

1 Litre Bottle Submarines

Topic Area:	Engineering - introduce campers a practical use for circuits. Also a take home project/design challenge.
Time:	1 hour 45 min
Safety:	Avoid touching the submarine's propeller when it is spinning. Keep magnets away from electronic equipment. Try not to get too much water inside the submarine - water isn't great for electronics (the batteries might short-circuit).

Materials:

- 25 Salbro water bottles with caps (1 litre bottles would work as well)
- 25 470 ohm resistors (to reduce voltage through LED to an acceptable amount)
- 25 LEDs
- 25 030 form flat sided motors (MOTOR MICRO WFF-030SB-11160 3V)
- 25 battery packs (double AA size)
- 25 4 inch plastic propellers (from Guillow's)
- 25 reed switches
- telephone or jumper wires (solid core wire would be nice)
- styrofoam plates
- 25 magnets
- electrical tape
- 50 AA batteries
- googly eyes
- 10 straws
- {25 small breadboards} OR {25 small PCBs (printed circuit boards) and 25 female header sockets}
- 1 drill
- wire strippers
- glue gun
- exacto knife
- soldering pencil
- solder
- flush cutters

Procedure:

- 1) Drill a small hole into the middle of a bottle cap.
- 2) Cut two jumper wires about 6cm in length. Strip the ends and solder one wire to each of the motor's leads.

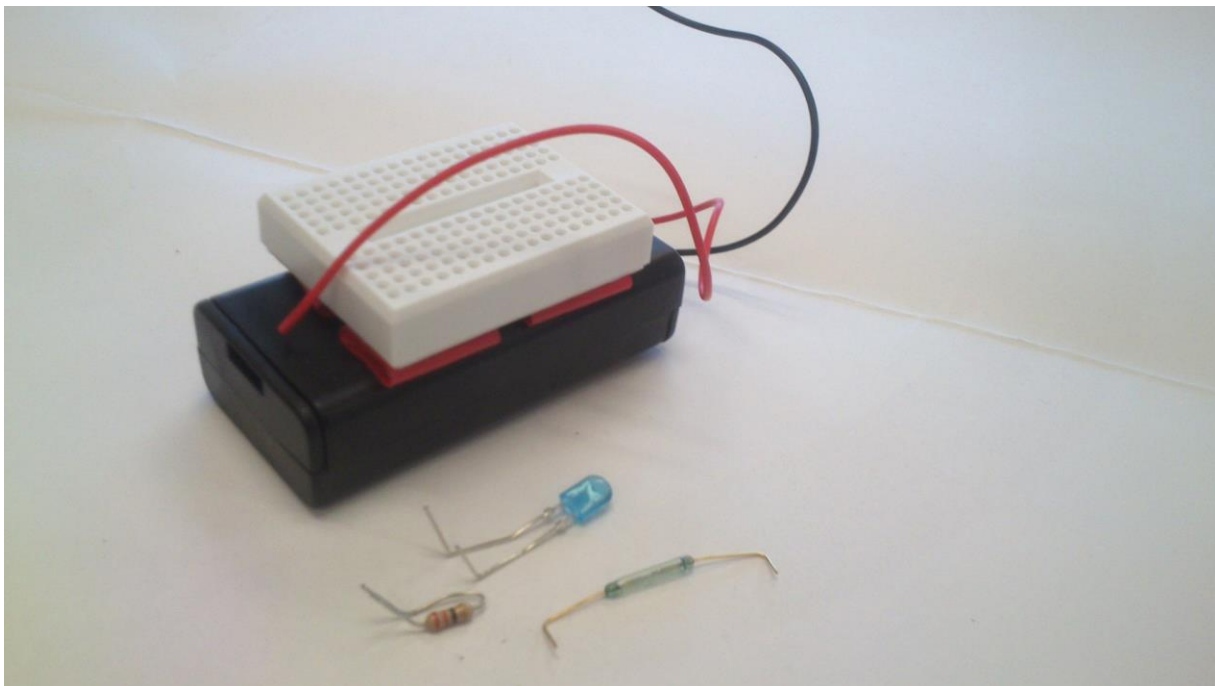
3) Glue gun the motor to the inside of the bottle cap (cover up any holes in the motor). Make sure the motor is still free to spin - you can test this by attaching two AA batteries to the motor. Clear out any glue if necessary.



4) Glue gun the propeller to the motor. (We used a short piece of straw to help us do this.)

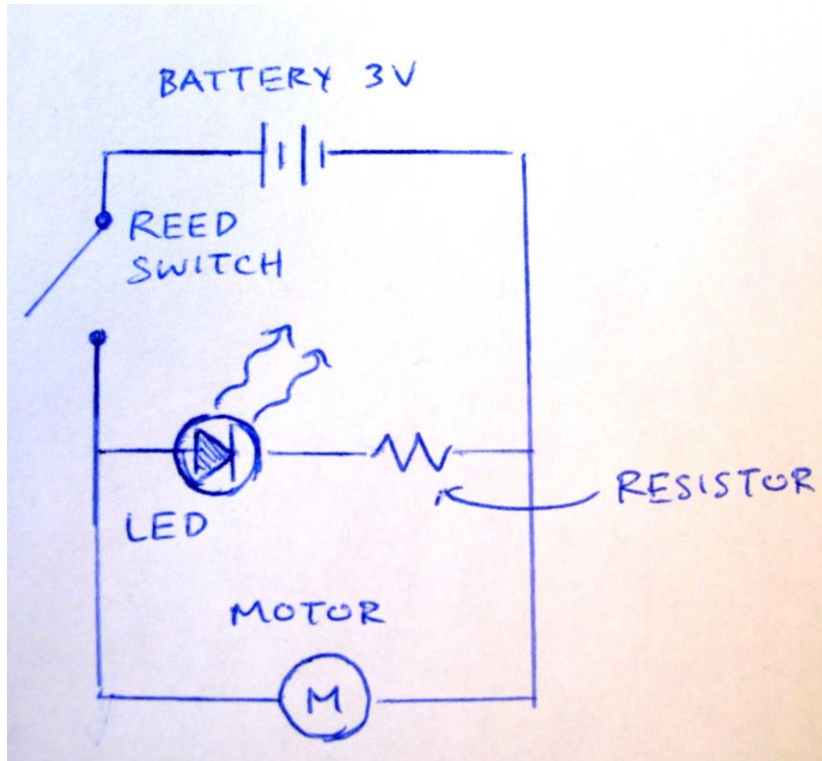
5) Cut a water bottle in half with the knife.

6) Tape the breadboard to the bottom of the battery pack. If you're using the PCB, ignore this step for now.

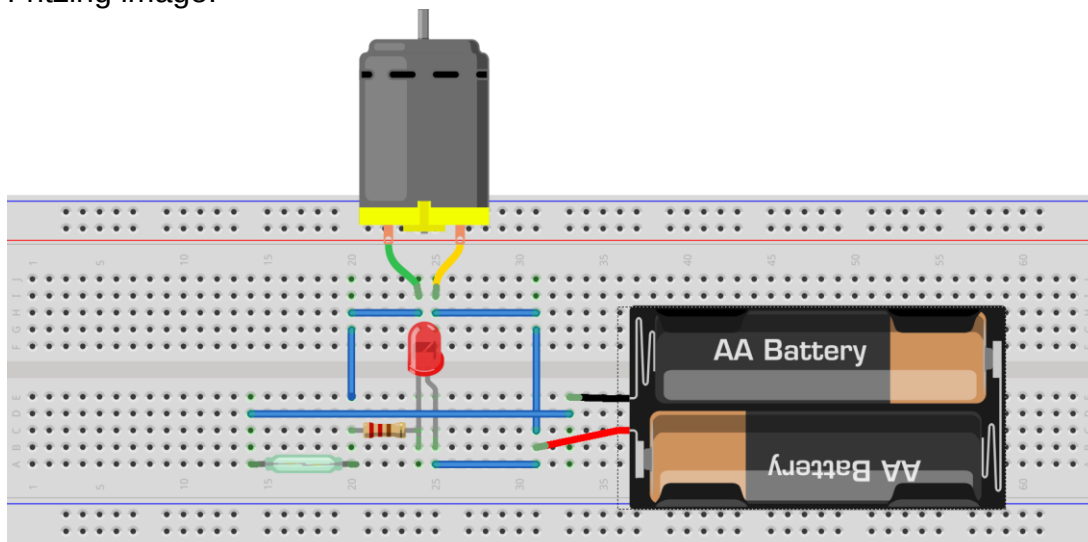


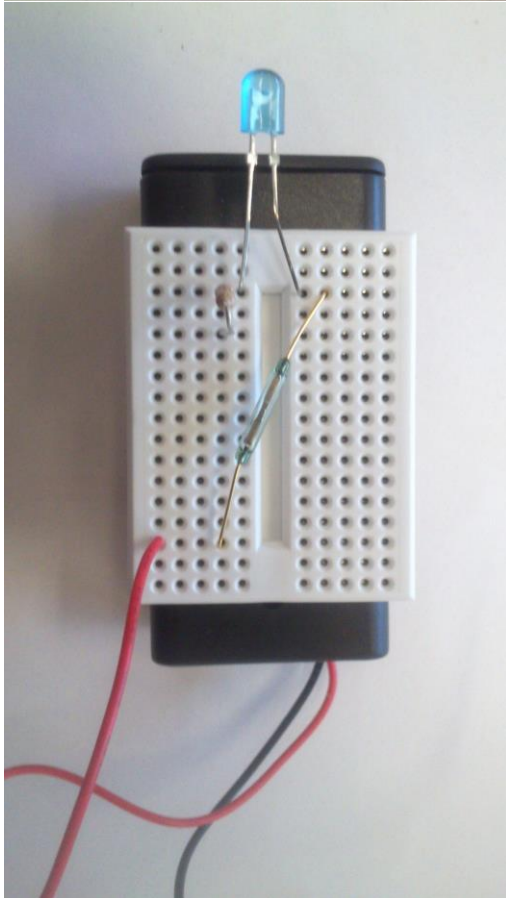
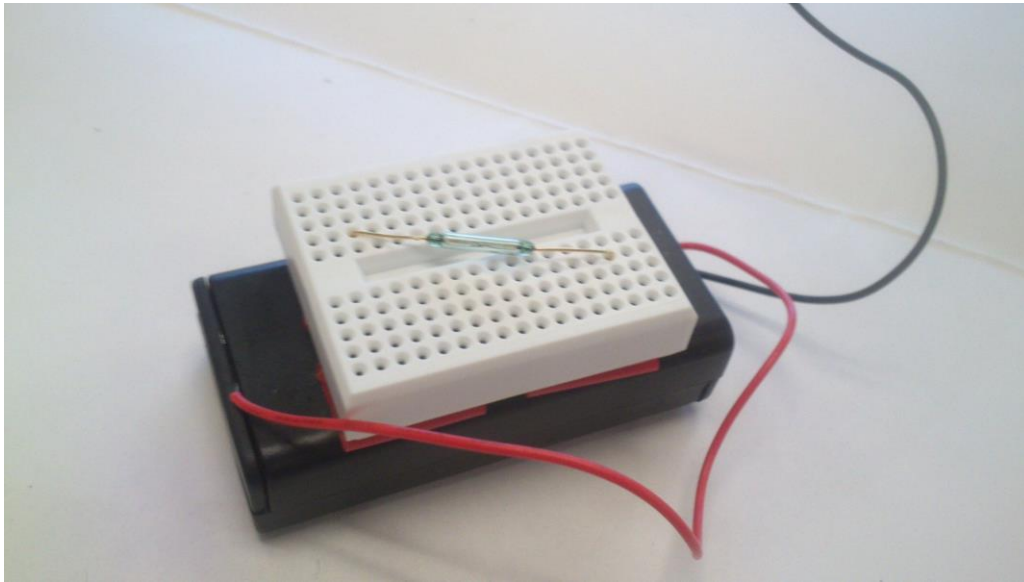
8) Wire up/solder the circuit according to the schematic diagram and pictures below. Leave the motor out for now. Take care when bending the leads of the reed switch as it is quite fragile (use pliers!). *If you're using a PCB, you'll probably want to solder some female socket connectors to the PCB to connect to the motor later.

Schematic diagram:



Fritzing image:

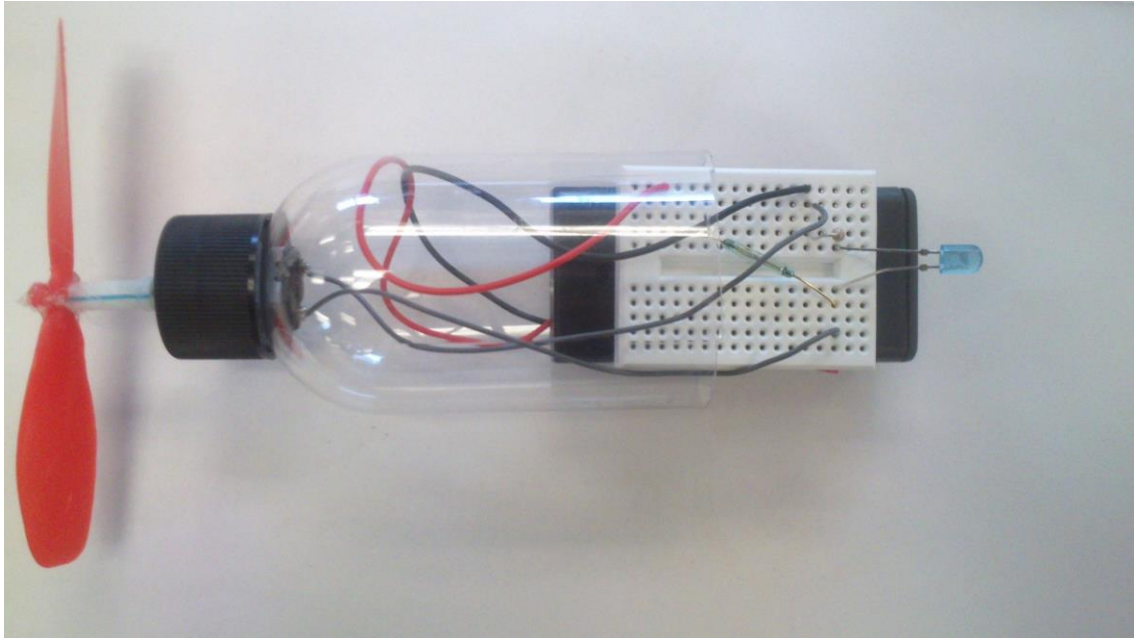




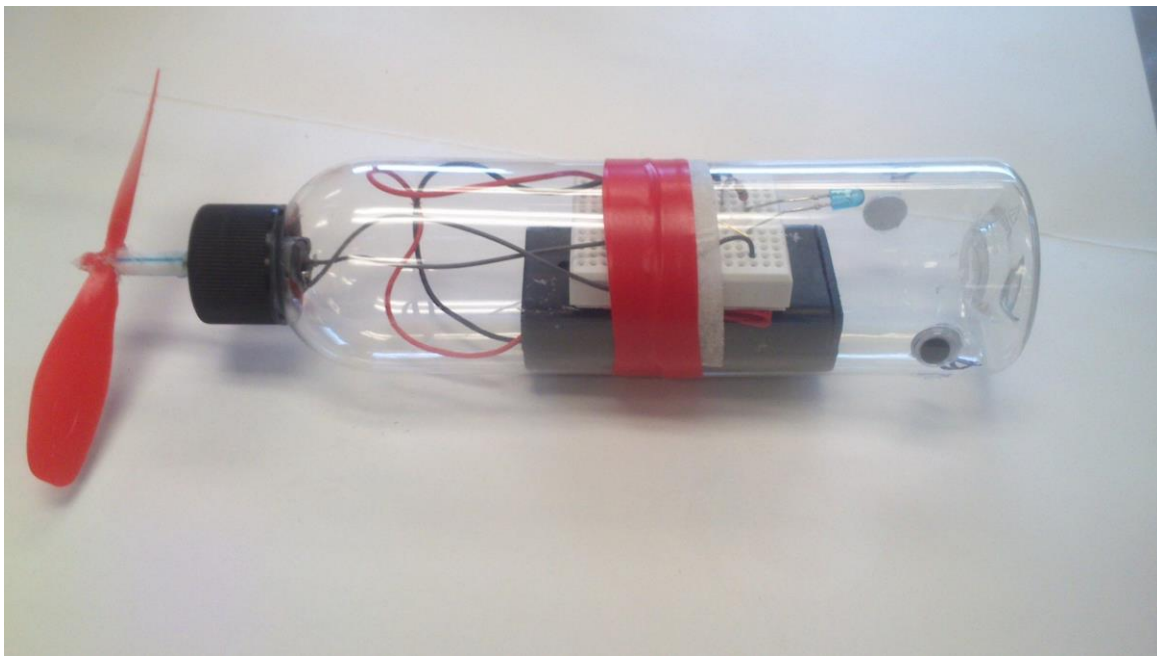
Note: The LED only works 1 way. The longer lead (end) of the LED should connect to the red battery wire through the reed switch.

9) If you're using a PCB, use a flush cutter to cut off the extra wires ends sticking out from the PCB and tape the PCB to the bottom side of the battery pack.

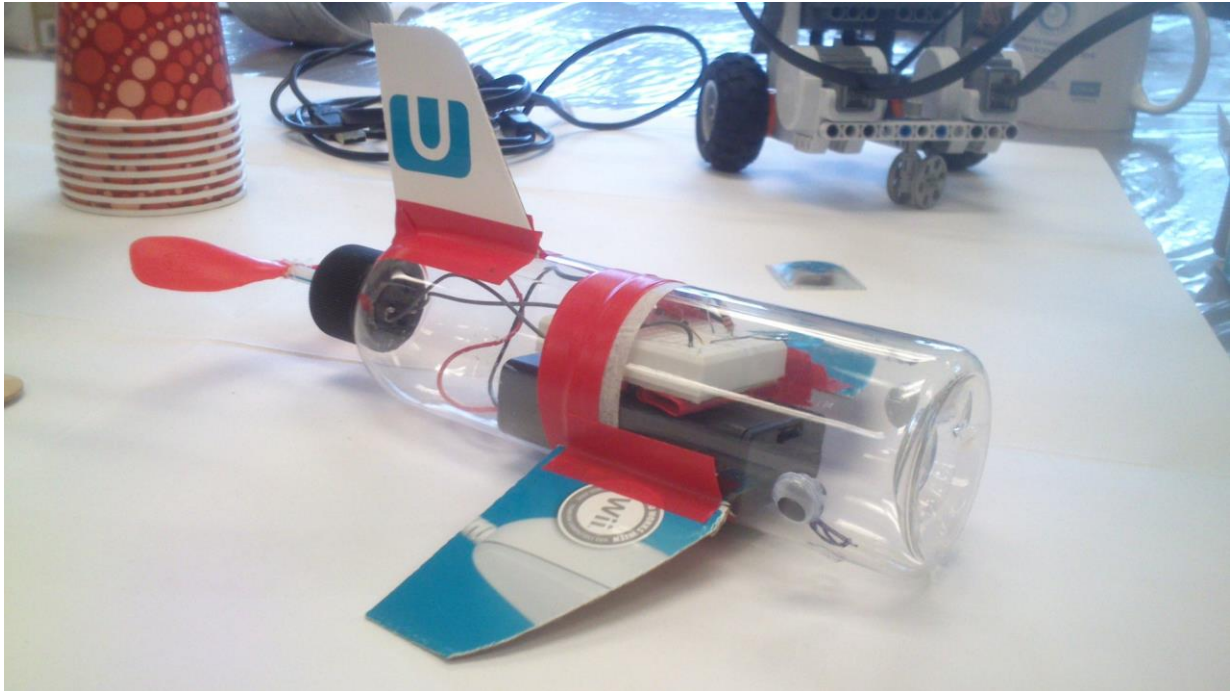
10) Screw the motor-bottle cap onto the top half of the water bottle. Insert the battery-breadboard assembly into the top half of the bottle. Connect the motor to the breadboard/female sockets.



11) Close up the bottle and tape the two halves together securely so no water (hopefully) can enter. The breadboard side of the water bottle will be the top of the submarine and the battery pack side of the water bottle will be the bottom of the submarine. This means your battery pack and breadboard should be upside down.)



12) Cut out long fins for your submarine using the styrofoam plate and attach them to the bottle using electrical tape. The fins will help prevent the submarine from rolling around in the water.



13) Glue googly eyes to your submarine!

14) To turn the submarine on, place a magnet near the reed switch (or tape a magnet onto the bottle on top of the reed switch). The LED should light up and the motor should spin. Place your submarine in water and see if it sinks or swims! (it should/will swim)

