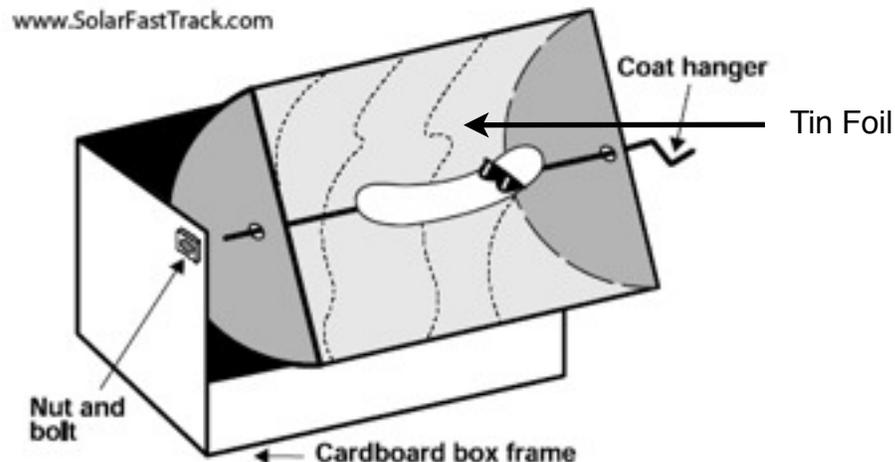


**Determining the amount of heat produced by a parabolic collector to then supply heat and electricity to the houses in Chestermere**

**Abstract:**

The parabolic collector was built by first assembling the trough made out of two semi circles attached by a piece of poster paper with tin foil on it. It was then set inside the cardboard box stand and the coat hanger was put through it. "Build a Solar Hot Dog Cooker." *Instructables.com*. Web. 8 Jan. 2016. By setting up this parabolic collector it allows for testing to be done to see if it is beneficial to set one up to supply energy and heat to the houses in Chestermere. Some errors in the lab were having an inaccurate focal point, not having clear clear skies and doing the lab on an extremely hot day. If the parabolic collector works efficiently then the hot dog will cook because of the sun reflecting off the tin foil and back at the hot dog which is on the focal line. The parabolic collector that was used to cook the hot dogs would be a good way to supply power to home in Chestermere. By using a scaled up collector to heat the houses and supply power to Chestermere it is a green and efficient way to supply energy. Since there is an unlimited amount of sunlight doing it will never run and out and is a reliable way to collect energy.

**Design:**



**Background:**

Solar power is the energy gathered by the sun's rays in order to produce heat and electricity. "What Is Solar Power? - Definition from WhatIs.com." *WhatIs.com*. Web. 8 Jan. 2016. A parabolic collector is a solar trough that is curved along one side and straight on the other. The curved side uses mirrors to focus the sunlight on the focal line which produces heat. In other cases a tube runs across the collector at the focal line and waits to be heated. The light collected by the sun is harnessed and focused on the tube to heat the liquid inside to a high temperature. The fluid that is heated then has many purposes such as generating electricity and heating homes. *Wikipedia*. Wikimedia Foundation. Web. 9 Jan. 2016.

Although the sun is 150 million kilometers away the rays it emits is very strong. The sun provides enough energy to the earth in one minute to create enough energy supply for one year. As the fluid in the pipes moves down the collector the liquid increases. When the heated liquid gets to the end of the pipe it is then turned into steam which then powers turbines to create electricity. The electricity created from the turbines is then used to supple power to houses and other buildings."Parabolic Solar Collectors." *Parabolic Solar Collectors*. Web. 8 Jan. 2016.

### **Purpose:**

The purpose of this lab was to determine an appropriate location to put up a parabolic collector in order to provide heat and electricity to houses.

### **Hypothesis:**

If the parabolic collector works efficiently then the hot dog will cook because of the sun reflecting off the tin foil and back at the hot dog which is on the focal line.

### **Variables:**

Controlled:

- Hot dogs/smokies used
- Distance away from the foil the hot dog was (focal line)
- Place in Chestermere the collector was placed
- Time the hot dog or smoky was rotated in each trial
- Angle of parabolic collector (Directed on focal line)
- Temperature hot dog is cooked to (140 degrees Fahrenheit)
- Temperature smoky is cooked to (160 degrees Fahrenheit)

Manipulated:

- Position of semi circle trough facing the sun

Responding:

- Time hot dog took to cook
- Amount of heat produced

### **Materials:**

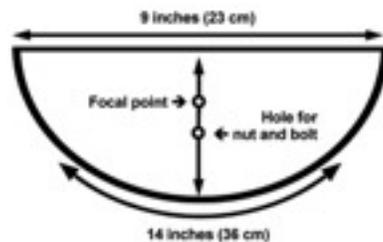
- 14 inch sheet of tin foil
- 14 inch by 11 inch poster board
- 1 wire coat hanger that is unpainted
- Masking tape
- 2 boxes, once used as the stand the other as the collector
- 2 nuts
- 2 bolts

### **Procedure:**

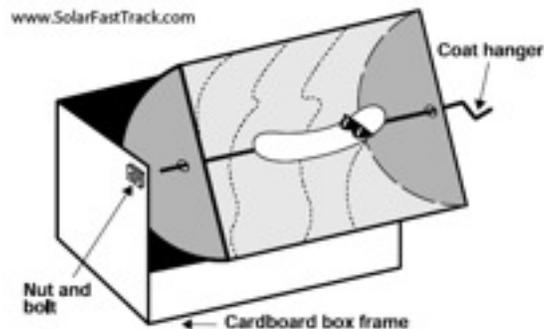
1. The cardboard was cut into a semi circle to make two identical ends that will be attached to the reflective foil. The length of the semi circle was 9 inches across and the curved part was 14 inches.

2. The tin foil was taped to the poster paper.
3. The poster paper was curved with the tin foil taped to it and was then attached to the curved ends of the cardboard with tape.
4. The semi circle trough was attached to the other box using the nuts and bolts. It was ensured that the semi circle trough was attached to the base and stayed in one place but was still able to move up and down.
5. Holes at each end of the semi circles were made to create the focal point.
6. The coat hanger was straightened out and bent at one end to create a handle to spin the hot dog as it cooks.
7. The coat hanger went through the hole that was made on one side. The hot dog was then put on the hanger and the coat hanger was pushed through and attached to the hole on the other side.
8. Once the device was assembled, the solar cooker was placed outside in direct sunlight.
9. Once the cooker was placed in the sunlight, it was made sure the part with the reflective tin foil faced the sun.
10. The part with the foil was adjusted by moving it up and down until the reflective foil focused the sunlight onto the hot dog.
11. Then waited until the hot dog was perfectly cooked and enjoyed.
12. Steps 7-11 were repeated adjusting the angle of the trough to see which angle was most efficient.

**Diagram:**



This image above shows how the semi circles looked once they were cut into the correct dimensions.



This image above shows how the hot dog cooker looked after it was completely assembled.

**Data:**

Table 1: length of time it took to cook the hot dog at different times throughout the day in Chestermere

Trial	Angle of Collector	Time of day	Time to Cook (Hot dog)	Rotation Times	Temperature of hot dog
1	Measured focal line	12:00pm	6 minutes 53 seconds	2 minutes	140 °F
2	Measured focal line	12:15pm	6 minutes 3 seconds	2 minutes	140 °F
3	Measured focal line	12:30pm	5 minutes 46 seconds	2 minutes	140 °F

Table 2: length of time it took to cook the smokey at different times throughout the day in Chestermere

Trial	Angle of Collector	Time of day	Time to Cook (Smoky)	Rotation Times	Temperature of hot dog
1	Measured focal line	12:45pm	8minutes 47 seconds	3 minutes	160 °F
2	Measured focal line	1:00pm	9 minutes 12 seconds	3 minutes	160 °F
3	Measured focal line	1:15pm	9 minutes 53 seconds	3 minutes	160 °F

**Calculations:**

Average time to cook hot dog:

$$6\text{min}=60\text{sec}/1\text{min}=6\times 60=360$$

$$6\text{min}=60\text{sec}/1\text{min}=6\times 60=360$$

$$5\text{min}=60\text{sec}/1\text{min}=5\times 60=300$$

$$360+360+300=1020$$

$$1020+53+3+46=1122$$

$$1122/3=374$$

$$374/60=6\text{ minutes } 23\text{ seconds}$$

**Average cook time:** 6 minutes 23 seconds

Average time to cook smoky:  
 $8\text{min}=60\text{ sec}/1\text{min}=8\times 60=480$   
 $9\text{min}=60\text{ sec}/1\text{min}=9\times 60=540$   
 $9\text{min}=60\text{ sec}/1\text{min}=9\times 60=540$   
 $540+540+480=1470$   
 $1470+47+12+53=1582$   
 $1582/3=527.33$   
 $527.33/60=8\text{ minutes }78\text{ seconds}$

$78/60=1.3$   
 $0.3\times 60=18$

**Average cook time:** 9 minutes 18 seconds

### **Analysis:**

This experiment was tested with both regular hot dogs and the bigger smokies. Since sunlight was being used there is no sound of the hot dog cooking and it takes a long time for anything to be seen. At first it took a while to figure out when the appropriate time was to turn the rod because if you wait too long the hot dog will blister. Once it was figured out that the hot dog takes approximately 6 minutes to cook completely. After it was figured out that it took 6 minutes, figuring out when to rotate it so it didn't burn was more simple. The regular hot dog was turned about every 2 minutes to evenly cook the hot dog. This was different with the bigger smokies. It was found that it took between 8 to 10 minutes to cook the smokies and that it should be rotated roughly every 3 minutes. Since the sun moves through the sky a little bit during each trial the intensity of the sun was slightly different for each. This has a direct effect on the length of time it takes to cook a hot dog.

### **Conclusion:**

According to the evidence, the parabolic collector used to cook the hot dogs would be beneficial in using it to heat and supply energy to homes. Using a scaled up collector to heat the houses and supply power to Chestermere residents in an environmentally friendly way to get power. Based on the results the hypothesis was correct and the hotdog did cook due to the reflectiveness of the tin foil. The errors in the lab were an inaccurate focal point, non clear skies and doing the lab on a hot day. These are errors because a focal point has the most heat so having it not be accurate causes issues in the results. By having clouds in the sky interrupts the amount of time in which the parabolic collector receives direct sunlight. Lastly, by doing the lab on a hot day gives inaccurate readings since the temperature in Chestermere is usually not that hot.

### **Extension:**

By testing the appropriate position to place a parabolic collector to cook a hot dog can then be used to create a collector that can be used to create energy. By using a parabolic collector to create energy it reduces the amount of pollution created when using coal or oil. Since a parabolic collector uses the sun's rays to harness energy it is good for the environment. The hot dog cooker is a simple way to ensure a good position

of the collector without spending a lot of money on a collector that might not work. By testing the position of the parabolic solar collector before permanently putting one up allows for the perfect angle to be determined and for the most energy to be harnessed.

"Hands-on Activity: Cooking with the Sun." *Cooking with the Sun*. Web. 7 Jan. 2016.

### **Error Analysis:**

In order to get the best results from this lab, ensure that the skies are clear. Since there was some clouds in the sky that intermittently covered the sun, it caused the results to vary. Depending on how long the clouds were covering the sun during each trial will effect how long the hot dog takes to cook. To fix this there are multiple things that can be done. One of which is knowing what clouds actually block the sun and what they look like. High clouds are created at 16 000 to 43 00 feet in the air, since these clouds are mostly made out of ice crystals they do not block the sun. Have these clouds during the experiment will no have any effect on the results. "Predicting the Weather with Clouds."

*Instructables.com*. Web. 8 Jan. 2016. By miss calculating the focal point it causes the strongest point of the reflection of the sun to not hit the hot dog which is a loss in energy. To ensure that the optimal amount of energy is gathered calculate the focal point exactly. This is done by using the formula  $y = x^2/4p$  where p represents the focal point. By using this foal point it will show exactly where the most heat is being reflected from the sun and then can be turned into energy. You can find your own focal point by choosing the value of p and then making x go up by 1 to solve for y. If this is the way you do it the x and y values give the shape for your parabola. "Solar Reflector Science Projects." *Solar Reflector Science Projects*. Web. 10 Jan. 2016. The last error in this lab was choosing a day that was high in temperature. By choosing a day that is hotter than the average day in Chestermere the hot dogs cooked will cook faster than if it was an average temperature. In order to see an accurate reading of how much heat is produced the experiment would need to be done on a day that was about 4 degrees Celsius. This would show how much heat was given off on an average day to help better the understanding of how a parabolic collector works and whether or not one should be set up in Chestermere. The reason this is important is because it needs to be tested whether the parabolic collector will get hot enough in Chestermere during its average temperature days." "Weather Statistics for Chestermere." *Yr.no*. Web. 8 Jan. 2016.

### **Sources:**

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