STEM: Experimental Design STEM Wars

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Statement of Problem: **The Millennium Falcon is stuck in the mud and needs to be lifted out without the use of the force.**

Knows:

1. What is Solenoid- **A solenoid is a cylindrical coil of wire acting as a magnet when carrying electric current.**
2. Cobalt- **a chemical element with symbol Co and atomic number 27. Like nickel, cobalt in the Earth's crust is found only in chemically combined form, save for small deposits found in alloys of natural meteoric iron. The atomic mass is 58.933195 ± 0.000005 u**

Unknowns:

1. Size of millennium falcon-Length: 34.75 meters, or 114.009186 feet Lando Calrissian, Han Solo, Gannis Ducain, have made special modifications that boosted the freighter's speed, shielding and firepower to impressive and downright illegal levels. This ship was made to travel many places, and also for battles.
2. Gravity on planet they landed on- will factor in with weight and magnetics on how forceful of an electromagnet will be needed to lift ship out of mud. We can assume the gravity is like that of earth because of the items found on the planet are similar to those found on earth; therefore, we will say the gravity of this planet is 9.81 m/s2.
3. Is the Millennium Falcon Magnet- Steel is magnetic, so durasteel can be magnetic
4. Weight of millennium falcon- 140 tons, Lando Calrissian, Han Solo, Gannis Ducain, have made special modifications that boosted the freighter's speed, shielding and firepower to impressive and downright illegal levels. This ship was made to travel many places, and also for battles. With all the modifications, the ship will either lose or gain more weight depending on if they take things out before they add more onto the ship.
5. Composition of Millennium Falcon-**The Millennium Falcon is made of durasteel and transparisteel, including military-grade armour, with duralloy welds and patches, all built on a substructure that is in some sense reinforced**

Science topics:

Magnetism: a physical phenomenon produced by the motion of electric charge, resulting in attractive and repulsive forces between objects.

Hypothesis: By adding more weight to the end of the pulley, the Millennium Falcon will increase its height off of the swamp.

Variables:

Constants:
The same pulleys
The same amount of string/vine
The same mass of the Millennium Falcon
The same electromagnet being used
The same hydro pump

Independent Variable: The amount of mass on the end of the pulley

Dependent Variable: The height of the Millennium Falcon out of the mud

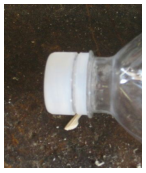
Materials Used:

- Electromagnet
  - Insulated Copper wire
  - Wire Cutters
  - Iron Nail
  - D Battery
  - Electrical Tape
- Three Pulleys
- Masking Tape
- Rope or Vines
- Plywood for platform
- Net
- Cobalt Rocks
- Water Pump
  - Water Bottle with Cap
  - Aluminum Can
  - Motor
  - Tubing
  - Wire
  - Plexiglas

    - Power Source (3 to 9 volts)
    - Hot Glue Gun
    - Scissors
    - Hacksaw
    - Drill
- Knife or Scissors

Procedure:

1. Make an electromagnet to lift the Millennium Falcon.
2. Take the copper wire and wire cutters. Use the wire strippers to remove some of the insulation from each end of the copper wire.
3. Wrap the copper wire around the nail. Make sure you wrap the wire in one direction, as the direction of a magnetic field depends on the direction of the electric current creating it. If you wrap some of the copper wire in one direction and some of the wire in the other direction, the magnetic fields from the different sections with cancel each other out. The more copper wire wrapped around the nail, the stronger the electromagnet will be, but leave enough wire unwound so the battery can be attached.
4. Attach one end of the copper wire with the insulation removed to the positive terminal of the battery. Then, attach the other end of the copper wire with the insulation removed to the negative terminal of the battery. It does not matter which end of the copper wire is attached to each certain terminal, it will just reverse the poles. If the connections are correct the electromagnet is now working.
5. The more wire your magnet has, the stronger it will be although the further the wire is from the center of the nail the less effective it will be.

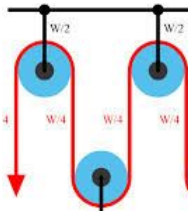



6. Make a water pump to empty the swamp under the Millennium Falcon.
7. Take the water bottle and cut off the top neck of the bottle. Drill a small hole in the center of the water bottle cap for the motor. Drill another hole into the side of the neck of the water bottle for the tubing.


8. Next take the aluminum can and cut a 2 ½ in strip of metal. Fold it in half and then bend at 90 degrees until the strip looks like a plus sign.
9. Hot glue the motor to the bottle cap. Check to make sure it spins. Screw the cap onto the neck after the glue is dry.


10. Cut the plexiglas into a square shape like the picture to the left. Drill a hole to place a tube in place. Glue the plexiglas to the top of the pump.
11. Connect to a 3 to 9 volt power supply. Your water pump is now working.
12. Attach a pulley 80.0 cm off the ground to a strong branch on a tree.
13. Using vines, tie a knot around the electromagnet.
14. Take the end of the vine not attached to the electromagnet and push it through a pulley.

15. Taking a step back, a simple pulley should have made with an electromagnet on one side and a hanging vine of the other.
16. Next, attach a pulley upside down on a branch at 30.6 cm.
17. Then attach another pulley right side up at the same height (80.0 cm) as the original pulley in step 6.



18. The pulley system should look like the picture to the left.
19. On the outside of the tree, build a platform using plywood 2 feet lower than the pulley. Make sure anything dropped from the platform can fall directly to the ground. Allow the base of the platform to be dropped out of the why allowing anything on top of the platform to fall to the ground.
20. Take a net and place it on top of the platform
21. Place cobalt rocks on top of the net. When 6,350.29 grams of rocks are placed on the net. Close and tie the net closed with vines. Attach the vines around the net to the vines attached to the pulleys.
22. Attach Han Solenoid and the electromagnet to the top of the Millennium Falcon.
23. Have Chewbeaker pull the platform out from under the cobalt rocks. Allowing the rocks to fall to the ground and lifting the Millennium Falcon.
24. Use the water pump to empty the swamp that is under the Millennium Falcon.
25. After the swap is dry, cut open the net from the side and slowly remove one cobalt rock at a time. Lowering the Millennium Falcon down slowly.

Data:

Qualitative Observations:

The poles (trees) were not completely steady. They moved slightly from side to side.
The rope on the pulley was a little too long. It could have changed the data.
The weights in the bag did not sit nicely on the ledge, possibly causing a change to the data.

Table:

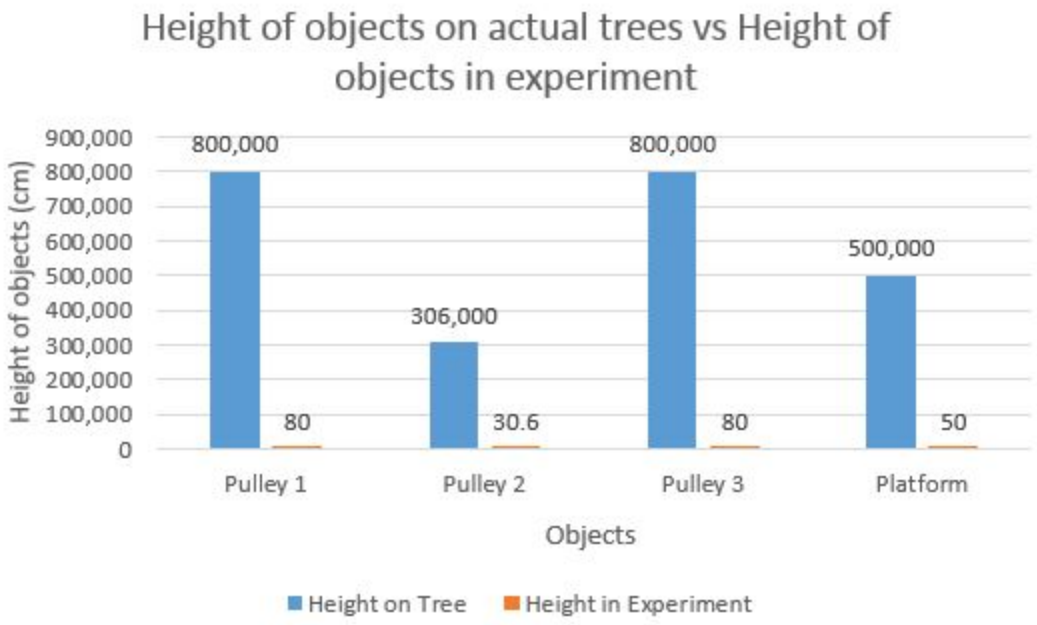
Table 1			
Object	Height on tree	Scale	Height in experiment
Pulley 1	800,000 cm 8,000 m	1/10,000	80.0 cm 8.0 m
Pulley 2	306,000 cm 3,060 m	1/10,000	30.6 cm
Pulley 3	800,000 cm 8,000 m	1/10,000	80.0 cm
Platform	500,000 cm 5,000 m	1/10,000	50.0 cm

Table 2						
Pulley	Distance from Pulley 1 on tree	Scale	Distance from Pulley 1 in experiment	Distance from Pulley 2 on tree	Scale	Distance from Pulley 2 in experiment
Pulley 2	5,210 cm 52.1m	1/100	52.1 cm	0.0 cm	1/10	0.0 cm
Pulley 3	10,420cm 104.2m	1/10	104.2 cm	5,210 cm 52.1 m	1/10	52.1 cm

Table 3			
Object	Mass in experiment	Scale	Actually Mass
Millennium Falcon paper clip	1.27 g 1g	1/100,000,000	140 tons 127,005,864 g
Cobalt Rocks	0.635029 g	1/100,000,000	69.99996495 tons 63,502,900 g

Table 4		
	Mass of cobalt rocks	Height of Millennium Falcon off of lab bench (cm)
Trial 1	50 g	15.6 cm
Trial 2	100 g	14.3 cm
Trial 3	250 g	14.6 cn
Trial 4	500 g	19.6 cm
Trial 5	1,000 g	21.8 cm

Graph:



Statistics:

Range of Data: 21.8 cm - 14.3 cm = 7.5 cm

Mean:

$$\frac{15.6cm + 14.3cm + 14.6cm + 19.6cm + 21.8cm}{5} = 17.2\ cm$$

Median: ~~14.3 cm, 14.6 cm~~, 15.6 cm, ~~19.6 cm, 21.8 cm~~ = 15.6 cm

Mode: None

Analysis of Results:

Table one stands for the heights of everything. The three pulleys and the platform. The table is comparing the actual height to the height in the experiment. Table two represents the three pulleys and the distance between all of the three pulleys. Table three stands for the Millennium Falcon and the cobalt rocks. The table shows the actual mass of the two objects and the mass that it was scaled down to in the experiment. Table four represents the five trials. The mass of the cobalt used and then in return how far the electromagnet raised. The first graph represents the height of the objects in real life and the height in the experiment. Graph two stands for the mass of the cobalt rocks and in return how high the electromagnet raised off of the ground.

Possible Experimental Errors:

There were many experimental errors in this lab. One error was that the poles that were used did not stand completely upright. The poles were a little unstable causing them to bend to the sides slightly. This could have affected the data because the poles could have been in a different location for each trial. A second experimental error that occurred was the rope for the pulley was very long. This excess rope caused the pulley to have some slack. This could have caused the data to change as the weight would have to pull the extra rope before pulling on the paper clip (Millennium Falcon). This was caught during the experiment once or twice and was corrected at those times. However, it could have happened without anyone knowing causing the data to be not accurate. The third and final error that happened in the lab was with the weights. Besides the 500 gram weight and 1,000 gram weight, the weights were in a plastic bag that acted as a net. The net did not sit very nicely on the platform. This caused the net to roll off of the platform pulling the electromagnet before we were ready. The weights were also just placed in the bag. Some of the bags had all of the small weights on one side, while others had the weights spread out in the bag. This uneven spread of weights in the bags, could have changed the data due to different bags pulling the paper clip (Millennium Falcon) differently.

Conclusion:

In this lab, we created an electromagnet for Han Solenoid and Chewbeaker to build to lift the Millennium Falcon out of the swamp. Han Solenoid will be used to increase the magnetism of the magnet to support the mass of the Millennium Falcon. While Han Solenoid is stuck to the top of the Millennium Falcon, Chewbeaker will have used different masses of cobalt rocks with a three-pulley-system to successfully lift the Millennium Falcon out of the swamp. Five different masses were tested. The different masses were 50g, 100g, 250g, 500g, and 1,000g. The 50g mass lifted the Millennium Falcon 15.6 cm off of the swamp. The 100g mass lifted the Millennium Falcon 14.3 cm off of the swamp. When Chewbeaker used the 250g mass the ship came 14.6 cm off of the swamp. The 500g mass lifted the Millennium Falcon 19.6 cm off of the swamp. The final mass, 1,000g, lifted the ship 21.8cm off of the swamp. After lifting the ship off of the swamp, Chewbeaker used the hydro pump to drain water out of the swamp so the Millenium Falcon can be lowered to the solid ground. In conclusion, Chewbeaker and Han Solenoid were able to get the Millenium Falcon off of the swamp.