Experiment Format

Name: Zeo Hattori Date:4/18/15

Title: Solar Cars

Part 1. Question:

What do I want to find out?

How does the affect the friction?

Part 2. Hypothesis:

A hypothesis is a scientific prediction

“If…, then…, because…,” format

- If we place the a platform that has a low coefficient of friction then we can increase the speed,because the friction on the wheels will decrease.
- Guide: http://www.miniscience.com/kits/CAR_SOLAR/

Part 3. Variables:

A. **Independent variable**. The position of the motor
B. **Dependent variable**. Friction (measuring the speed)
C. **Constants**: The sunlight, The same design (fleshed out: for example: axles determined by the roll down test

   Teflon has a very low coefficient of friction and is very common with pots and pan.

Part 4. Procedure:

This is what I will do

- Build one solar car according to the specification of the constants described above.
- Note the material of the platform (cm?)
- Test it using a constant source of light:
- Specify the number of trials for each step
- **Method 3: Tilted plane**
- Place a block on a tilted plane and increase the angle of tilt until the block begins to slide. The tangent of the tilting angle just found is the so called "friction angle". This angle is related to the coefficient of friction.

Part 5. Materials:

Here is what I will need

- Cut and paste from the manual.

Background Research

Solar Car Planning Guide (09) Some of the most important things to consider when designing and building a solar car are. 1. Reduce all friction as much as you can, especially around the axles, wheels, and gears. 2. Make your car as light as it can be and still carry the solar panel, motor and battery pack. 3. Make sure the axels are mounted straight so that the car runs straight, otherwise it will bump into the track rails and get slowed down. 4. The car must have the axles parallel and the solar panel mounted such that everything is balanced and the power wheels (The ones attached to the motor) have good traction. CHASSIS (The body of the car made of Balsa Wood) 1. Weight vs. Strength: It is easier to mount axles and get your car to roll straight on a longer wider chassis, but it will be heavier. One solution is to cut away all parts of the chassis that are not needed. (Be careful not to cut away too much though). Another solution is to create a narrow or short chassis, but getting it to run in a straight line will be more difficult. 2. Space: You must have a space to put a AAA battery holder (2.5 cm X 5 cm) if it rains on the race day. Plan for this carefully because you want it to be near the solar panel leads, so that you can avoid long wires that will add weight. You must also have a place for team number stickers on race day (2 cm x 3 cm). 3. Motor Mount: Mounting the motor on the outside of the chassis is easier than on the inside. Not only is it easier to build, but also it will be easier to change gears if you choose to. If the motor is mounted on the outside, there should be less friction, since the turning gear is only in contact with the chassis on one side. 4. Aerodynamic design and balance. Wind and air friction can be a factor in slowing down your car (especially in an outdoor race). However the sun is not directly overhead during the race. You will need to decide whether you will build a lower profile car that reduces drag or attach a solar panel, which is angled more directly toward the sun (or an adjustable solar panel). From past winners, lower slung cars seem to have the advantage over cars that have the solar panel at a larger angle. 5. Connecting the Axels: Before you do any cutting of your balsa wood, draw a series of parallel lines on your chassis using the T squares that can be used in order to line up and mount the axels so that the car will run straight. (Al demonstrates this in one of the videos) WHEEL AND AXLES 1. Axles: The axels are the aluminum rods that attach to the wheels and the gear. The axels spin when the motor gear (pinion gear) spins the driving gear. The axels must be straight and parallel or your car will wander and be slowed down by friction with track guides. This is perhaps the most important factor in designing and building your car. Axles bend very easily and do not work well if bent. Use great care when handling and attaching wheels and axles. (No big hammers!) 2. Bearing Choices: The bearings are the pieces of tubing that attach to the chassis and contain the axel and allow it to spin. A full piece of brass tubing running all the way across the chassis is easier to mount in a straight line, but it is heavy. You can also choose to use two small piece of brass tubing on each side of the chassis or you can use the pre cut plastic bearings, but these are harder to line up. In either case the axle should slip through and spin with little or no scraping noise if the bearings are aligned correctly. You may want to use the round file to make sure there are no sharp edges in the bearings. The tubing of the bearing should extend a little beyond the edge of the chassis so that the wheels and gears do not make contact with the chassis (too much friction). Many students also use an extra washer or a tiny extra bearing made out of a piece of brass tubing to be sure that the wheels spin without rubbing against the chassis. You can also chose to use the adjustable bearing system described in one of Al's videos. 3. Wheels: The wheels you choose may be narrow or wide and some even contain a gear. In any case the wheels should never touch the chassis. Also make sure to keep glue away from the wheels axles and bearings. Be sure the wheel surface that will be touching the ground is smooth as well. You may choose to try tires on some or all of your wheels to add traction (these can be made out of slices of bicycle inner tubes.) 4. The roll down test will be your first chance to see whether your axels are straight and if your car rolls straight and rolls far to show it has little friction in the wheels and axels to slow it down. GEARS, MOTOR AND BATTERY 1. Multiple gear combinations may increase your overall acceleration and speed but they can be prone to problems at race time. 2. Most cars will be fastest with a gear ratio of around 2:1 or 2.5:1. 3. Be sure your gears aren't loose on the axle. If the motor turns the gears but the car either does not run or runs very slowly with a lot of noise, it may be that the gear needs to be glued on better. Be careful not to have too much extra glue though. 4. Be very careful to keep glue and paint away from the gear teeth and all other moving parts. (We have also had trouble with students dragging strings of glue across the room and making lots of messes that kept the custodians way too busy! Be sure that your glue has detached from the car before you walk away or you will be scrubbing the floors) 5. Think about the placement of the motor with respect to the solar panel leads and the gears. You want your wires to be able to reach, but not to add too much extra weight. Be very careful with the solar panel leads. Make sure they are taped to the solar panel. (If they break off the $35 solar panel is useless) 9. The pinion gear (the one attached to the motor shaft) and the axle gear (the gear attached to the axel) must fit together so that they move smoothly. If they are too loose they will make a rattling noise because the teeth don't connect well. If they are too tight, the car will have trouble getting started. SOLAR PANEL 1. Determine whether you want your solar panel to be mounted in one position only (with Velcro) or moveable so that it can adjust to the angle of the sun depending on the race time. If it is to be moveable, decide in which direction and how much. Use the sun angle finder website link on my website to calculate the angle of the sun that date. (We are at 44 latitude and 123 longitude) 2. The race is run from north to south outside on our track if it's sunny and inside on roofing paper tracks if it rains on race day. 3. Placing the solar panel at an angle of about 15 degrees seems to work well even though it is a little more than 90 degrees to the sun.

Experiment Format (continued)

NOTE: Do this page WHILE YOU PERFORM YOUR EXPERIMENT, except prepare the blank data table ahead of time. Fill in the data table as you perform the experiment.

Part 6. Lab Set-Up:

This is a labeled sketch of your experiment

- Sketch large enough that your drawing can be easily understood
- Use enough detail for your drawing to be understood
- Label the important parts of your drawing
- If necessary, note the sequence ('before' and 'after', for example)

Part 7. Data Table:

Data are the bits of information you measure during your experiment

- Keep track of the data on a neat, organized table
- Name the measured variables, and give units
- Give totals or averages where appropriate
- Count or measure accurately
- Make appropriate records, such as charts, tables, bar graphs or line graphs

Part 8. Observations:

Use complete sentences to describe what you noticed during your experiment

- Give specific, relevant details
- Avoid opinions, feelings or generalizations

https://www.energysage.com/solar/cost-benefit/solar-incentives-and-rebates

Experiment Format (continued)

NOTE: Do this page AFTER you have performed your experiment. It's fun to actually do the test, but the learning comes in reflecting afterwards about what happened.

Part 9. Summary:

Use words to tell what the data mean

- Use complete sentences that show the main ideas of the data
- Describe any trends or patterns
- Use scientific and math vocabulary wherever it is appropriate

Part 10. Conclusion:

Did my data support my hypothesis?

- Use "The data supported/didn't support [choose one] my hypothesis"
- Don't say "I was right", "I was wrong", or "This proves…" (one experiment doesn't prove anything!
- If the data are unclear, state that more research is needed, and say what you should do next

Part 11. Big Idea:

What did I learn?

- How is what I learned related to a larger idea in science?
- How is what I learned related to something else I know about the world?

Part 12. Reflection:

What do I think about my experiment?

- Use complete sentences
- Did anything happen that you didn't expect?
- Were there any possible sources of error in your data?
- This is the section to put in any feelings or questions you have about what you did

Part 13. Next Testable Question:

What related experiment would I try next?

- Use complete sentences
- Use a question mark
- Your question must be related to this experiment in some way
- Your question must be testable

Background Paper: Three pages : **must include a bibliography with at least 3 references. See other side for correct format.**

Describe the Independent detail:

Car design in general and the importance of the motor and its placement

Dependent variable :

What is friction?

How is it measured?

What affects it?

You will find friction everywhere that objects come into contact with each other. The force acts in the oppositedirection to the way an object wants to slide. If a car needs to stop at a stop sign, it slows because of the friction between the brakes and the wheels. If you run down the sidewalk and stop quickly, you can stop because of the friction between your shoes and the cement.

Measures of friction are based on the type of materials that are in contact. Concrete on concrete has a very high **coefficient of friction**. That coefficient is a measure of how easily one object moves in relationship to another. When you have a high coefficient of friction, you have a lot of friction between the materials. Concrete on concrete has a very high coefficient, and Teflon on most things has a very low coefficient. **Teflon** is used on surfaces where we don't want things to stick; such as pots and pans.

Scientists have discovered that there is even less friction in your joints than in Teflon! It is one more example at how efficient living organisms can be.