

OVERVIEW

In this project makers visualize motion and create art by building small robots. Makers create a simple circuit from a low voltage battery and a toy motor, then place the circuit in plastic cups. Pathways for electricity are formed by conductive materials. Some conductive materials are highly resistive, meaning they slow the electric flow. Other materials offer less resistance so that the electricity moves faster. (To imagine this flow as it slows and quickens, think of applying pressure with your foot or hand to a garden hose and the resulting trickle or gush of water.)

The Drawbots not only move around, but with the addition of a marker, they draw a path wherever they go. These colorful paths allow students to view a physical representation of mechanical energy, or energy possessed by an object due to its motion or position, and how electrical energy powers machines. Mechanical energy can be kinetic, the energy an object has based on its motion, or potential, the energy an object has based on its position.



LEARNING OBJECTIVES

Makers will be able to...

- 1) Assemble and operate their own robot.
- 2) Build a basic circuit that includes a motor.
- 3) Identify conductive materials.
- 4) Explain the role of conductivity.
- 5) Describe how a circuit works.
- 6) Understand how energy can change from one form into another.

KEY TERMS

ROBOT - a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.

MECHANICAL ENERGY - energy possessed by an object due to its motion or position.

POTENTIAL ENERGY - the energy an object has based on its position.

KINETIC ENERGY - the energy an object has based on its motion

CIRCUIT - a closed path that electric current flows through from a power source. Electrons always move in one direction from the power source back to ground, the point where electrons leave or enter back into the circuit.

ELECTRICITY - a type of energy resulting from the flow of electrons from a positive to a negative pole. Electricity has three important components that help people measure and use this invisible force: voltage, current, and resistance.

MATERIALS

- _ Drawbot kit
- _ Large sheet of paper

OR, if you prefer DIY:

- _ 2 Plastic Cups (same size)
- _ 3 Markers
- _ AA battery and case
- _ Double-sided tape
- _ Toy motor
- _ Off-set motor weight
- _ Velcro with adhesive backing

CURRENT - the flow of electrons through a conductive material or object. It is the same at all points in a similar circuit. Current is measured in amps. You can think of this as the water flowing out of the tank.

CONDUCTIVE - a property of a material that allows current to flow through it easily.

INSULATED - a property of material that does not allow current to flow at all. This is the opposite of conductive.

VOLTAGE - electrical pressure that causes electricity to flow. It is measured in volts. You can think of this as the height of the water tank. There are 2 types: direct current (a battery) and alternating current (electricity from the wall). We are using direct current from a battery - DO NOT try these projects with alternating current from the wall.

BATTERY - one or more cells that convert chemical energy into electrical energy. Chemicals in the battery free electrons so they can move from one terminal to the other. This movement creates electrical energy that you can use to power the electronics you use every day.

POLARITY - in a circuit electrons move in one direction from the positive pole (power) to the negative pole (ground). When constructing a circuit, all components must be aligned properly so electricity can move through them.

SHORT CIRCUIT - a direct connection between two sides of a power source. A short circuit can destroy your circuit and the components in it. Most importantly, this can be dangerous with high voltages, especially with electricity from the wall, and can electrocute or burn you.

CURRICULUM CONNECTIONS

Energy

Compare the two types of energy the Drawbot uses to draw a line: the potential energy of the battery and the kinetic energy of the motor.

Generative Art (for older students)

Can you control the lines of the Drawbot? What are examples of other artists who have used a similar technique? (Jackson Pollack, etc) What is the difference between a person and a machine creating art? Who created it?

NYS STANDARDS

STANDARD 4—The Physical Setting

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved. (4.1c, d, e; 4.4d, e, f; 4.5a, b)

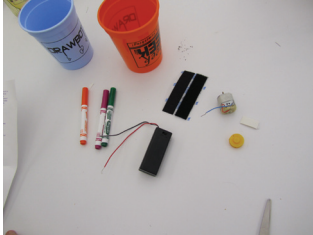
Key Idea 5: Energy and matter interact through forces that result in changes in motion. (5.1a, b, c, d, e; 5.2c, d, f)

STANDARD 6—Interconnectedness: Common Themes

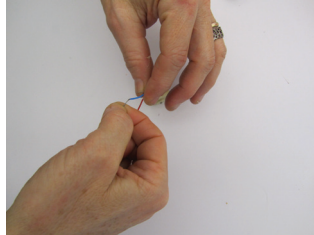
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Key Idea 1: Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions. (1.1, 1.2, 1.3, 1.4)

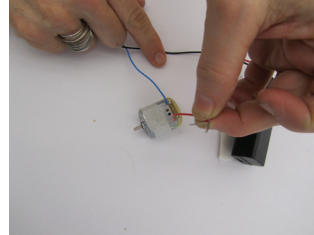
MAKING



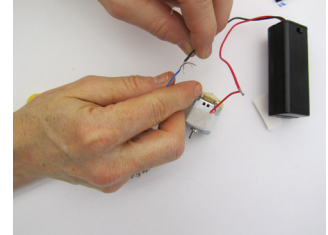
Materials: toy motor, AA battery and case, 2 plastic cups, 3 markers, double-sided tape, offset motor weight (yellow), velcro



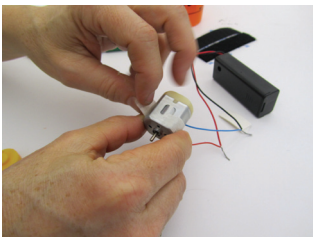
1) Carefully twist the metal ends of each of the two wires attached to the motor. This will bunch the wires together so they do not fray.



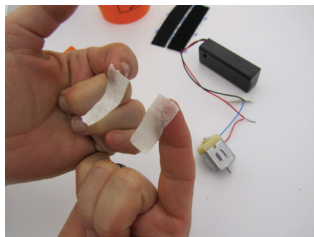
2) Take one red wire from the motor and one red wire from the battery pack and cross the ends.



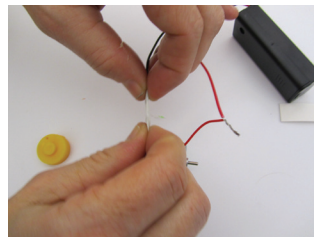
3) Twist the metal ends of the two wires together. Repeat this process for the other two wires (the black wire and the blue wire).



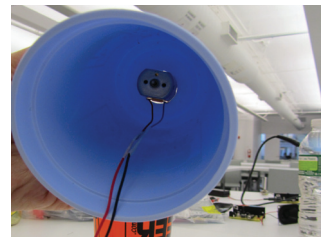
4a) Carefully take the piece of tape off of the motor.



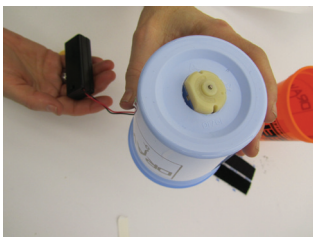
4b) Rip it into two pieces.



5) Wrap the tape around each of the connections between the wire from the battery pack. It doesn't matter which color wires are connected.



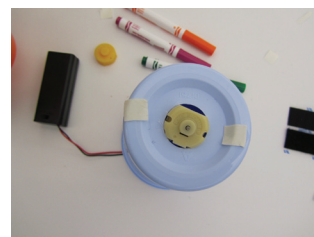
6) Push the motor through the opening of the hole in one of the cups. This will be your top cup.



6a) This is the top view.



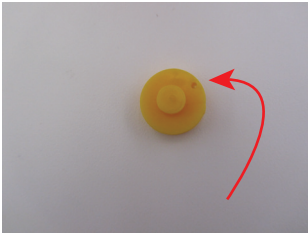
7a) Cut the piece of double-sided tape in half.



7b) On the bottom of the top cup, adhere the two pieces of the double-sided foam tape.



8) Stack the cups like the picture above. Align the first cup with the second cup so it will be even with the first cup. Push it over the motor in the first cup.



9a) Pictured above is the yellow offset motor weight. This will allow your Drawbot to stand up. The hole by the red arrow is where you will attach it to the motor.



9b) Push the tiny hole of the yellow offset motor weight onto the motor shaft.



10a) Open the battery pack.



10b) Insert one "AA" battery into the battery pack. Close the battery pack.



11) Fold the velcro in half so it sticks to itself.



11b) Cut the three inch piece of Velcro into seven pieces.

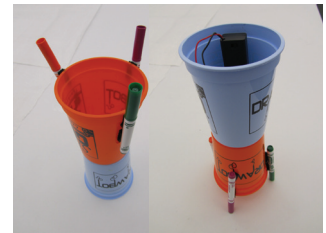


12) Adhere one piece of Velcro to the cover of the battery pack (the side WITHOUT the on/off switch).



13) Attach the battery pack to the inside of the cup.

14) Create a guide like the one below to help determine where to attach the three markers on the bottom of the cup. The markers should be attached as indicated by the red line. The markers need to be evenly spaced so the cup will not topple over.



15) Adhere two pieces of Velcro vertically to the bottom cup for each marker. Press the marker firmly against the Velcro on the cup.

16) Take off the marker caps, turn on the Drawbot, and have fun creating robotic art!

DEBUGGING

POWER?

Is the battery turned on? Sounds obvious, but sometimes we forget!

CONNECTIONS?

Are the wires connected securely? Both for the wires twisted together and in the terminal? You should check this first. If they are not, or if they are loose, the circuit will not close and as a result cannot produce sound.

SHORT CIRCUIT?

Are wires touching that shouldn't be? This will send too much current (electricity) to your circuit and could even break it.

