raft resource area for teaching
www.raft.net

Curriculum topics:

- Solar Energy
- Energy Conversions
- Vibration
- Electrical Circuits

Subjects:
Physical Science, Earth/Space Science

Grade range: 4 – 12

Who we are:

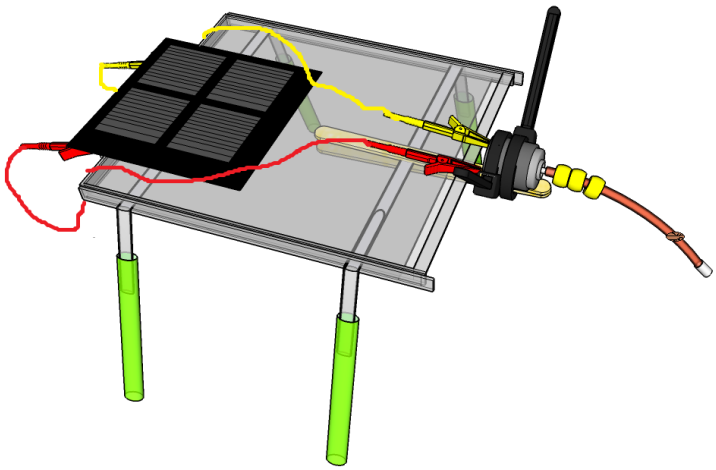
Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable "hands-on" activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

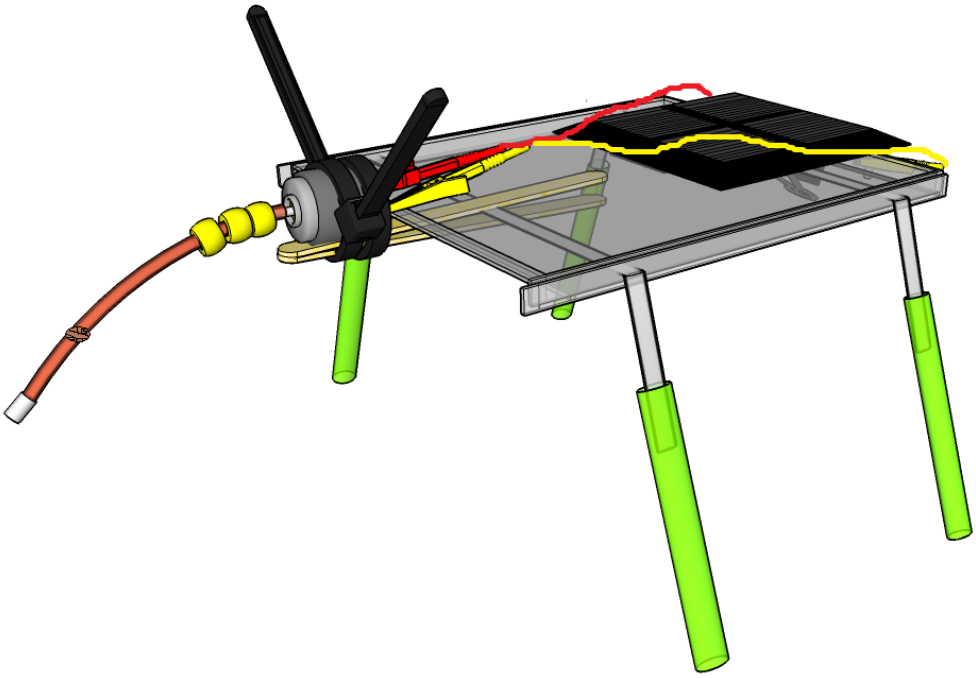
www.raft.net/visit-raft-locations

SOLAR JITTERBUG

Shake things up with the power of the Sun



Create and decorate a "critter" whose moves are powered by sunlight. To vary the critter's movements explore making changes to the swinging "proboscis".



Materials required

Per Solar Jitterbug:

- CD Jewel Case, Regular size (not slim); clear, media tray removed, if needed, 1
- Straws, jumbo, 2
- Paperclips, Jumbo (not non-skid), 4
- Motor, 1½ volt; which can be powered by solar cell below, 1
- Solar Cell (which can power above motor), 1
- Wooden sticks, flat, (craft sticks), 2
- Alligator test leads, each a different color, ~30 cm (12") long, 2
- Beads, ~8 mm (~⅓“) in diameter, 4
- Zip ties, releasable preferred, ~13 cm (5"), 2
- Binder clip, small, 1
- Rubber band, thin, 1
- Tubing, 3 mm (⅛") outer diameter (O.D.) x 1.5 mm (1/16") hole; ~6.5 cm (2½") long; tubing is a jam fit on the motor shaft, 1
- Tubing, with a ~3 mm (⅛") hole; ~1.3 mm (½") long; a jam fit over above tubing, 1; could be replaced with tape
- Velcro, adhesive, hooks and loops, ~ 2 cm x 2.5 cm (3/4" x 1"), 1
- Straw, super jumbo (fast food size), 20 cm (8") long, colored; (straw needs to be a jam fit over wide loops of jumbo paper clips), 1
- Eye protection
- Optional: Materials to decorate the bug

Safety tip: Hands should be washed after handling electrical components such as wire, motors, and test leads.

How to build it

Motor Assembly

1 Push the long, narrow tubing onto the motor shaft leaving a gap; add 3-4 beads, looped rubber band, and small piece of tubing as shown. Hold the motor assembly and tug on the tubing to check for a secure connection. See right.

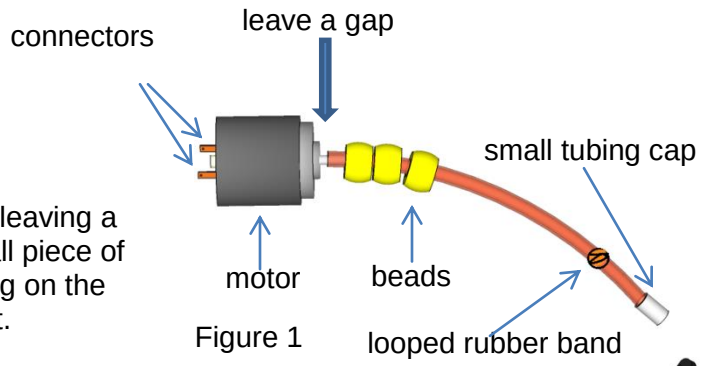
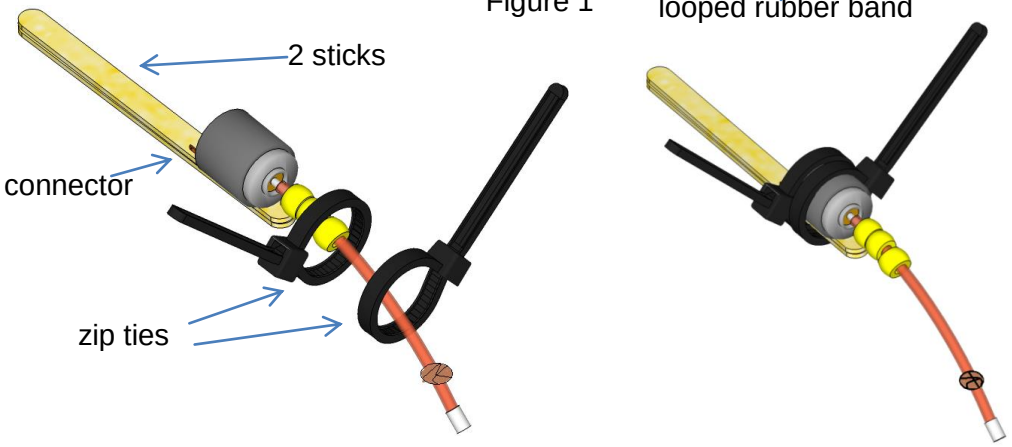


Figure 1

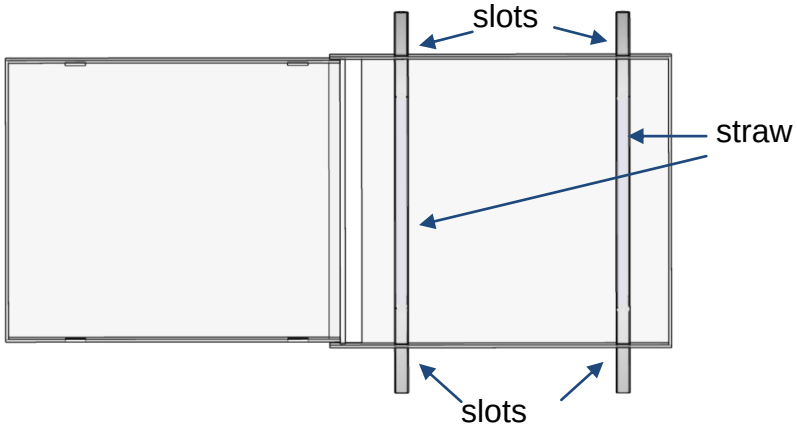
2 Stack 2 wooden sticks. Add the motor so the shaft is at the end of the sticks. Loop the 2 zip ties and thread onto the tubing as shown.



3 One at a time, push the looped zip ties over the motor and sticks. Pull the zip tie ends to tighten.

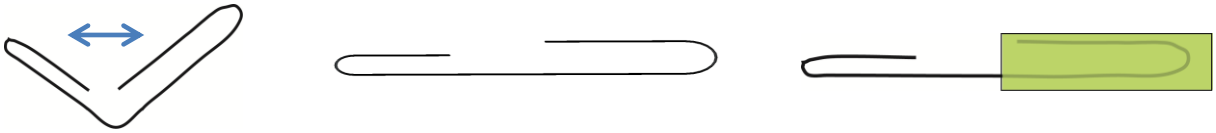
Body Assembly

4 Open CD jewel case and lay flat; flatten the end of a clear straw and insert through slots in the side of CD case as shown. Repeat with 2nd straw.

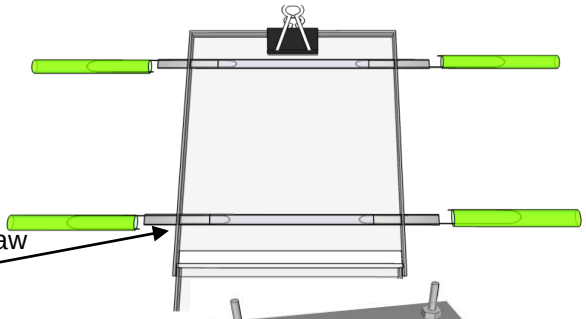


5 Cut colored straw into 4 equal pieces.

6 Straighten a jumbo paperclip into a “C” as shown. Push a piece of colored straw over the wide loop of each paperclip.

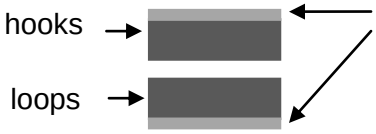


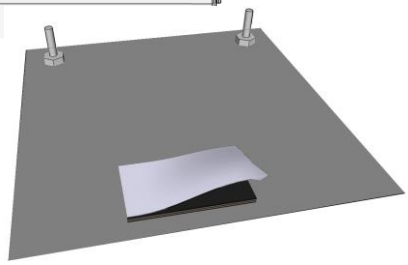
7 Push the narrow loop of a paperclip into a straw end in the CD case. Stop when a small part of the narrow loop is still outside the CD case. Repeat for 3 more paperclips. Attach a small binder clip to the edge of the CD case as shown.



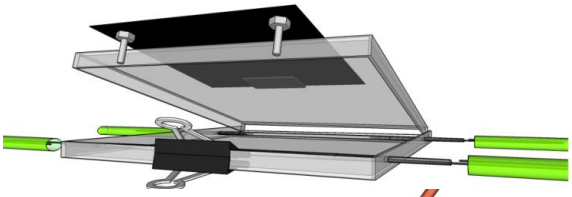
Solar Cell Assembly

8 Join the two pieces of Velcro. Peel the backing off the “loops” (fuzzy) side of the Velcro and attach to the back of the solar cell as shown.



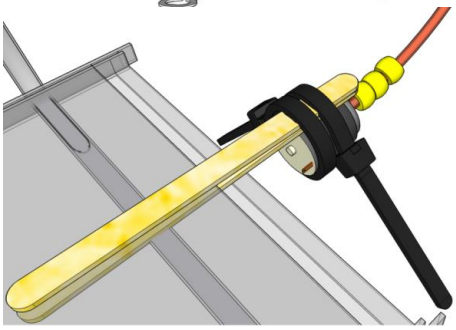


9 Peel the remaining backing off the Velcro. Place the solar cell on the CD case as shown, press firmly.

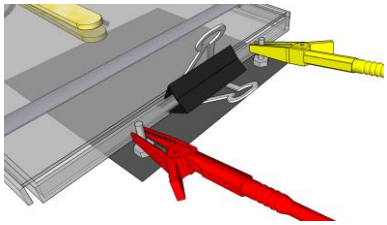


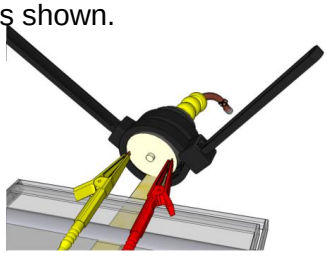
Final Assembly

10 Turn CD case over. Insert the motor assembly into the wide slot on the hinge end of the CD case as shown. One stick fits between the straw and the inside of the CD case – the other stick goes outside the case. Push until the motor is next to the case.



11 Attach wires to motor & solar cell as shown.





12 Bend legs as shown and adjust until bug does not fall over. Move the motor towards the CD case if needed. Peel the clear film off the top of the solar cell. See illustrations on page 1.

To do and notice

Safety tip: Wear eye protection when using Solar Jitterbug. Avoid contact with spinning parts.

Place the Jitterbug in direct sunlight and see what happens. Explore with ideas from **Learn more**.

Troubleshooting - If the tubing on the Jitterbug’s motor does not start spinning when the solar cell is in direct sunlight check that the alligator clips are securely attached to the metal tabs at the back of the motor and to the bolts on the back of the solar cell. If the problem persists, swap the alligator test leads, solar cell, and/or motor with an item that is known to work in order to isolate the problem.

Curriculum Standards:

Energy can be transferred between places and converted (Next Generation Science Standards: Physical Science, Grade 4, 3-2 & 3-4; High School, 3-3)

Forces & Motion (Next Generation Science Standards: Physical Science, Middle School, 2-2; High School, 2-1)

Motion changes and energy transfer (Next Generation Science Standards: Middle School, Physical Science, 3-5)

Energy, resources, & the environment (Next Generation Science Standards: Grade 4, Earth & Space Science 3-1)

Human Impacts (Next Generation Science Standards: Middle School, Earth & Space Science, 3-3; High School, Life Science 2-7)

Compare Multiple solutions/Test Variables (Next Generation Science Standards: Engineering Design, Grades 3-5, 1-3; Middle School, 1-2 &1-4; High School, 1-3)

Break down problems (Next Generation Science Standards: Engineering Design, High School, 1-2)

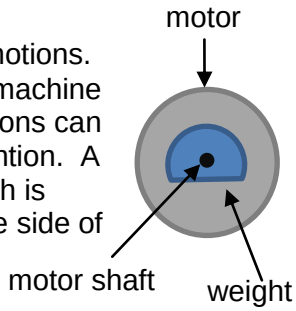
Science & Engineering Practices (Next Generation Science Standards: Grades 4 – 12)

Additional standards at: http://www.raft.net/raft-idea?isid=684

The science behind the activity

Science of vibration

Things **vibrate** when there are repetitive back and forth motions. Vibration often indicates a problem - as when a washing machine vibrates due to laundry being unbalanced (offset). Vibrations can also be useful, as when a cell phone vibrates to gain attention. A cell phone vibrates when a tiny motor spins a weight which is designed so that the weight's **center of mass** is off to one side of the shaft of the motor. See illustration.



In the Jitterbug the beads on the curved tubing act as an offset weight. When the beads on the tube are farther away from the motor (more offset) the motor will spin more slowly, with larger movements, as the motor has to work harder to turn a weight that is farther from the motor shaft. When the beads are closer to the motor (have less offset) the motor will spin faster as the motor has to do less work moving the weight. When the motor spins faster the vibrations happen more often, have a high **frequency**, but the movements are smaller, have a smaller **amplitude**.

In order for the Jitterbug to move, rather than just vibrate in place, the feet of the Jitterbug need to be jerked out of position. The surface below a foot needs to be smooth enough so a vibration will move the foot, but rough enough so the foot does not slide back into the original position. Many variables can affect the movement of the Jitterbug along a surface.

Find an expanded **science behind the activity** including Solar Cell science & Electrical Energy into Motion at http://www.raft.net/raft-idea?isid=684.

Learn more

Explore the Jitterbug by making the following changes – note what happens!

- Move the rubber band toward or away from the motor.
- Change the angle of the paperclip legs make to the jewel case or cut the ends of the straw feet to a different angle.
- Tilt the solar cell by raising the jewel case cover; use the binder clip to maintain the angle.
- Reverse the wires going to the motor to reverse the way the motor spins.
- Compare the Jitterbug's motion on different surfaces.

Related activities:

Solar Cell Demonstrator **-** http://www.raft.net/ideas/Solar Cell Demonstrator.pdf

Solar Cell Sandwich **-** http://www.raft.net/ideas/Solar Cell Sandwich.pdf

Resources

Visit www.raft.net/raft-idea?isid=684 for "how-to" video demos & more ideas!

See these websites for more information on the following topics:

- **Vibrating motors -** http://www.precisionmicrodrives.com/application-notes-technical-guides/application-bulletins/ab-004-understanding-erm-characteristics-for-vibration-applications
- **Solar cell information and links -** http://www.eere.energy.gov/basics/renewable_energy/photovoltaics.html