Sierra College MECH-01
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Lab 05 M-W

Magnetism
Electromagnetism
Magnetic Reed Switch Motor Project

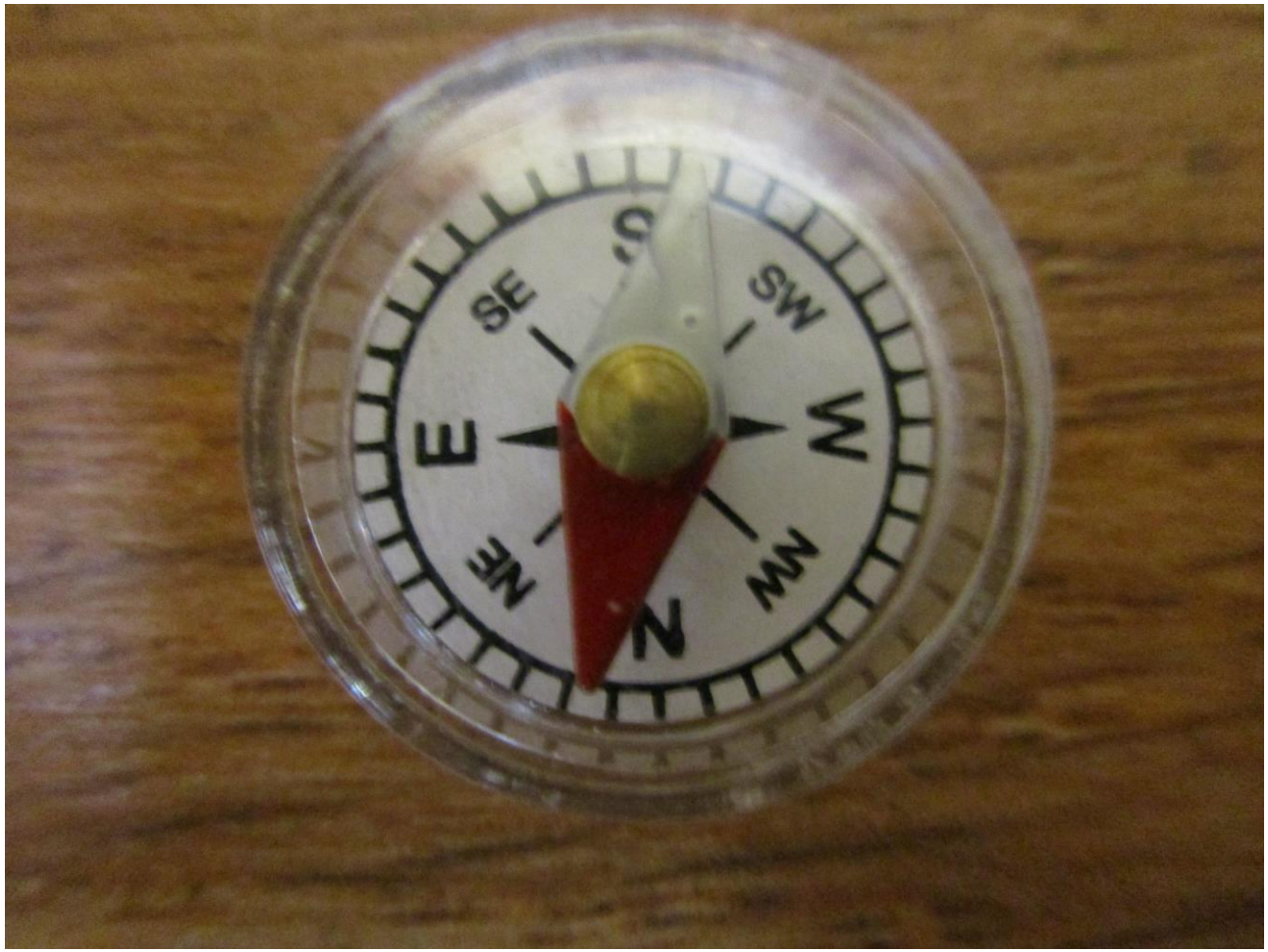
A. Common Assembly Steps

1. Orienting the magnets.

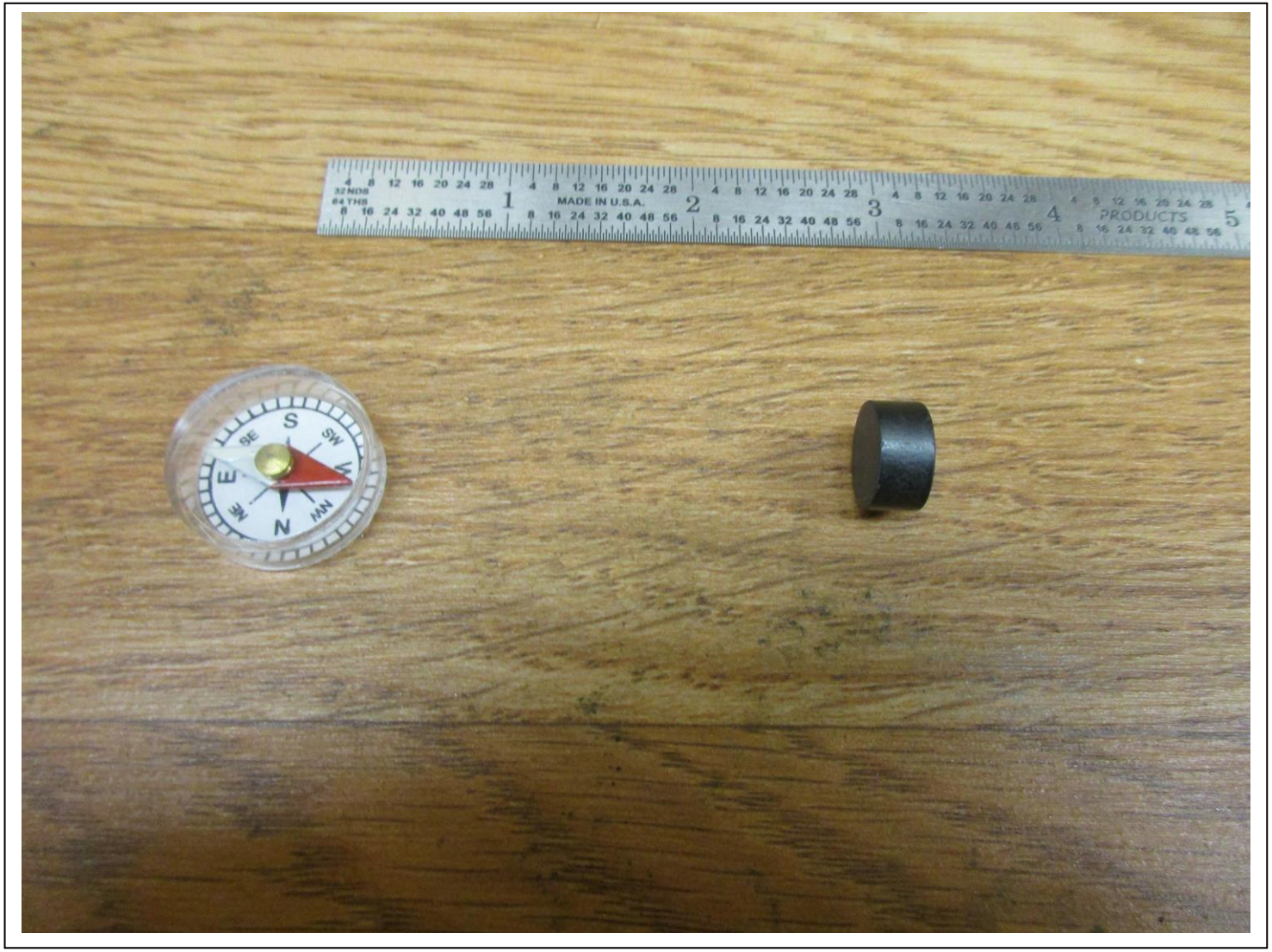
   a. Note whether or not the compass is polarized properly by noting whether the NORTH band is pointing north.

   b. At Rocklin, when you come through the downstairs double doors to get into the V building, you are facing north. At NCC when you go across the bridge of the pond headed for the computer lab, you are facing north. At Truckee when you go out the main double doors on the front of the building and look across the parking lot, you are facing north.

   c. In all cases you will have to be OUTSIDE the building to get the compass to read correctly. There is far too much iron or steel in the building walls to get the compass to point north.



d. You will need two small round ferrite magnets. Bring one of the small magnets near the compass (caution, not TOO close … the picture shows just how close is right on the edge of being too close).

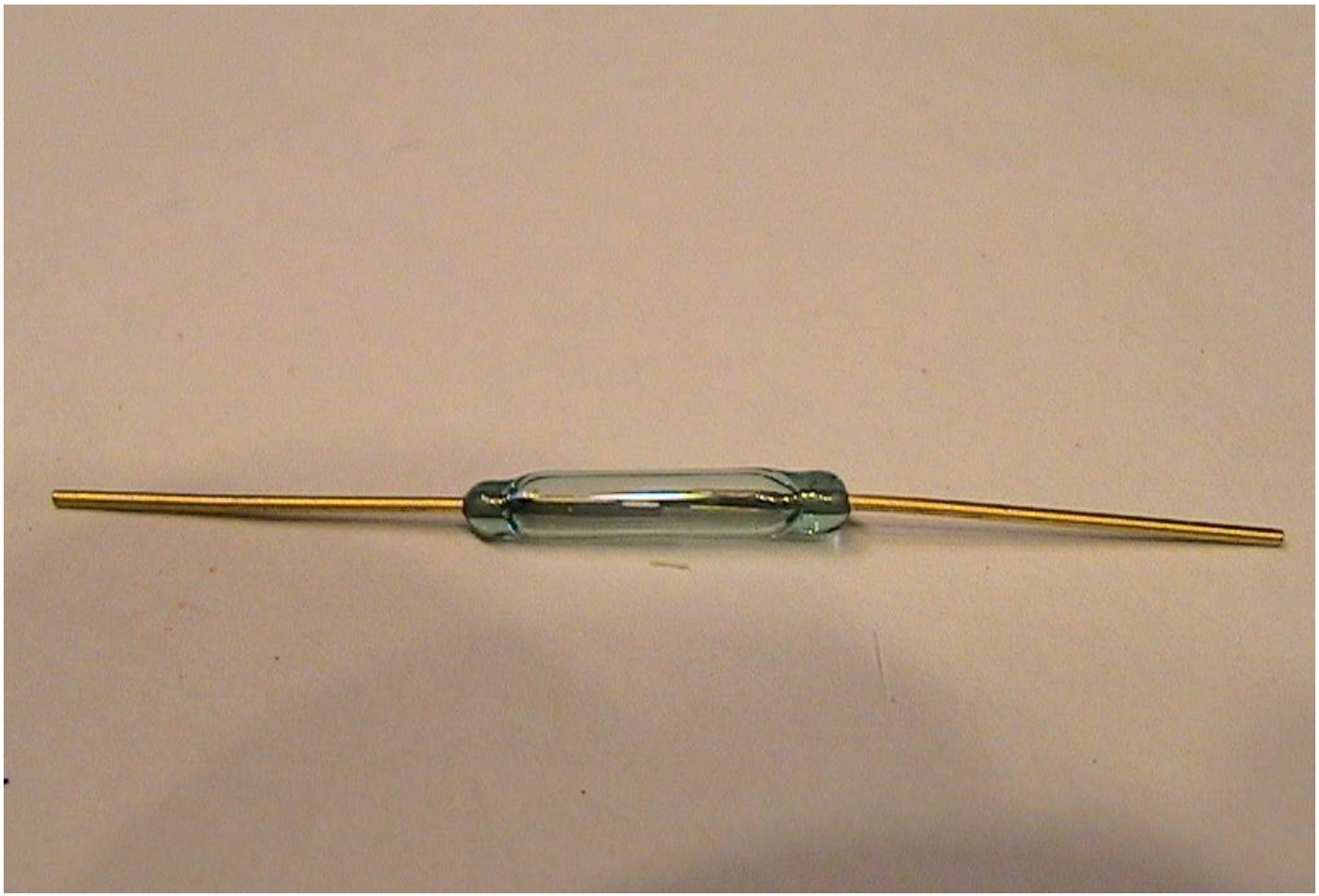


e. Use the compass to identify the faces of the magnet. Rather than arguing that the SOUTH pole of the magnet attracts the NORTH pole of the compass (or getting all tied up in trying to remember which is which), simply note that the north pole of the compass is a GREEN or RED needle and the south end of the compass is a WHITE needle. Mark a G or R (for green or red) and W (for white) with a PENCIL onto the face of the magnet that attracted the green and white lines respectively. Mark both magnets this way.

f. With the two permanent magnets marked, verify that like poles repel and unlike poles attract.

g. Set the digital multimeter to read the lowest OHMS scale. Verify that the meter is working by touching the test leads together. The ohmmeter should read nearly zero on the right side of the digital readout.

h. (Caution, the magnetic reed switch is very delicate. Handle it carefully.) Take the magnetic reed switch and put one DMM test lead on one of the switch leads and the other test lead on the other switch lead. It is easier to do this if you use alligator clipleads on the leads..



i. The switch is “normally open ‘NO’” Move the magnet around the switch at various angles and distances. Is there an optimum orientation where you can cause the switch to "close” or “make" at the longest distance?

B. At this point there are three major divisions of assembly … the electromagnet, the rotor, and the base. If the tools to do one of these steps is being used, do one of the other steps until the tool you need is available.

1 Making the electromagnet.

a. Take the 10-32 x 1 ¼" bolt and wrap a 1" x 1" piece of masking tape on the threads. Put one edge of the masking tape as close to the head of the bolt as you can. Run the nut onto the bolt so that it comes flush with the other end of the tape. Put a ***small*** dab of hot glue onto the bolt threads and the nut (outside the masking tape area) to "keep" the nut onto the bolt. Thread a metal hex spacer onto the threads of the bolt to act as a handle while you are winding the wire.

b. **Leave approximately 12" of #28 magnet wire as a connection** and hot-glue this wire onto the masking tape as close to the nut as you can get.

c. Use a hand electric drill and the hex spacer to wind the area between the head and the nut of the bolt as full of wire as you can. It should be around 300 turns (300") of wire. When you have the electromagnet wound, it should look like this:

d. Leave another 12" of wire as a connection at this end of the wire. Use a VERY SMALL dab of hot glue to keep this wire from unraveling.

e. Put another 1" x 1" piece of masking tape over the winding. Remove the metal hex spacer .

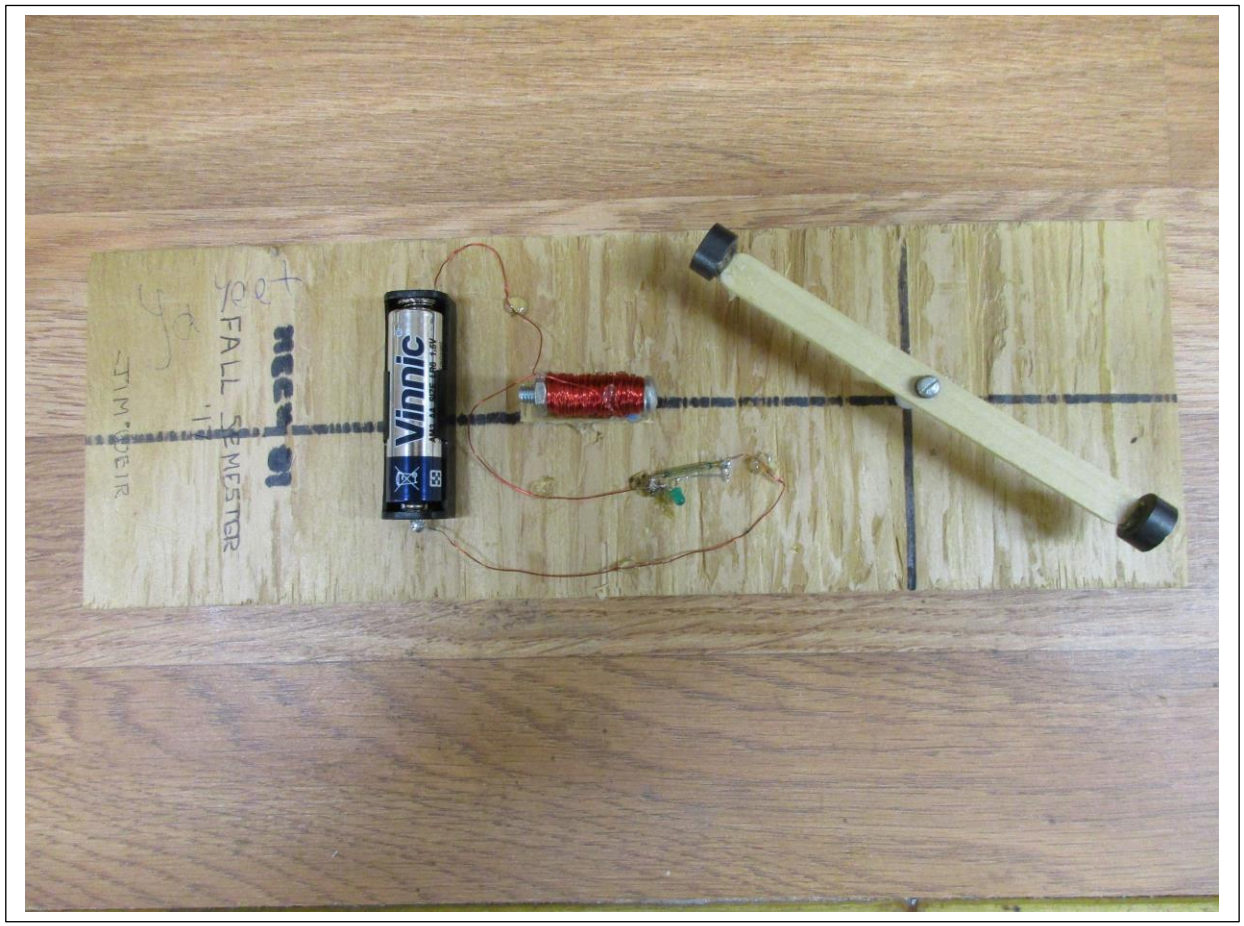
f. Put a piece of masking tape over each lead of the electromagnet out about 1' from the wire end..

g. Strip the very end of the wire using the "hot ball of solder" trick on this wire. (The trade name for this wire is Polythermaleze, which means that it strips in hot solder quite easily.)

h. Use a lab power supply set to 1.0 volts and power up the electromagnet by attaching one of the electromagnet wire to the + terminal of the power supply and the other electromagnet wire to the - terminal. How much current does it draw? (Normal current is between one and two amperes.)

i. CAREFULLY using the compass, determine which is the GREEN/RED and which is the WHITE end of the electromagnet. If the bolt HEAD is not the white end, reverse the wires at the power supply and prove to yourself that the bolt head is now the white end.

2. Making the base.



a. Measure and mark a centerline along the length of the wooden base. Mark one end of the base "A" and the other end "B".

b. Mark a line approximately 4" from the B end of the base. At the intersection of these two lines drill a 0.078" (#47 or $^{5}/_{64}$" bit) diameter hole completely through the wood. Use a drill press in the machine shop to accomplish this task.

c. Thread a 4-40 x 1" sheet metal screw into this hole in the base approximately 2 or 3 threads (a thread is one complete revolution of the screwdriver). Remove the screw and set it aside.

2. Making the rotor …

   a. Hot glue one of the magnets to one end of a popsicle stick so that the WHITE face is facing out.

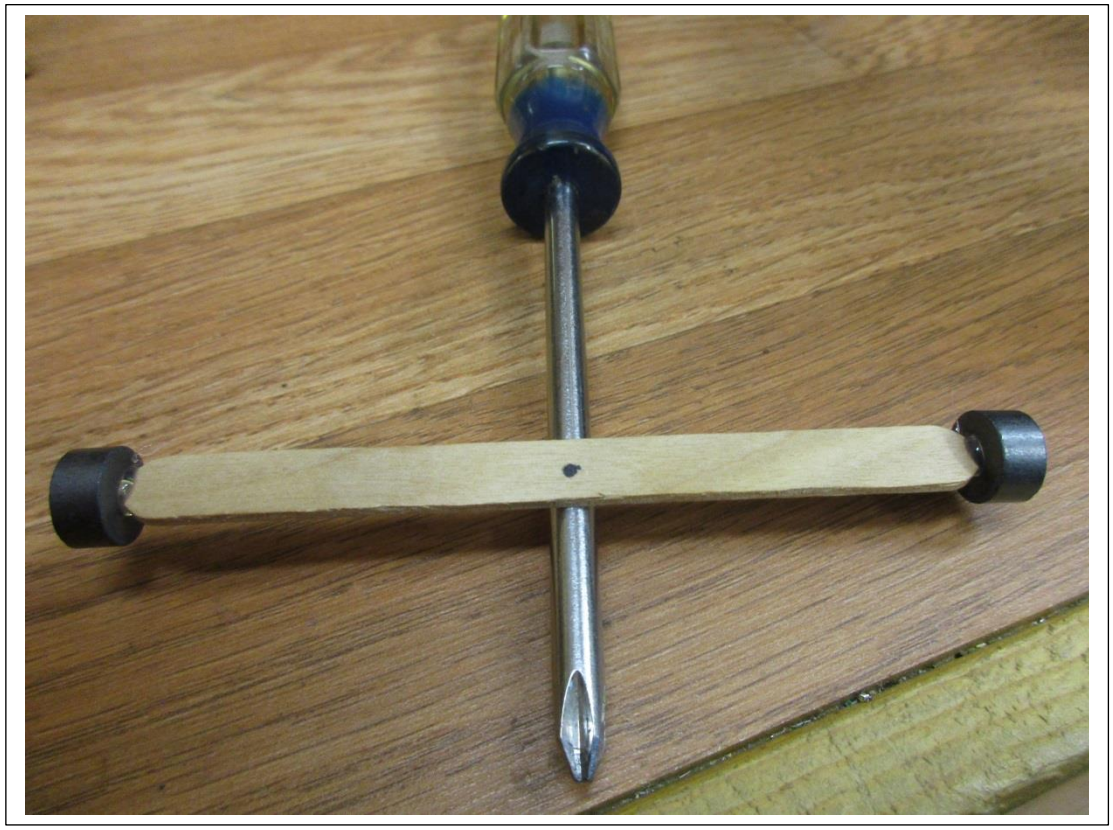
   b. Hot glue the other magnet to the other end of the popsicle stick ***with the white side facing out*** as in step d above.

   c. Use a drill bit or screwdriver to find out where the popsicle stick balances. Mark a line across the stick at the balance point

   d. (Use the drill press in the machine shop to accomplish this task.) Drill an 0.089" (#43) diameter pilot hole in the exact center of the line drawn at the balance point of the stick.

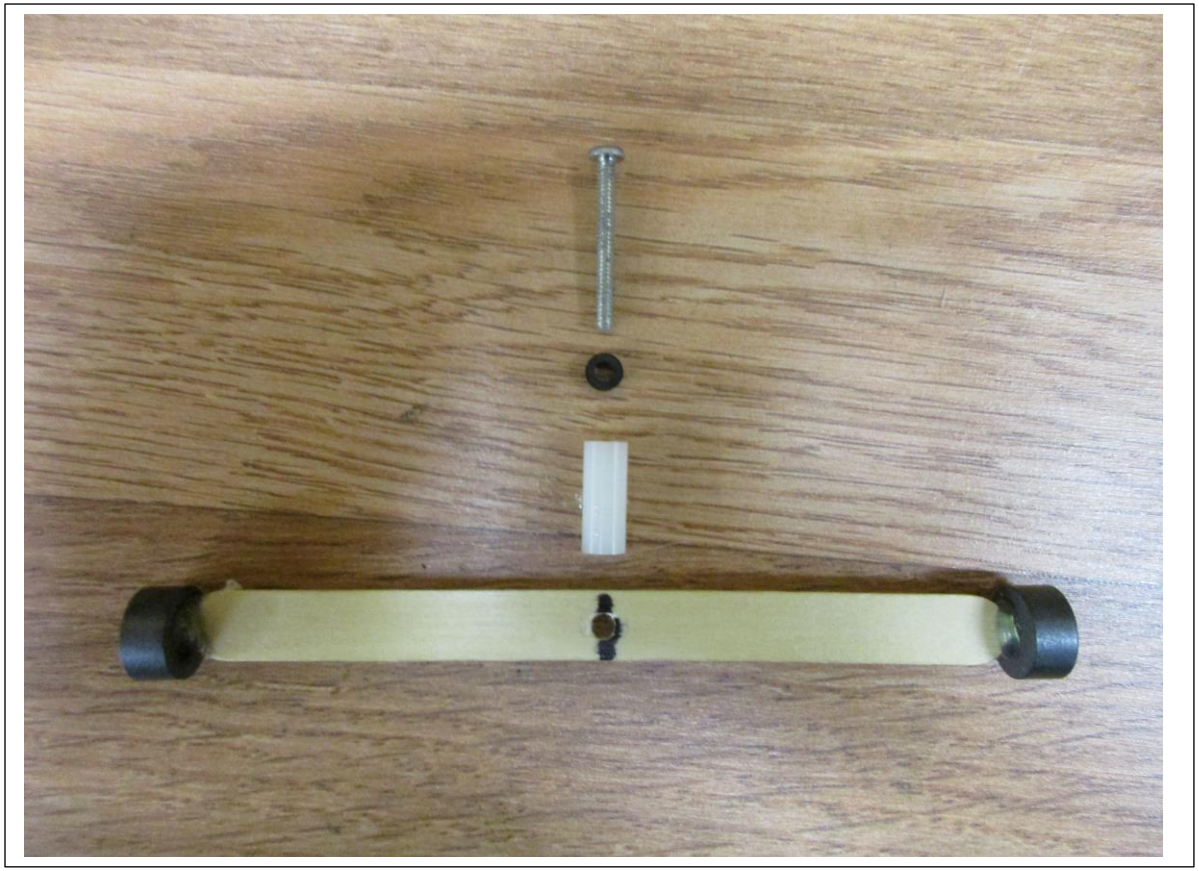
   e. Drill a 0.113" (#33) diameter clearance hole through the pilot hole as clearance for a #4 x 1" sheet metal screw. Fit the #4 screw through the hole and remove any burrs or splinters that are binding on the screw.

      (NOTE: You may wish to "cheat" just a little bit by drilling this hole with a #34 or even a #35 hole to eliminate "wobble" that reduces the speed of the motor greatly. However, the stick must spin effortlessly on the #4 screw.)

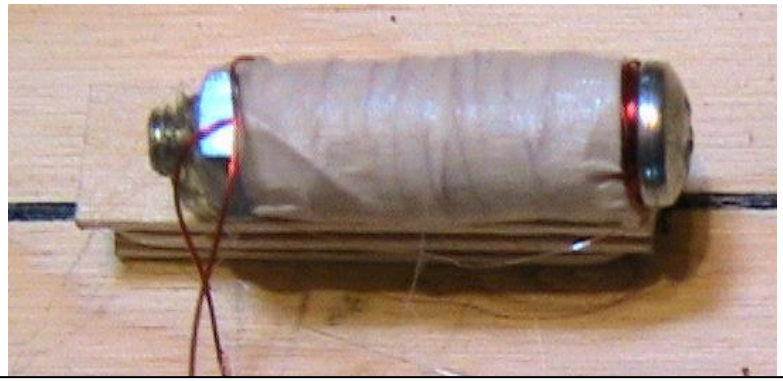


4. **FINAL ASSEMBLY**

a. Assemble the rotor as follows: #4 x 1" sheet metal screw through the hole in the stick, then a very thin nylon washer, then through a #4 x $^{5}/_{8}$" nylon standoff, and then into the hole drilled through the hole in the wooden base. Tighten the screw down so that the rotor doesn't wobble but still turns very freely .



b. Cut a popsicle into thirds crosswise. (3 pieces, 1 ½" x 0.37"). Use tin snips to cut the stick.

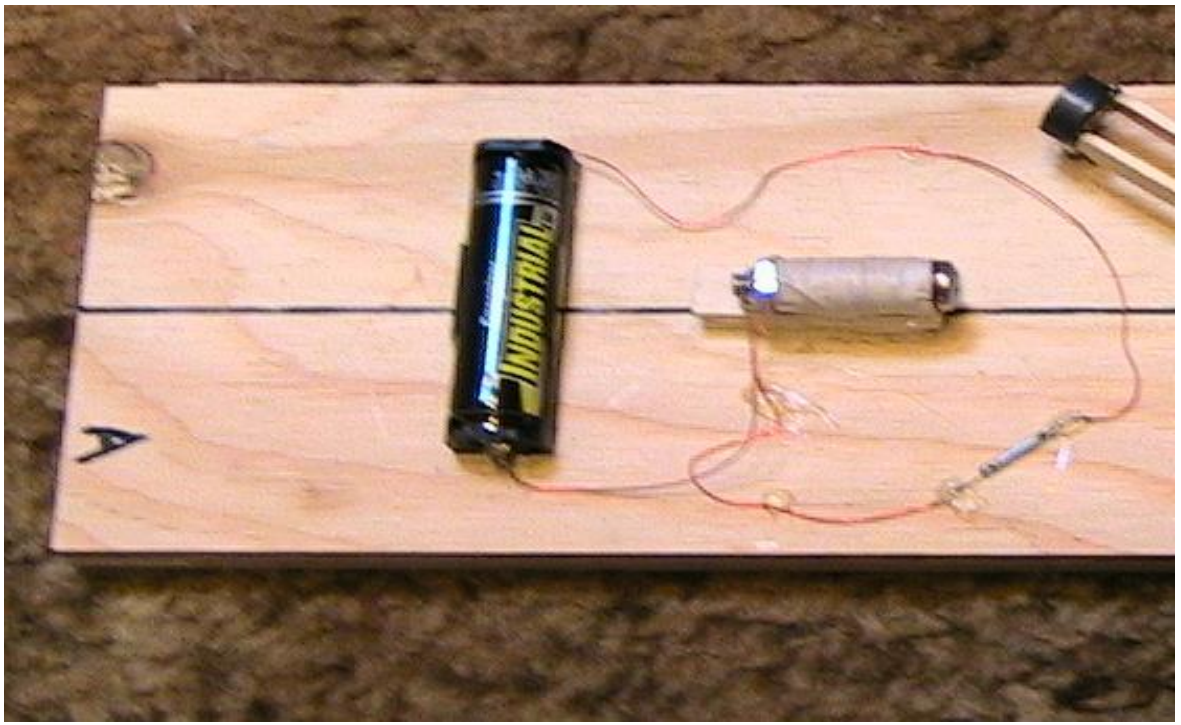


c. Place the electromagnet on section A and move the rotor until it is "attached" (magnetically) to the electromagnet. Raise the electromagnet until the head of the electromagnet is in the center of the magnet. Slide the cut popsicle sticks under the electromagnet until the head of the electromagnet is as near the center of the rotor magnet as you can get it. Hot-glue this assembly together

d. Hot glue the electromagnet-base assembly to the A side of the board and on the centerline of the board so that there is a 0.1" to 0.12" gap between each of the magnets and the head of the electromagnet. Be sure to check BOTH magnets for clearance before hot-gluing the electromagnet assembly in place.

e. Hot glue the battery holder in the approximate position shown with the spring at the bottom of the picture.

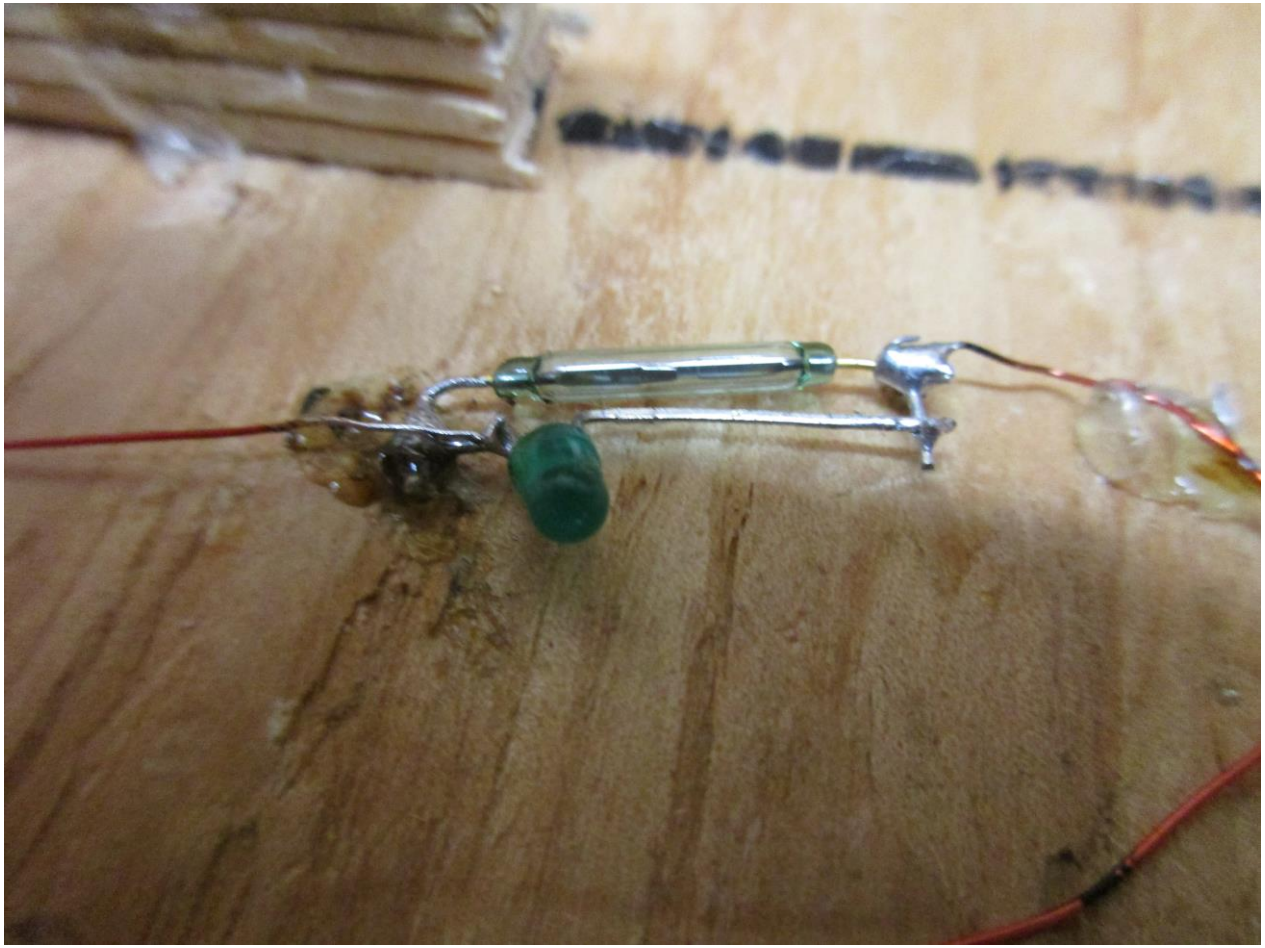
f. CAUTION, the battery holder is very sensitive to temperature. Make the connection as fast as you can. Use the multimeter to be sure that you have battery voltage at the battery holder terminals when you insert an AA battery into the holder. Temporarily remove the battery.



g. Put the reed switch temporarily in the approximate position shown in the photo. Be sure that the magnet will pass directly over the reed switch. Connect the (+) wire from the electromagnet to one lead of the switch. (Do NOT shorten the electromagnet leads.) Use blue masking tape to temporarily affix the wires to the wooden base..)

h. Connect the other lead of the switch to the plus (+) end of the battery terminal. Use an extra piece of magnet wire to make this connection. Leave enough extra wire to be able to move the reed switch a few inches in both directions.

i. Connect the (-) wire of the electromagnet to the (-) minus end of the battery (the spring end).

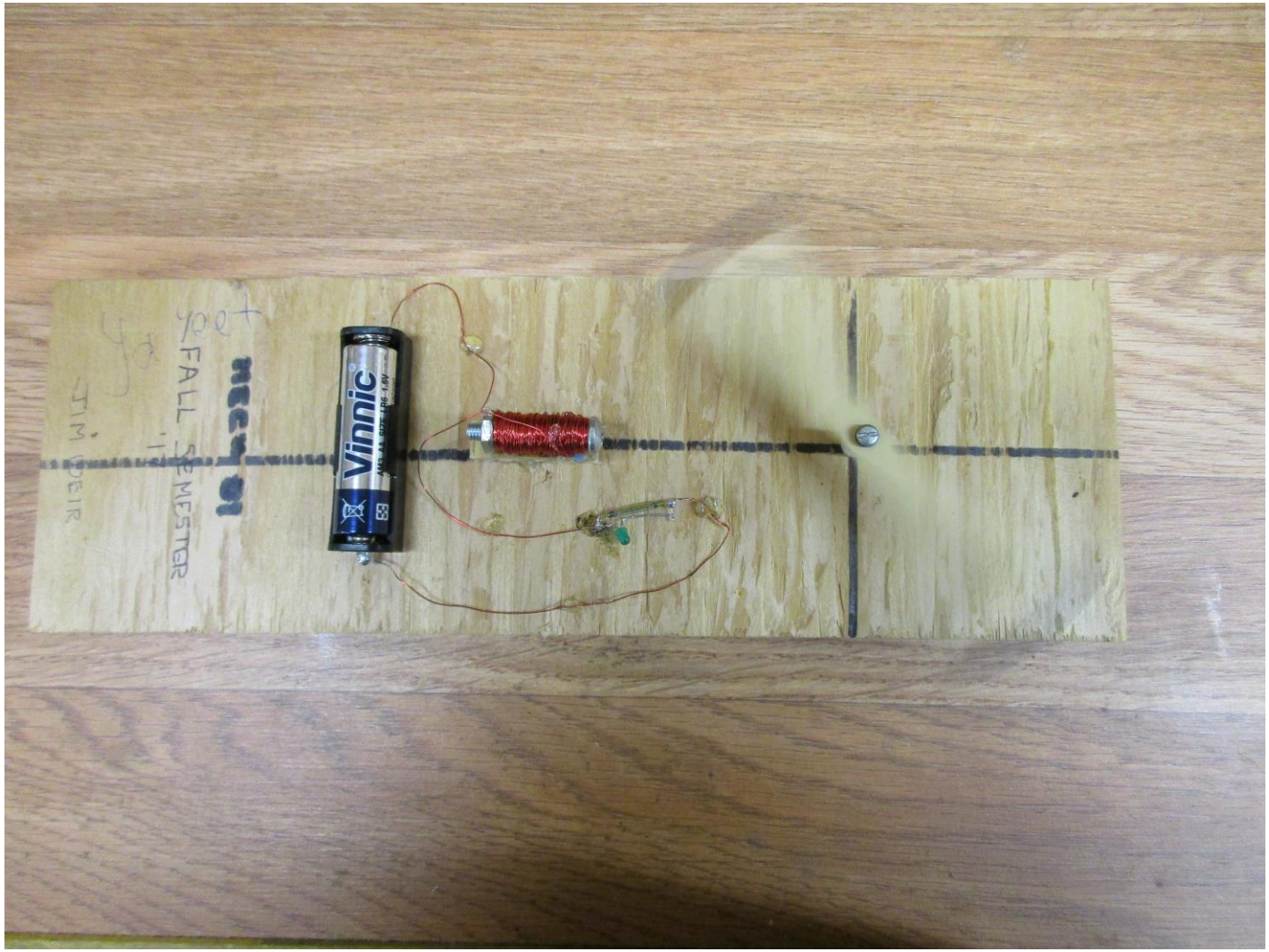


j. Insert the battery into the battery holder.

j. "Start" the motor by spinning it clockwise looking at it from the top.

k. Move the reed switch until the motor reaches maximum speed. You may use an oscilloscope if you wish to optimize the speed.

l. Do not run the motor very long without a "protection diode" across the reed switch. A green LED will serve as a protection diode. While the motor is running, temporarily connect the LED across the switch. If it does not flicker on every time a magnet passes over the switch, turn the diode around end for end and try it that way. The diode WILL light up when it is in the correct direction.



m. After determining which way you want the permanent configuration for the LED, hot-glue spots of the wiring to the board.

5. OK, So It Doesn't Work

a. Take a voltage reading across the reed switch. If you don't have 1.5 volts (or thereabouts) your battery is not connected. Most probable cause is that you used too much heat soldering the wires to the battery clip and melted the plastic clip. It is possible to save the clip. See the instructor.

b. Recheck which end of the magnets you have on your rotor. Use a hand magnet to close the reed switch and see if the head of the electromagnet bolt is the same polarity as the rotor magnets. If not, you have three options:

i. Take the battery clip off and reverse the battery connections.
ii. Take the wires off of the battery clip, reverse the clip, and reverse the battery connections.
iii. Take the electromagnet bolt off and turn the bolt around to use the "thread-nut" end as the magnet.