## Lesson 4 Teacher Reference

## **Teacher Generator Instructions**

## Materials (for the teacher to make a generator):

- 11.57" paper tube--similar to toilet paper tubes, but thicker cardboard
- 1 heavy steel nail, 4-5" long and 1/4"-3/16" diameter
- 2 cylindrical neodymium magnets, 3%" diameter, 3%" height
- 200-440 ft of 28AWG magnet wire sandpaper or a sharp blade
- sticky tack

nail polish (or permanent marker)

• 2 alligator clips and 1-2 ultra-bright LEDs

(optional) power drill with 2 speeds

Preparing generator tubes: (For guidance, see https://youtu.be/larsLDIZ6XM).

B.

1. Leaving 4" (10 cm) of loose wire at 1 end, wrap 1 paper tube in 200-400 tight wraps of magnet wire, about 1 cm in from 1 end (A). **Do not** wrap in the center of the tube.

2. Continue wrapping in a new position closer to the center of the tube, leaving 1 cm between the 2 groups of wraps. The second wraps will be the same as the first, for a total of 400-800 tight wraps.

3. Finish by twisting the wire around itself 3-4 times in an overhand knot fashion (B), then pull tight. Leave 4" of loose wire at the other end and cut the wire. Use a thin strip of sticky tack to secure the wraps against the tube. If any parts of the wrap seem loose, secure them with sticky tack (C).







4. Use a nail to poke a hole in the cardboard tube in the space between the 2 groups of wraps (D). Push it through the other end of the tube, making sure the nail goes directly through the middle of the tube, leaving 1/2" of space on both sides for magnets to spin (E). Slide and spin the nail in and out until it rotates freely inside the 2 holes you've made, then remove the nail.

5. Use sandpaper or a sharp blade to scrape ¾" (2 cm) of red insulation off the edges of the magnet wire on each loose end (E). Scrape around the wire so the orange copper wire is visible on all sides.



6. Use nail polish (or permanent marker, though this will quickly rub off) to label the same side of each magnet with a dot of color. An undamaged compass should point to the magnet's N pole. Alternatively, **2 poles are identical if they repel each other. Do not** use attraction to the nail to identify poles--both sides of the magnet will attract the nail.

## Notes about wire wrapping:

Wrapping the wire can be tedious and the wire itself can be expensive, **but more wire wraps will indeed create a better generator**. Our recommendation is to use the most wraps that you can, given the availability of magnet wire.

- The ratio of wraps to feet of wire is about 2.2 wraps per foot. 400 wraps is about 180 ft of wire; 550 wraps is 250 ft, 730 wraps is 330 ft.
- OK: 1 spool of 170 ft of 28AWG magnet wire can construct 1 tube with 380 wraps.
- **GOOD:** 1 spool of 250 ft of 28AWG magnet wire can construct 1 tube with 550 wraps. This generator will work well, and you should see 1 LED blink on briefly as they flick the nail.
- **EXTREME (in a good way):** 1 spool of 340 ft of 28AWG magnet wire can construct 1 tube with 730 wraps. This generator will be fairly powerful, and you should easily see the LED light continuously by tugging a string wrapped around the nail.

If you need to "splice" 2 wires together, first secure existing wraps temporarily with sticky tack so the wraps don't unwind. Sand/scrape the enamel insulation off about 2 cm of the end of both wires, then twist them together at least 5 times. Keep twisting **or** cut off the excess, then tuck the twisted connection into the existing wraps. Remove the temporary sticky tack and keep winding tightly.

If the tube becomes damaged, it is possible to rewrap the wire onto a new tube. Remove the sticky tack from outside the old tube, as well as the nail and magnets, and use a ring stand or something similar as an "axle" for the old tube. "Untie" the original overhand knot at the end of the old wrapping, then wrap the wire around the new tube, taking care to keep tension on the wire at all times. **Do not get interrupted or distracted during this rewrapping, or you can end up with an unpleasant mess.**