Berkeley Engineers and Mentors

Light-bulb circuit/Bristle Bots

Lesson Type: Engineering + Robotics
Target Grade: Elem/High School
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Brief Overview/Challenge:

Students will learn about the basics of robotics and how it applies to their everyday lives. The lesson will be split into two parts – circuitry and robotics.

Teaching Goals

For students to…

- Understand how a basic electric circuit operates
- Construct an circuit to light up a bulb, determine what materials are insulators vs conductors
- Understand what a robot is and build a robot from the materials provided

Materials

Material	Amount per Group	Expected $$	Vendor (or online link)
Basic circuitry set (copper wires, alligator clips, battery, light bulbs, electrical tape, conductivity vs insulator materials)			(see if can be borrowed from physics department)
Toothbrush head (preferably with angled bristles)	1 per bot	$5	(can be supplied by mentors)
Foam tape	1	$10	(can be supplied by mentors)
Vibrator pager motors	1 per bot	$0.80 each + shipping	http://www.circuitdiy.com/product/vibrator-pager-motor-bristle-bot-vibrobot-beam-motors
3 V watch batteries	1 per bot	$3	(can be supplied by mentors)

Agenda

- **Electric Circuits** (15 – 20 min)

  Introduce lesson (where is electricity found, how do light bulbs work?)

  Demonstrate/draw out some basic circuits

  Series vs parallel circuits can be taught at the high school level

  Allow students to play around with circuit boards, see which combinations yield the brightest bulb

- **Robotics** (20 min)

  Discuss what robots are, ask where they can be found, gather initial impressions of robots

  Build the bristle bots – relate it to the circuitry lesson (powering a robot instead of a light bulb)

  If time permits, create a small "battle arena" and let students "battle" their bristle bots

- **Recap** (10-15 min)

  Review concepts and ask students to explain why the bristle bot is a robot

  Discuss various applications of robots, what kind of robots would students build if they could build any robots

  What do they think of robots replacing tasks humans used to do? Are robots more helpful or dangerous?

Procedure for circuits

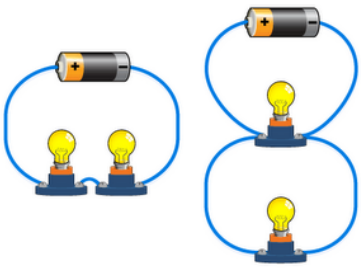
1. Start by guiding students to create a basic circuit (battery, wires, light bulb)
2. Experiment with conductor and insulator materials
3. Experiment with circuits in parallel and series circuits – see which combinations produce the brightest bulbs
4. Let students play around with different combinations

Procedure for building bristle bots

5. *Toothbrush heads should be detached (ensure bristles are even/flat) and some plastic insulation may need to be stripped from copper leads
6. The bristles of the toothbrush should preferably be angled, but robot will still work with straight bristles (will just go around in circles) – bristles can be manually trimmed to create an angled effect
7. Attach strip of foam tape to back of toothbrush head to hold components in place
8. Stick vibrating pager motor on top of the tape so that the rotating weight hangs over the edge of the head (side nearest to the top of the toothbrush). One copper lead should be placed down on the tape as well.
9. Place battery down on opposite end of the motor (near the toothbrush handle) and on top of the copper wire already on the tape so that the battery and the wire maintain constant contact.
10. When ready to run the robot, place the second copper lead down on top of the battery and place the robot down on a flat surface and watch it go!
11. Make any necessary adjustments to the motor or battery placement in order to achieve the desired robot motion

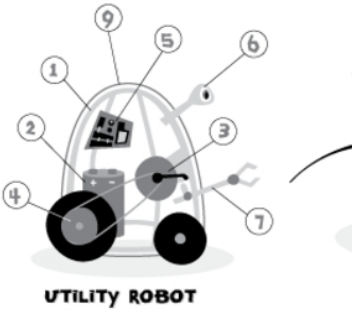
Material to Teach

- Electricity and Circuits
  - How do light bulbs light up? Electricity is flow of electrons and the rate electrons flows is the current. A simple circuit is a complete loop of current that includes source of power (battery) which is required to make electrons flow through wires. Resistors can also be added to a circuit, in this case, a light bulb which converts electrical to light energy upon entering light bulb causing it to light up
    - Conductors vs insulators: conductors allow heat and electricity to flow through it while insulators stop flow of heat and electricity
    - Test different materials (paper clip, rubber eraser, penny, paper, foil, plastic, glass, etc) with circuit and see if light bulb still light ups
    - Real life examples: plastic insulation on wires, oven mitts, what else can students think of?

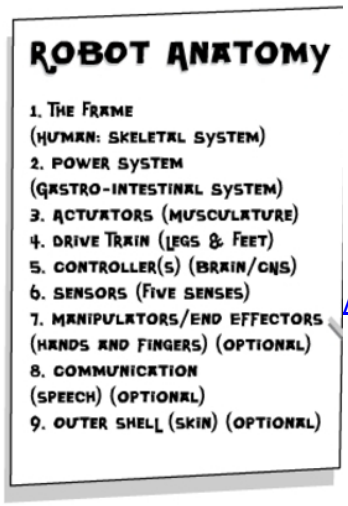


- For high school: different current configurations will affect how much power is delivered to the light bulb, namely series versus parallel circuits. In a series circuit, the resistors (light bulbs) is connected along same path so only one path current can flow which will diminish the current flowing through. In a parallel circuit, more paths are opened up so resistance is less (use car traffic analogy – more roads means less traffic/blockage whereas one road means more traffic)
    - Can introduce Ohm's Law (V=IR/voltage=current*resistance), but be sure not to make it too mathematic unless students are interested. Otherwise more intuitive explanation is preferred
    - Name situations where one type of circuit is preferred over the other – parallel wiring is preferred for houses so when one resistor fails the others don't, series circuits for Christmas lights – use less energy

- Robots
    - What are robots? "Any machine that senses its environment (in some way), organizes a reaction (in some way), and then executes it (based on the sensor input), can be considered a robot."
    - Robot anatomy – frame, power system, drivetrain (parts that allow robot to move), controllers (controls robot operation), sensors , manipulators, communicators (optional – for high school)
    - Where can we find robots in real life? Robots that sweep floors, explore the deep sea and deep space, distributing medicine to patients in the hospital, large manufacturing factories. Some categories that robots usually fall under include factory, dirty/dangerous/dull, health, and research robots



UTILITY ROBOT



Background/Tips for Mentors

- If possible, have a few more complex demo robots to show kids to get their attention, ex: http://www.instructab /?ALLSTEPS

Sources

- http://evilmadscientist.com/2007/bristlebot-a-tiny-directional-vibrobot/
- http://makeprojects.com/c/Robotics
- http://www.miniscience.com/kits/KITSEC/index.html

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