**Hyperloop Instructions**

**General**

This is a proof of concept exercise. You will build a not very pretty version of a moving part to use in your city model. This is called a Proof of Concept or POC. It gives you experience in working with the materials and prove that the concept works.

**WARNING**

The Neodymium magnets in your bag are very strong.
**When working with Neodymium magnets or standing near someone who is you MUST WEAR SAFETY GLASSES.**
We have a generous supply of safety glasses.
They can pinch your fingers hard enough to make you bleed, they will fly across the table or through the air to bang against a piece of steel. They might break into many pieces and/or break whatever they slam into. If one breaks or cracks throw it away. Read the warning attached to the magnets in your kit before starting.
All of the parts you need are in your team's brown bag or on the table.

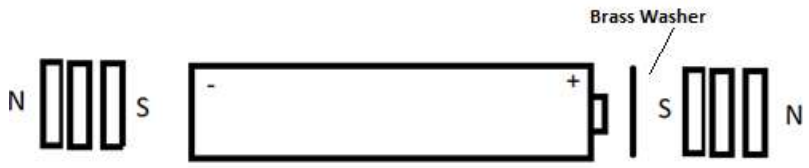
Note: The batteries will go dead very fast if they get stuck in the coil of wire. Use the dowel to push them out if they get stuck.

**Assemble Coil**

a. Take the coil of wire out of your bag
b. One team member holds the coil so it doesn't unravel as you remove the masking tape from the wire.
c. Tape the free end of the wire near the end of the dowel
d. Rotate the dowel to wind all of the wire tightly around the dowel. Do not let the wire overlap itself.
e. Push the coils tightly together should rebound slightly when pressure is released
f. Carefully slide the wire coil off the dowel on to the table
g. Make sure there is some space between the each loop of the coil
h. Slightly expand both ends of the coil so they are slightly wider so that the battery-magnet assembly does not catch going in or coming out of the coil.

**2. Build the battery-magnet assembly**

a. Hold the brass washer on the positive side of the battery.
b. Carefully attach 2 of the Neodymium magnets to the positive side of the battery. Do not let the magnets jump out of your hand.
c. The same pole must be on the battery side of the magnet stack on each end of the battery. Get a firm grip on the magnet stack for the negative side of the battery. Slowly bring it towards the stack already attached to the positive side of the battery. You will feel it either pull towards or push away. If it is pulling than that is the end of the stack that goes against the negative end of the battery. If it is pushing away than the other end goes against the negative side of the battery. See diagram.




**3. Test the hyperloop**

**a.** Slide the battery-magnet assembly into the coil until it is all the way in. It will either:
   i. Zip through the coil to the other end
   ii. Pop back out, in which case put the other end of the battery-magnet assembly in first

iii. Not move or not go all they way through. This can happen if the coil is not smoothly round or too many of the coils are touching each other. Try the following:

1. Slide the wooden dowel back into the coils and adjust the winding.
2. If your assembly has worked before and the coil looks smooth, the battery might be dead.
3. Try a smaller length coil first (instructor will have a few options).
4. Ttry different combinations of the battery and magnets as they attach to the ends of the battery. You might need to switch the north and south sides of the magnets as both north and south sides will attach themselves to the battery.
5. Try to push the battery assembly quickly into the coil to get it started.
6. If it does not work with 2 magnets, try 3 or 4 on each side.

4. Do these tests to find the combination that that works best.
   a. Spacing of windings on coils. Stretch or compress as needed.
   b. Change the number of magnets on the battery-magnet assembly
   c. You can use the table below to record how fast the engine went through the coil for each combination works. You will want to record the voltage of the battery before each run and replace the battery at a consistent level. There will be a DVM available for this. Your mentor can help you.
   d. You probably won't have enough time or batteries to test every combination but try at least a few. If your batteries all go dead, ask for more.

| Magnets Used | Tight Spacing | Medium Spacing | Far spacing |
|---|---|---|---|
| 2 | | | |
| 4 | | | |
| 6 | | | |
| 8 | | | |

Other things to try

a. Paint the outside of the wire coil (don't get paint on the inside)
b. Paint the batteries with spirals or stripes
c. Put a slight curve in the coil to go around a building
d. Going uphill and downhill
e. Connecting more than one run of coil

5. Before you leave, Store the coil of wire on the dowel supplied. Use masking tape to hold it in place

References

Here are a few You Tube videos on similar projects.

https://www.youtube.com/watch?v=BWW4kPjd4yc\

https://www.youtube.com/watch?v=tTLmqYBVdQk

If you Google Homopolar Motor, you will find some other projects that use the same electromagnetic principles.

Source for magnets

https://totalelement.com/products/totalelement-1-2-x-1-8-inch-neodymium-rare-earth-disc-magnets-n48-30-pack?utm_campaign=dsa&gclid=EAIaIQobChMI-5natrfH3AIVmISzCh1tBgAEEAEYAiAAEgJ9CvD_BwE

## Parts List and Receipt for Parts

| Description | Vendor | Unit Cost | Unit | Count | Cost |
|---|---|---|---|---|---|
| 1 of: Bare Copper Wire, Bright, 18 AWG, 0.04" Diameter, 195' Length (Pack of 1) | Amazon.com | $0.09 | foot | 50 | $4.50 |
| 1/2x1/8 Inch Strong Neodymium Rare Earth Disc Magnets N438 (30 Pack) | totalelement.com | $0.42 | each | 8 | $3.36 |
| Brass Washers 1/2 Inch | Lowes | $0.16 | each | 2 | $0.32 |
| Wooden Dowel 1/2 Inch x 4 feet | Lowes | $0.45 | foot | 2 | $0.90 |
| **Hyperloop Total** | | | | | $9.08 |

Batteries Not included
You will need to include the cost of these materials if used in your model and any batteries used on your expense form for the competition