BristleBots

Bristlebots are robots made of a vibration motor, battery, toothbrush, and some foam tape. The robot is brought to life by completing a **simple circuit** between the battery and the **motor**. The **vibrations** of the motor cause the bristlebot to move and shake in various directions, depending on your design.

YOUR CHALLENGE:

Use the materials provided to design your own bristlebot. Can you make a switch? Can you redesign your bot to move faster, slower, straight, or in circles?

BristleBot Related Standards

Computational Thinking Skills:
• Algorithms and procedures: series of ordered steps taken to solve a problem or achieve some end. Students must first design the robot by following instructions or creating their own unique model. They then have to program the robot's movements, refining and editing their scripts in order to achieve the desired outcome.
• Automation: having computers or machines do repetitive tasks.
• Open-ended project with opportunity to engage in the design process: identify a problem, brainstorm, design, build, test and evaluate, redesign, rebuild, share solution.

Real World Application:
Electrical engineering includes the study of electricity and the design of electrical systems like circuits and computer chips. Some of the areas electrical engineers might work in include telecommunications, electronics, signal processing and control systems.

Next Generation Science Standards
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. **4-PS3-2.** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

MS.Energy. ETS1.A: Defining and Delimiting an Engineering Problem. The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3) ETS1.B: Developing Possible Solutions. A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS. Engineering Design. ETS1.B: Developing Possible Solutions. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
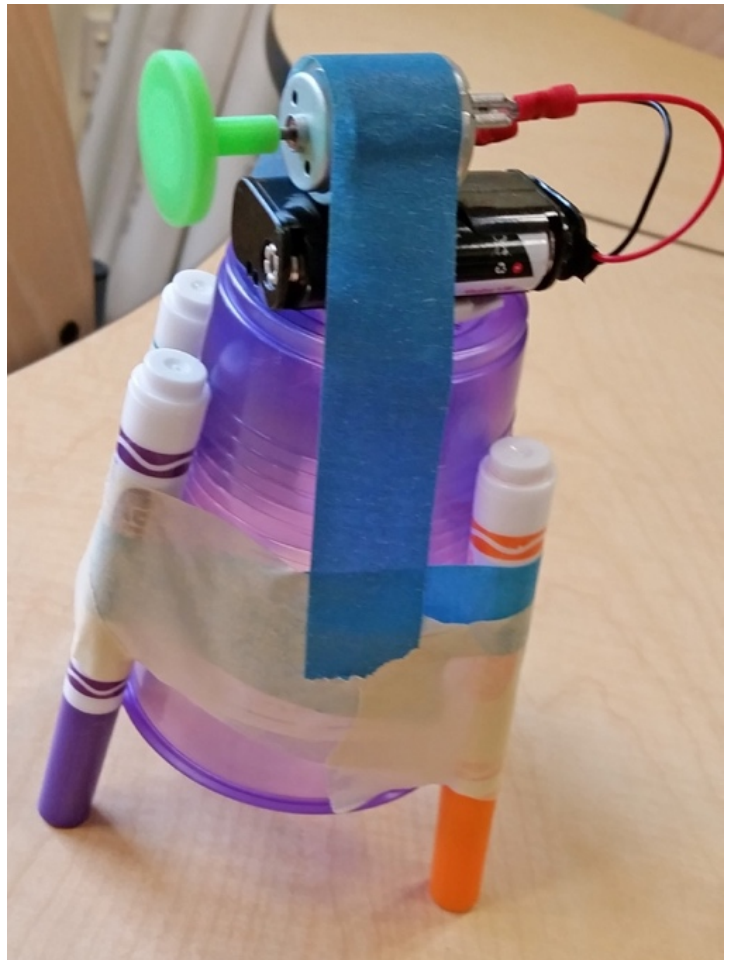
Draw Bots

Your challenge:

Make your own drawing robot made of a DC hobby **motor**, battery pack and art supplies. The robot is brought to life by completing a **simple circuit** between the **battery** and the motor.

Can you design a bot that draws:
- Dotted lines?
- Straight lines?
- In circles?

Draw Bots Related Next Generation Science Standards

K-2 Engineering Design
- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]

PS3.A: Definitions of Energy
"Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5) ETS1.A: Defining and Delimiting Engineering Problems. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2- 3) ETS1.C: Optimizing the Design Solution. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS2-3)

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

MaKey MaKey Mash-up

What: The MaKey MaKey works by creating **simple circuits** connected to a specific **input** (Space Key, Up Arrow Key, etc). Control the computer in new ways by turning **conductive** objects like fruit, tin foil, and play dough, into a touch pad, mouse or keyboard. With **Scratch**, you can program interactive stories, games, animations, music & art — and share your creations with others.
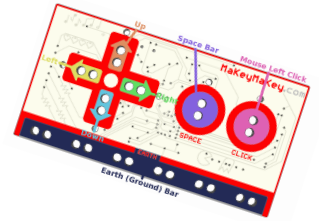
Programming Blocks: drag these onto script area and snap together.

Background /stage

Scratch

Script area

Sprite

YOUR CHALLENGE:

Use **conductive** materials (and your voice!) to create an original piece of music. Hint: some of the materials are **non-conductive**. Test them to find out which!

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MaKey MaKey Related
Next Generation Science Standards

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]

MS PS2.B: Types of Interactions
Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

HS. PS3.A: Definitions of Energy: "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)

littleBits: Kinetic Robots

What: littleBits are small electronic components that snap together with magnets to create a circuit. littleBits kits include components such as power, sensors (inputs), sound/lights/numbers (outputs) and a whole bunch more.

YOUR CHALLENGE:

Using recyclable materials & littleBits build a robot that moves and makes sound.

littleBits Related: Next Generation Science Standards

Grade Band Endpoints for PS4.C
By the end of grade 2. People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch. People also use a variety of devices to communicate (send and receive information) over long distances.

PS3.A: Definitions of Energy
The faster a given object is moving, the more energy it possesses. (4- PS3-1) Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2),(4-PS3-3)

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

MS. Forces and Interactions. Systems and System Models. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2- 1),(MS-PS2-4).

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

Rube Goldberg Scratch Machine
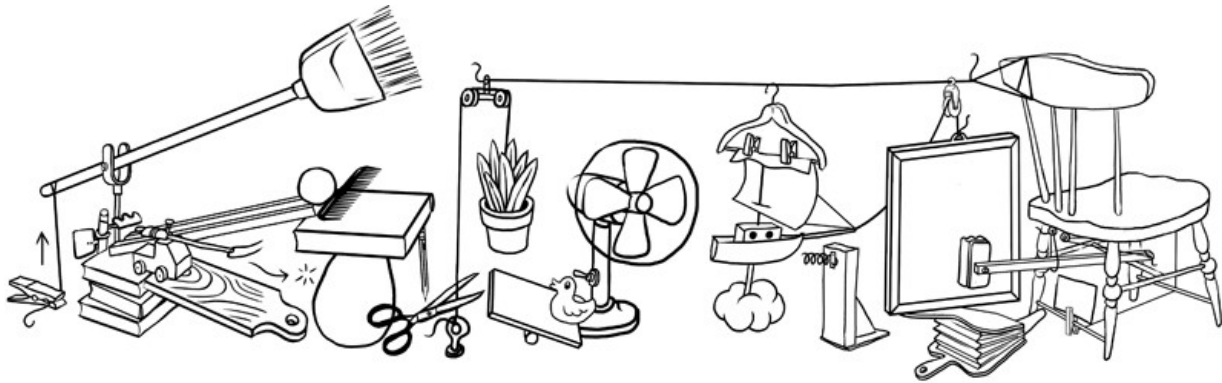
YOUR CHALLENGE:

Create the most **interesting** and **complex** path between the motor (the kicker) and the distance sensor.
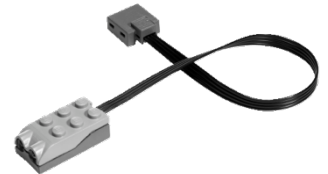
- How many moving pieces can you create?
- Consider the aesthetic quality of your construction.
- What pieces can you add/subtract/modify?
- Can you customize the scratch program to do something different?
- How tall can you go?

Rube Goldberg Related
Next Generation Science Standards

Grade Band Endpoints for PS2.B
By the end of grade 2. When objects touch or collide, they push on one another and can change motion or shape.

Grade Band Endpoints for PS3.C
By the end of grade 2. A bigger push or pull makes things go faster. Faster speeds during a collision can cause a bigger change in shape of the colliding objects.

By the end of grade 5. When objects collide, the contact forces transfer energy so as to change the objects' motions. Magnets can exert forces on other magnets or on magnetizable materials, causing energy transfer between them (e.g., leading to changes in motion) even when the objects are not touching.

Grade-Level Endpoints for PS3.B
By the end of grade 5. Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.

By the end of grade 8. A stable system is one in which any small change results in forces that return the system to its prior state (e.g., a weight hanging from a string). A system can be static but unstable (e.g., a pencil standing on end). A system can be changing but have a stable repeating cycle of changes; such observed regular patterns allow predictions about the system's future (e.g., Earth orbiting the sun). Many systems, both natural and engineered, rely on feedback mechanisms to maintain stability, but they can function only within a limited range of conditions. With no energy inputs, a system starting out in an unstable state will continue to change until it reaches a stable configuration (e.g., sand in an hourglass).

By the end of grade 12. Systems often change in predictable ways; understanding the forces that drive the transformations and cycles within a system, as well as the forces imposed on the system from the outside, helps predict its behavior under a variety of conditions. When a system has a great number of component pieces, one may not be able to predict much about its precise future. For such systems (e.g., with very many colliding molecules), one can often predict average but not detailed properties and behaviors (e.g., average temperature, motion, and rates of chemical change but not the trajectories or other changes of particular molecules). Systems may evolve in unpredictable ways when the outcome depends sensitively on the starting condition and the starting condition cannot be specified precisely enough to distinguish between different possible outcomes.

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]