELA)

| CODE | WHAT IT COVERS |
|---|---|
| **RI.K-2.7** | Use Information from Illustrations |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **study the build photos to tell the short rectangular-hole foam piece apart from the L-shaped one**, matching each picture to the correct motor-mount piece before feeding the motor's gear through it and wrapping the foam snugly around the motor's metal body. | |
| **SL.K-2.1** | Participate in Collaborative Conversations |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **talk through where to slide each of their three markers into the circular base with a partner**, using words like "even" and "balanced" as they decide together whether a marker needs to move before the Drawbot will stand on its own. | |
| **RI.3-5.7** | Use Information from Text Features and Diagrams |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **follow the numbered build photos to see exactly how the rubber band should wrap the battery and motor wires**, noticing from the diagram which wire touches which end before testing whether their own circuit matches the pictured connection. | |
| **W.3-5.2** | Write Informative/Explanatory Texts |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **write a short paragraph documenting one redesign from the Iterate step** - for example, moving the unbalanced weight from one gear notch to another - explaining in their own words why that specific change made the Drawbot vibrate in tighter circles instead of long, loose swoops. | |

| CODE | WHAT IT COVERS |
|---|---|
| **RST.6-8.7** | Integrate Quantitative and Technical Information |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **cross-reference the written troubleshooting list ("motor moves but bot doesn't move: adjust foam weights, reposition the motor, or change marker angles") against the build diagrams** to decide which single adjustment to try first on a Drawbot that spins in place without traveling. | |
| **W.6-8.1** | Write Arguments with Claims, Reasons, and Evidence |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **write a claim about their Speed Challenge results** - for instance, that moving the unbalanced weight farther from the motor's center made the Drawbot vibrate faster - and back it up with the specific before/after weight positions and drawing patterns they observed as evidence. | |
| **K.MD.A.1** | Describe Measurable Attributes of Objects |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **describe measurable attributes of their three markers** - comparing how far each one is pushed through the base and how evenly they are spaced - noticing that a marker pushed in less far, or spaced unevenly from the others, makes the whole base wobble instead of standing flat. | |
| **1.G.A.2** | Compose Two-Dimensional and Three-Dimensional Shapes |
| **WHERE YOU'LL SEE IT (GRADES K-2):** Learners **compose their Drawbot's body by combining the circular foam base with the three-hole foam connector and the L-shaped motor-mount piece**, describing how the round base and the straight and L-shaped rectangular pieces fit together into one three-dimensional structure that stands on its own. | |
| **3.MD.B.4** | Generate Measurement Data |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **measure the spacing between their three marker legs in inches with a ruler**, then the class records everyone's measurement on a shared line plot to compare how far apart legs need to be spaced for a Drawbot to stand without tipping. | |
| **4.MD.A.3** | Apply Area and Perimeter Formulas |
| **WHERE YOU'LL SEE IT (GRADES 3-5):** Learners **measure the length and width of the rectangular hole in each motor-mount piece** - the short one and the L-shaped one - and use the area formula to confirm both holes are the same size before overlapping them so the motor's gear can pass cleanly through, then compare the perimeter of the L-shaped piece to the straight piece to see how much more foam edge the L-shape has. | |
| **6.RP.A.3** | Use Ratio Reasoning to Solve Problems |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **time how many seconds it takes their Drawbot to travel the same 12-inch distance** with the weight close to the motor's center versus moved to the gear's outer notch, comparing the two rates (inches per second) to see how weight placement changes speed. | |
| **7.G.A.2** | Draw Geometric Shapes with Given Conditions |
| **WHERE YOU'LL SEE IT (GRADES 6-8):** Learners **treat their three marker legs as the vertices of a triangle and test different spacing conditions** - legs spaced evenly apart versus two legs bunched close together - observing which side-length conditions produce a stable stance (a working triangle) and which produce a Drawbot that tips over immediately (no working design). | |

**LEARNERS EXPLORE**

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