

Magnetic Spinning Pencil

(Balanced repulsive forces can make a pencil stand at attention!)

LIGO-SEC/ Tien Huynh-Dinh 2015



Version 1: Pencil magnet is **above** the other 5 magnets.



Version 2: Pencil magnet is **below** the other 5 magnets.

(Step-by-Step) Visual Instructions

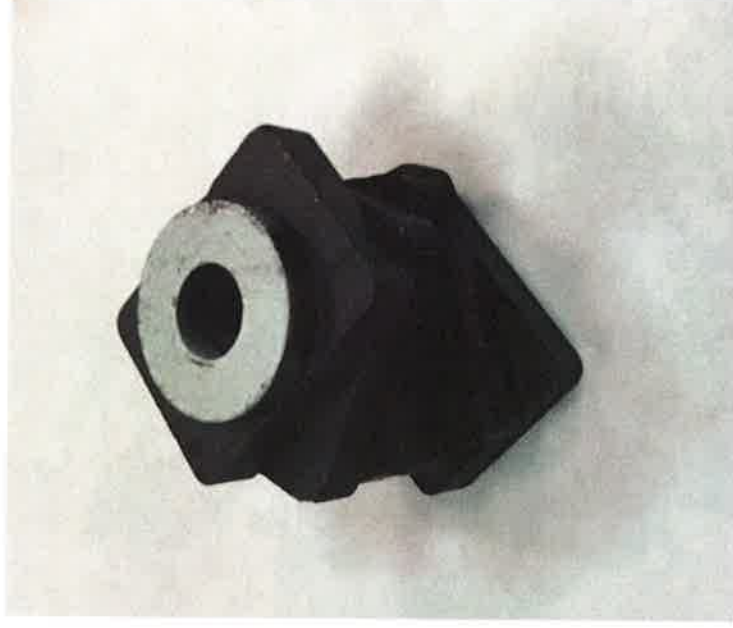


Materials:

- 1 Plastic cup
- 1 Pencil (sharpened)
- 1 Ring magnet
- 5 Block magnets
- Adhesive-backed Velcro
- ~ 12cm white loops (4 3/4in)
- ~ 12 cm black loops (4 3/4in)
- ~ 24 cm any color hooks (9 1/2in)
- Long skinny pointed object*
- Hammer or medium-sized rock*

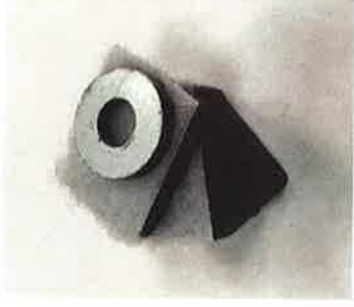
* Late addition to materials list

Make a stack with the magnets and place the ring 'donut' magnet on the top.



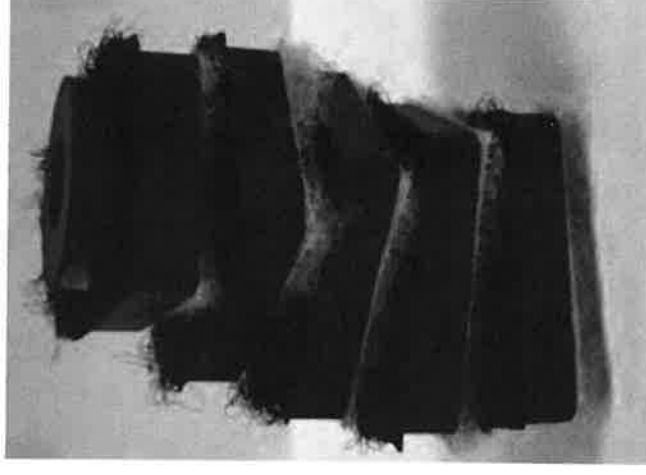
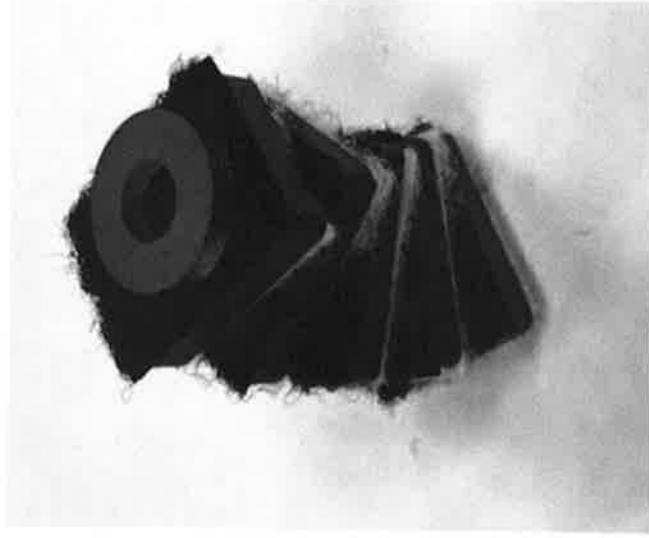
This step arranges the poles of all the magnets in the same direction.

With the 'white' side of the ring 'donut' magnet facing up stick a piece of white 'loop' Velcro on the top surface of each magnet in the stack.



This step will keep the poles of each magnet 'labeled' and will save time (and possible student frustration) later...

If you attached the white Velcro loops in the previous steps, then attach the black Velcro loops to the bottom surface of each block magnet now.



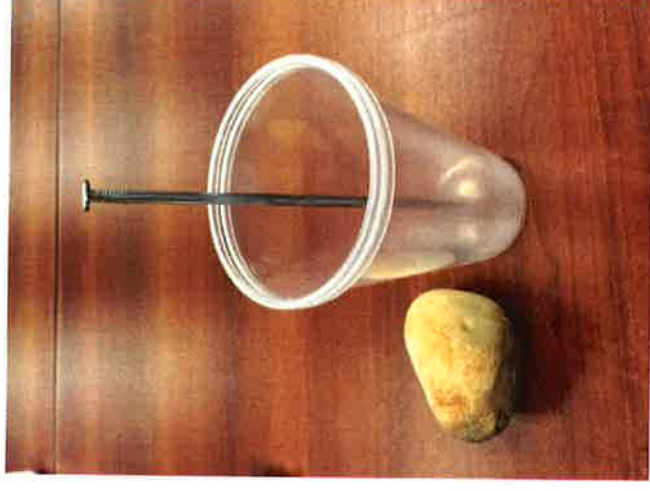
Attach the long hook Velcro strip to the top inside
surface of the plastic cup. (I found cutting this hook
Velcro into 3 equal pieces made it easier to attach!)



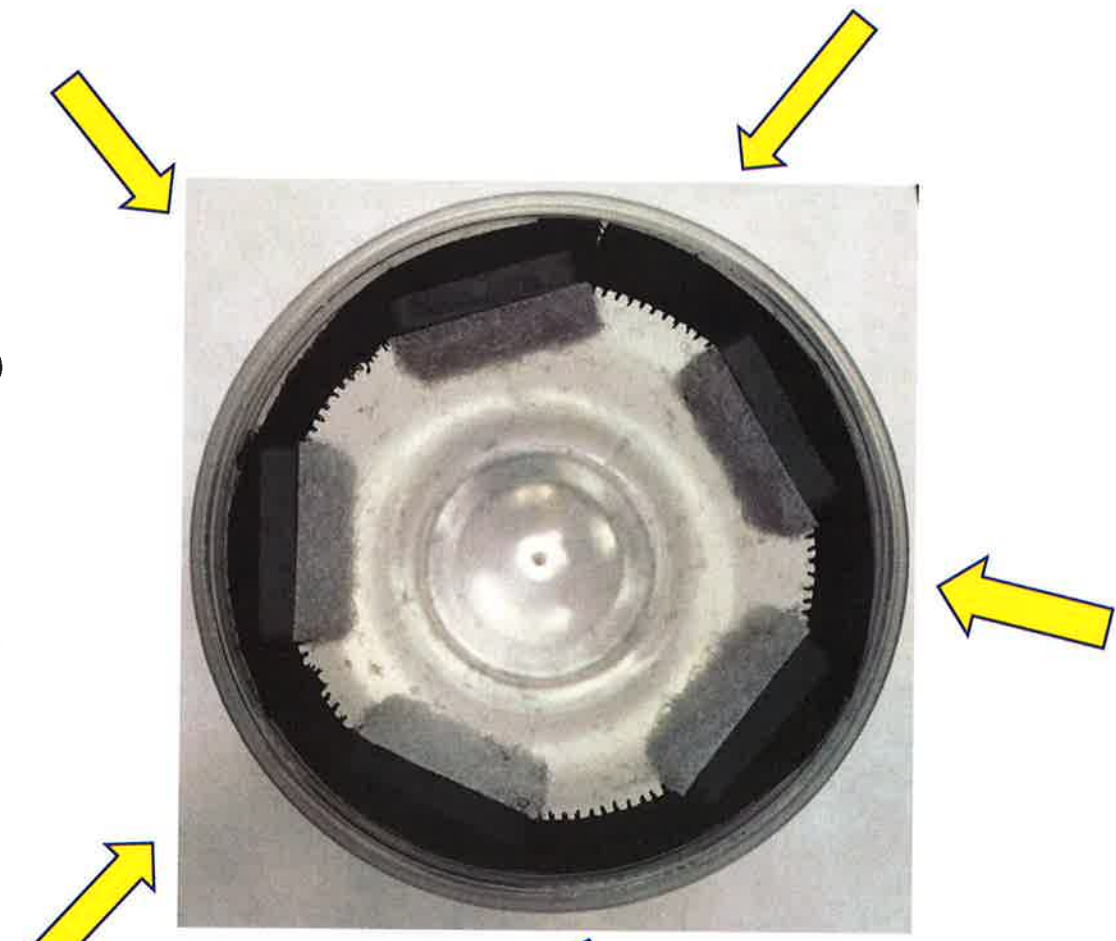
Place the cup on a thick piece of cardboard (or poster board) and using a long skinny pointed object (a very long nail or knitting needle), firmly push a small indentation/divot into the bottom of the plastic cup.

For optimal results, this indentation/divot should be as close to the center as possible!

This little indentation will keep the tip of the spinning pencil centered and prevent it from moving around.



Attach the five block magnets to the plastic cup by mating the 'hook' and 'loop' Velcro pieces together.

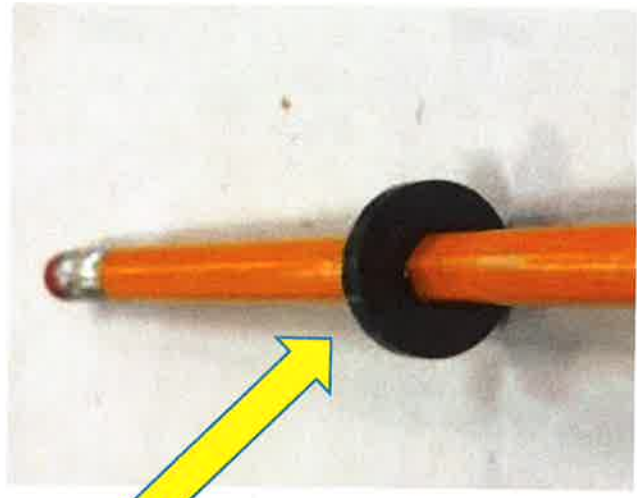


Orienting the magnets *horizontally* will minimize the magnetic 'dead' spots a little bit better than if you attached them *vertically*.

Version 1: *(the pencil magnet is slightly above the level of the cup magnets)*
Slide the ring 'donut' magnet onto the pencil with the painted white surface facing the eraser end.



White painted surface



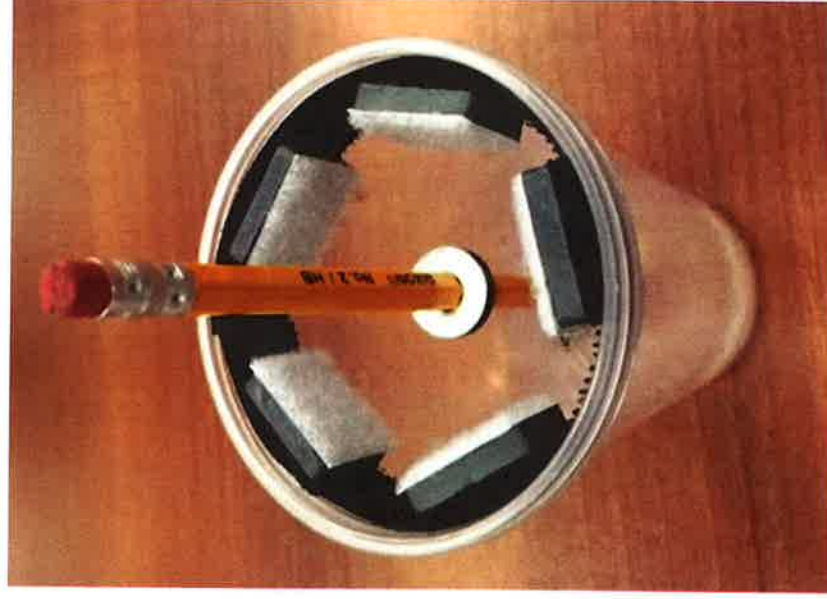
You will need to *experiment* to determine how far up or down the 'donut' magnet has to go so that the pencil will be balanced in the middle of the cup!



When the block magnets around the cup have their black Velcro loops facing the pencil and the black-colored surface of the pencil magnet is facing down (towards the pencil tip and FACING THE CUP MAGNETS), the pencil magnet will be balanced ABOVE the level of the block magnets. **The pencil remains centered due to the balanced repulsive forces from the cup magnets.**

Once the pencil is balanced and centereded in the middle of the cup, spin it gently!

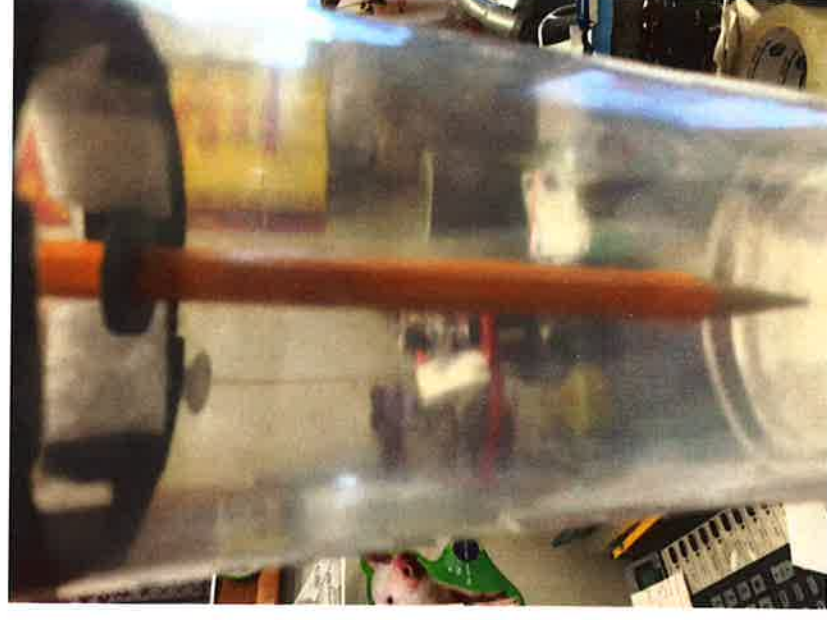
Version 2: *(Pencil magnet is located BELOW the cup magnets)* Flip all the block magnets so the white Velcro loops are facing the center of the cup. Place the pencil in the cup, what happened? *(The pencil magnet is attracted to one of the cup magnets!)* Experiment to find the best location for the 'donut' magnet on the pencil so that the pencil will remain balanced in the middle of the cup. **Hint:** Move the donut magnet down towards the tip of the pencil little by little and notice what happens!



In version 2 the 'donut' magnet appears to be slightly below the bottom of the cup magnets.

I like this version better for 2 reasons:

1. The pencil seems to be more stable.
2. The pencil appears to spin faster and much longer!



After successfully determining the optimal location for the 'donut' magnet, you may want to place some masking tape on both sides of the donut magnet to keep it from moving! (Very often, the donut magnet may shift up or down and when that happens the pencil will not stay balanced!



* If (and when) the tip of the pencil wears down, you will need to adjust the location of the donut magnet again!

Challenge #1:

Balance the pencil with 4 cup magnets.



Challenge #2:

Balance the pencil with ONLY 3 cup magnets.



Making this into a even more difficult challenge:

*** Make a 2nd set of cup magnets using ONLY one color of Velcro loops for both sides of the cup magnets.

Questions:

What happens when you gently push (or pull) the pencil slightly towards one of the magnets on the plastic cup?

Why is Version 2 more stable than version 1?

Can you determine the pole of a magnet located at the white velcro?

Why did the cup magnets have to be reversed in version 2?

What happens in each version if the ring 'donut' magnet moves towards the tip of the pencil (down)? Towards the eraser (up)?

What would happen if 2 of the cup magnets were white and 2 were black?

**For questions, comments and/or
suggestions please email:**

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