

### **The Magnaprobes.**

Pick up a magnaprobe from the paper from one of the outlines. These are actually very expensive little things, so be very gentle with them. They have a very strong magnet balanced on a gimbal<sup>1</sup>. Try to avoid sticking them to anything.

- If you do stick it to a piece of metal or a magnet, grab the little magnet itself to pull it loose; don't try to pull it loose using the delicate handle. This will exert too much force on the gimbal mechanism.
- The red end is the North Pole end, and so it is like the tip of an arrow; whichever way the red end points, so points the magnetic field.

<sup>1</sup> – The department store in *Elf* is called *Gimbels*. Different.



### **The Fixed Magnets.**

1. Move the probe around the red rectangular fixed magnet and let the magnaprobe trace out the magnetic field. Which end of this magnet is the North Pole end? Notice that the North Pole has a little divot to identify it. This is a secret code that you must learn.
2. Find the N and S poles of the other magnets scattered about. Laugh at the incorrectly labeled dark grey magnet. Wonder at the circular ceramic magnets from speakers. Marvel at the spherical magnets. See if you can toss them into the air and make them go “Brdtdtdtdtdtd!” See if you can put the “cow” in the cow magnet. Horse around with the horseshoe magnet.
3. The rock looking thing is a piece of lodestone – magnetic ore from the earth. Map out its magnetic field. Where is its north pole?
4. Carefully figure out on the hard drive magnets taped to the counter where the N and S poles are. Inside the hard drive they would face each other. If you accidentally stick to the hard drive magnet, grab the little magnet to remove it, don't try to jerk the handle away.
5. Try to make a platypus with the building toy. (or not)

# B.

## **The Mysterious Levitation Spinnny Magnet.**

- Solve the mystery that is the levitation spinnny magnet using your magnaprobe. Where are magnets hidden in the base, and spinnny part? What is their polarity? Where are they located? Draw a little diagram of this on your lab.
- Check out the ferrofluid – Don't open the jar, but lift it up and move the neodymium magnet around and watch it make fantastic weird shapes. The Ferrofluid is trying to follow the magnetic field lines. Watch some Ferrofluid movies on YouTube. It's cool stuff.
- Try the moustache generator. Open it up and hold it up to your face as if it is your moustache.
- Set up the Chaos pendulum so it is attracted to and repelled by the magnets on its base. Watch it go. Put money on the outcome. Gamble.

# C.

## **Electric motors**

- Check out the demonstration electric motors. Where are the poles on the fixed magnets? Notice that one doesn't have permanent fixed magnets, but rather has an electromagnet that generates the external magnetic field.
- Pull out the platters on the hard drive with the tape and:
  - Notice the little electromagnets that drive the motor as part of the base
  - Turn over the platters, and use your magnaprobe to find the poles of the permanent magnets on the bottom rotor that fit inside the electromagnet array.
- Check out the floppy drive motor. Notice that it too must have a bunch of electromagnets driving it
- Mess with the speaker – use the battery to make the speaker move out and in. Check out the voice coil exposed in the taken apart speaker.
- Look at the hard drive seek arms on the taken apart hard drives. On one you can see the seek arm coil with the hard drive magnets removed, on the other you can see the hard drive magnets in their position.
- Check out the see-through computer hard drive in the working computer. Press the wee microswitch to turn on the computer. Watch the seek arm moving across the platter. Notice how fast it moves. When the computer prompts you to, press F1, and it will start to load W98. Watch the seek arm go nuts. A properly organized hard drive tries to put the files it needs most in one place. As files get fragmented and scattered across the disk, the hard drive is slower because of the seek time. Solid state drives don't have this same problem. Shut the computer down when you are done.

# D.

## **The Generators.**

- Grab one of the hand crank generators. Be gentle with these – they cost about \$50 to replace. Try:
  - Turning it with no load attached
  - Turning it with a light bulb attached
  - Turning it with the leads connected together in a dead short
- What is happening to the torque needed to turn the generator?
- Try the red squeezezy squeeze flashlight. Squeezing the handle makes a generator spin inside the body of the flashlight. How does the light stay lit when you are not actually squeezing the handle?
- Try the shaker flashlight. Look at how it is constructed – just like the ILD we just did, right? Turn it on, and shake it vigorously. Notice when the light flashes on. How could you make this light stay on when you are not actively shaking it?

# E.

## **A Current-Carrying Straight Wire.**

Turn the power supply on, and check to see that about 4 A of current is flowing. Find the large square made of many windings. Pick the vertical side nearest you and treat it as a long straight wire. Use the wire right hand rule to predict which way the magnetic field wraps around the wire. (Thumb – I, fingers wrap as B) Take the magnaprobe and let it show you the direction of the magnetic field. The red end is the direction of the B field.

# F.

## **The Flat Flat solenoid.**

Now treat the large square with many windings as a flat magnet. Use the right hand rule for solenoids to determine where the North Pole is on this magnet. (fingers wrap as I, thumb is the N pole) Use the magnaprobe to check this. Figure out which way the field is in the area inside the coil in general.

# G.

## **The Long Long Solenoid.**

- Solenoid is just a big word for coil of wire
- Turn the power supply on and check to see that a current of about 4 A is flowing. The current is coming out of the red terminal of the power supply, and going into the black terminal. Using that direction of the current, use your right hand rule for solenoids to determine the North Pole for this solenoid. (fingers wrap as I, thumb is the N pole) See if the S pole (blue end) of your magnaprobe is attracted to the solenoid's North Pole.
- Generally check out the direction of the magnetic field around and inside the solenoid.

**Put your magnaprobe back on the paper where you found it.**

# H.

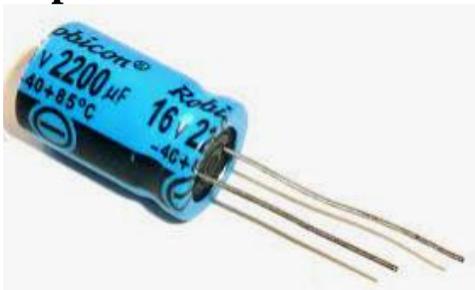
## Transformers

- Check out the beefy microwave oven step up transformers. If they are step up transformers, which side is the primary? The one with more windings, or the side with fewer?
- Admire the doorbell transformer. Check out the isolation transformer. Notice that the toothbrush can charge without electrical connections. The connection is inductive.
- Look at the power supplies – notice that they have a transformer, diodes, and capacitors. That should look familiar. (Oscilloscope lab)

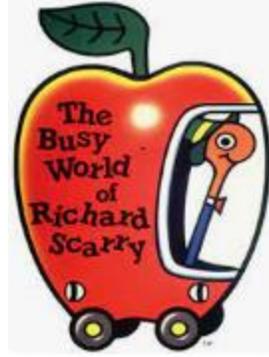
## Diode:



## Capacitor:



# I.



## BusyTown

- By reaching under the box, find the little magnets stuck to the underside of the street. Use this to drive your little car around the streets of BusyTown. Remember to stop at the intersections – they are all four way stops, and also stay on the right side of the road – because this isn't Britain, is it??
- See if you can find your way to the gas station, the antique shop, and the shoe store.
- But seriously, you can steer the car, so how must the poles of the magnets be laid out above and below the cardboard?
- Did you play read Richard Scarry books as a kid?
- Did you play the PC game Busy Town as a kid? My kids did. Favorite.
- What is the favicon for my website?