SCIENCE LAB PREP WORK

LAB DATE: 3/15/07

LAB TITLE: Ice Melting

PURPOSE:

To answer the following questions –

1. Will Greenland's melting process be similar to melting process of the ice-cap on North America at the end of the last ice age?

I hypothesize that the melting process of Greenland and the melting process of the North American ice cap will be very different.

2. What is the difference between land-based ice melting and sea-based ice melting?

I hypothesize that the difference between land base ice and sea-based ice is sea-based ice melts faster because when the water is exposed to the sunlight it absorbs 90% of the heat, and melts the ice surrounding it.

3. What are the melting possibilities and the melting results of Greenland?

I hypothesize that there are two melting possibilities: Greenland can either melt from the outside to the center or from the center to the outside. If Greenland melted from the outside to the center it would create more water slowly, and the rise in sea level would be gradual. If Greenland melted from the center to the outside it would create a large pool in the center and eventually would break open and million of gallons of freshwater would come rushing out, creating a sudden increase in sea levels world wide.

MATERIALS & EQUIPMENT:

- Water
- 3 Cookie trays
- Freezer
- 3 pieces of paper
- Pen
- 1 Ten gallon fish tank
- 1 ½ pounds of salt
- Knife
- Lamp
- Sponge
- Towel
- Large gravel
- Fine bits of gravel
- Sand
- Soil
- Spatula
- Cup
- Two Thermometers
- Scale that measures pounds
- Tape

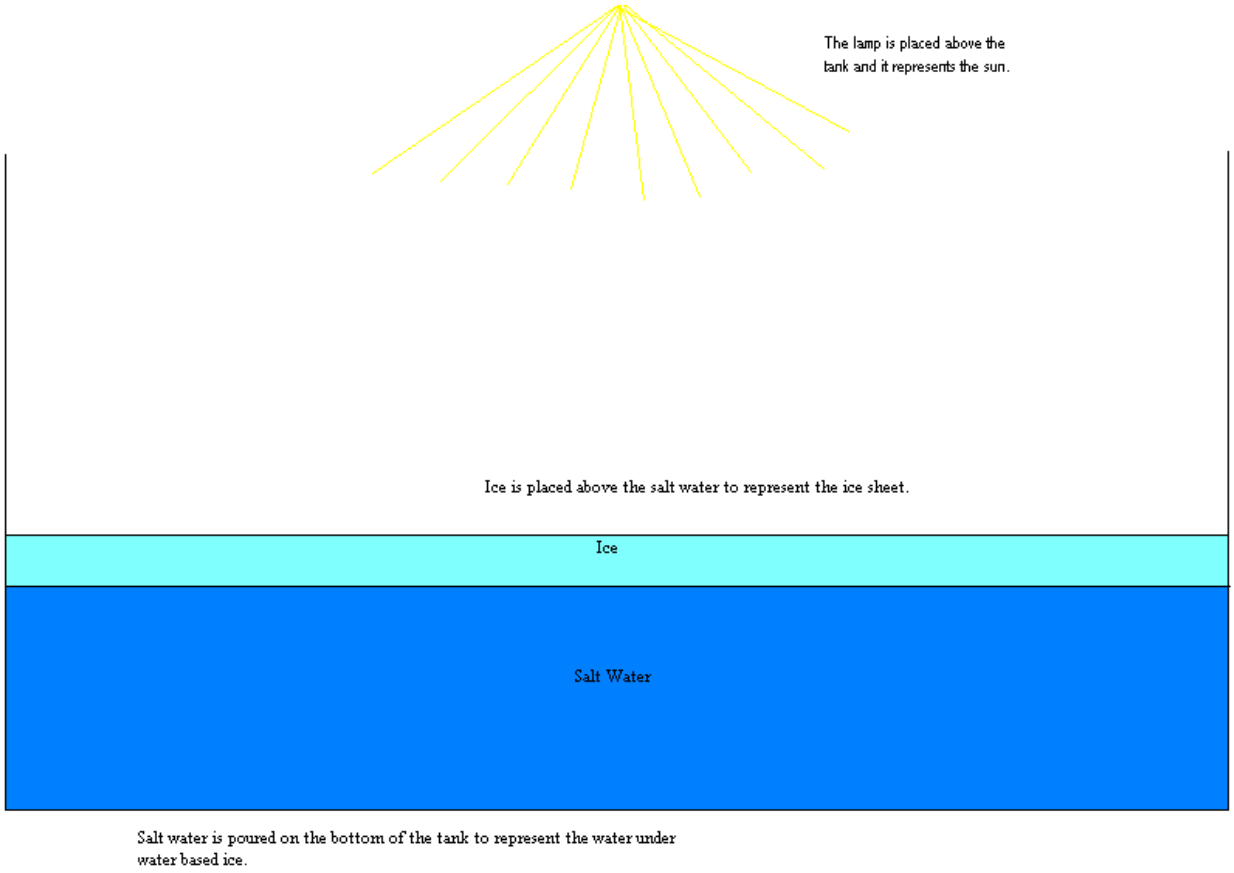
PROCEDURE:

Step One (Do this a full day before doing the lab)

1. Pour water from the sink into the cup.
2. Place the cookie tray into the freezer.
3. Using the cup transport the water from the sink to the cookie tray.
4. Continue this process until the cookie tray is around ¾ full.
5. Place a note on the cookie tray stating: Science Experiment please don't move. Thank You.
6. Repeat this process two more times. In two different freezers. If they can fit put more than one tray into a freezer.

Step Two (Water based ice)

1. Tape one thermometer on bottom inside of the tank.
2. Fill the ten-gallon fish tank with water until it appears 1/3rd full.
3. Add 5/6th of a pound of salt to the water and stir until all the salt appears to have dissolved.
4. Remove the frozen ice from the freezer and carefully use a knife to separate the ice from the tray. If needed cut the ice with the knife so that it can fit into the tank. This may be dangerous.
5. Place ice into the water.
6. Place lamp around four inches above the top of the tank, but don't turn it on.
7. This is what it should look like from a side view:

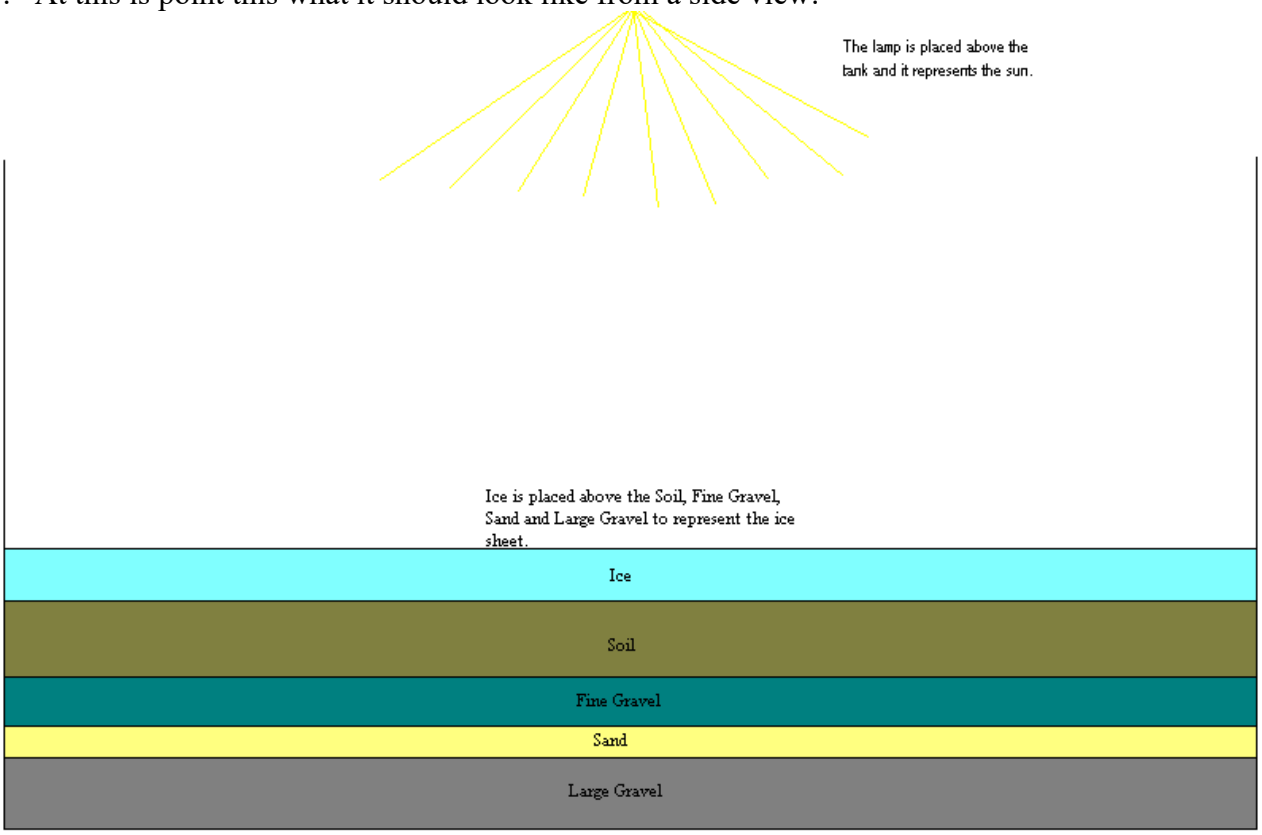


8. Tape the thermometer onto the inside of the tank above the ice.
9. Turn the light on.
10. Record your observations at the end of every five minutes until the ice is completely melted. At the end of every minute record the temperature of both thermometers in the tank. This may take at the most 1-½ hours.
11. Dispose of salt water.
12. Wash out tank thoroughly.

Step Three (Land based ice)

1. Add all of the large gravel to the fish tank.
2. Add all of the sand into the tank above the gravel; smooth it out with the spatula.
3. Add all of the fine bits of gravel to the fish tank, even it out with the spatula.
4. Add around half of the soil to the tank and spread it out evenly.
5. Dig a hole in the soil and place the thermometer into it.
6. Remove the frozen ice from the freezer and carefully use a knife to separate the ice from the tray. If needed cut the ice so that it can fit into the tank.
7. Place ice into the fish tank.

8. Place lamp around four inches above the top of the tank, but don't turn it on.
9. At this is point this what it should look like from a side view:



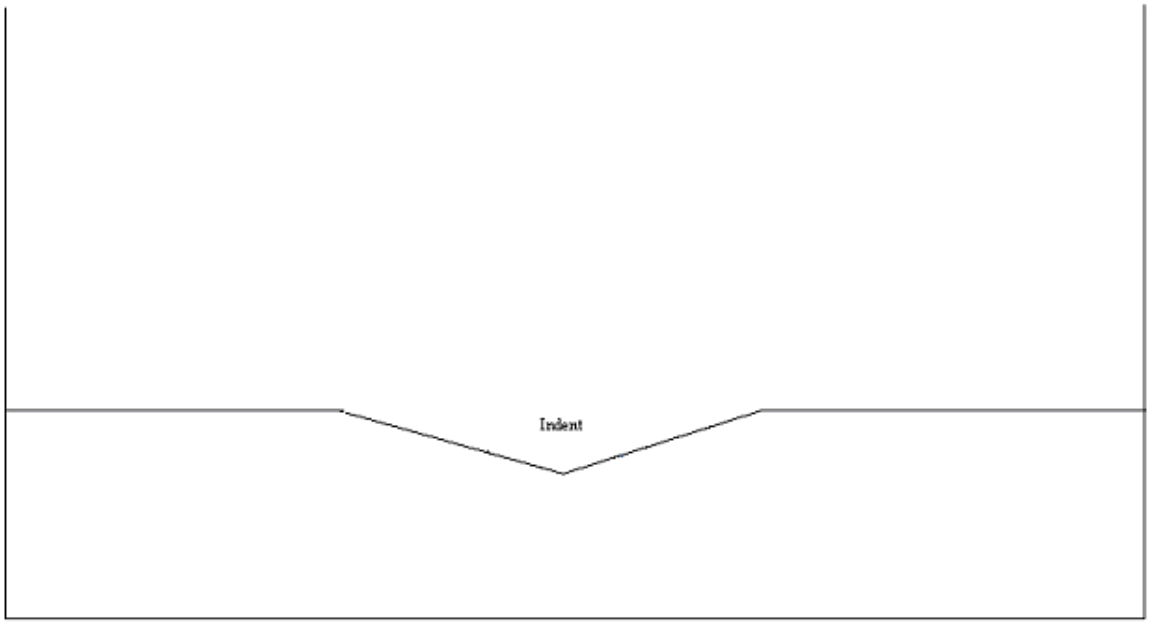
10. Tape the thermometer onto the inside of the tank above the ice.
11. Turn the light on.
12. Record your observations at the end of every 5 minutes until the ice is completely melted. Record the temperature of both thermometers in the tank at the end of every minute. This process may take at the most 2 hours.
13. Dispose of the top layer of soil.
14. Leave the thermometers, fine bits of gravel, large bits of gravel and the sand in the tank.

Step Four (Water and Land based ice)

1. Add the rest of the soil to the tank and spread it out evenly.
2. Stand near one of the shorter sides of the tank, and point the tip of the spatula (at a 45 degree angle) at the approximate middle of the tank and slowly push the spatula into the soil. Stop when you have made an indent in the soil around four inches deep.
3. Go to the other short side of the tank and repeat this process so that your end result is in a circular shape from a bird eye view.

Your side view of the indent should look like this:

Side View



4. Fill the indent with water until it is completely full.
5. Add 1/5 of a pound of salt to the water.
6. Stir water until the salt appears to have dissolved.

This is what your tank should look like from the top:

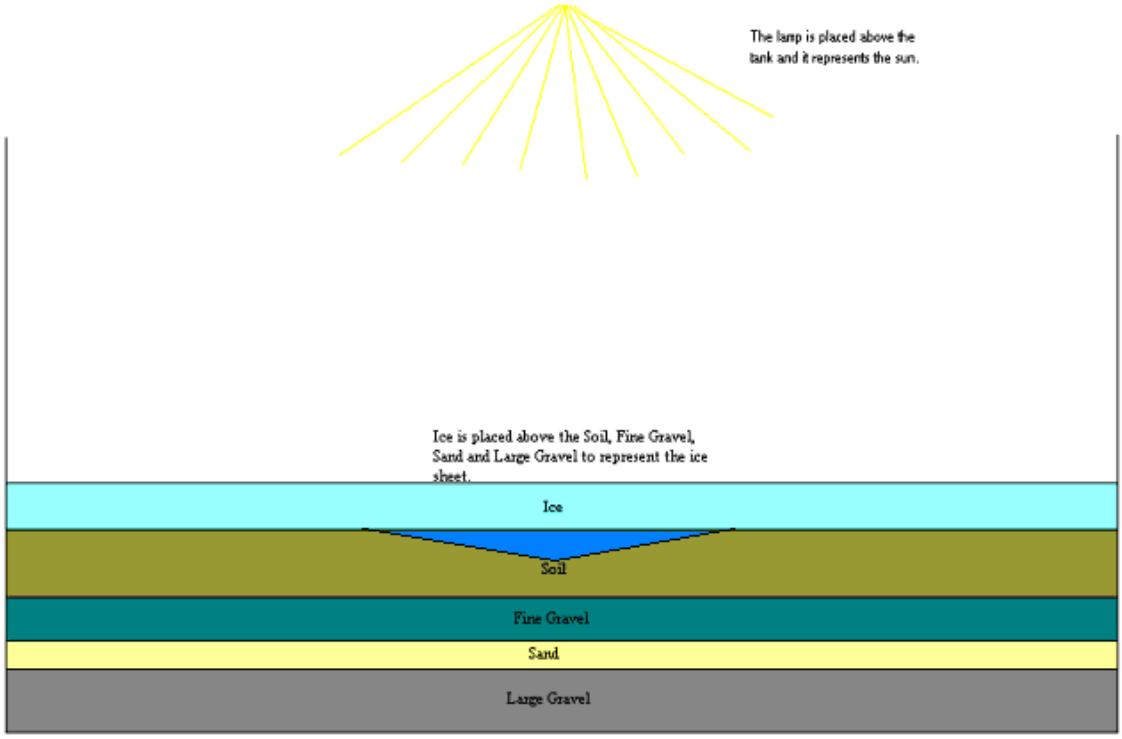
Top View of Tank

This black line is a top veiw of the tank.

The soil represents the land.

The salt water represents the Hudson Bay.

7. Remove the frozen ice from the freezer and carefully use a knife to separate the ice from the tray. If needed cut the ice with the knife so that it can fit into the tank. This may be dangerous.
8. Place ice on the soil and salt water.
9. Tape the thermometer onto the inside of the tank above the ice.
10. Place lamp around four inches above the top of the tank, but don't turn it on.
11. This is what it should look like from a side view:



12. Turn the light on.
13. Record your observations at the end of every 5 minutes until the ice is completely melted. Record the temperature of the tank at the end of every minute.
14. Dispose of everything in the tank.

DATA TABLES AND OBSERVATIONS:

Note: the average starting height of the ice in Water, Land and Water and Land based ice was 1 inch.

Water Based Ice: In the first set of five minutes I noticed that the bubbles that were caught in the ice were escaping as it melted. And I noticed that as the ice melted from the lamp it created pools of water on the surface of the ice and as these pools

increased in size the melting of the ice would increase too. In the second set of five minutes I noticed that the water was melting the ice faster than the lamp was, this is either because I used warm water or the fact that ice, reflects 90% of the light that shines on it opposed to water which absorbs 90% of the light that shines on it thus making the water melting the ice faster.

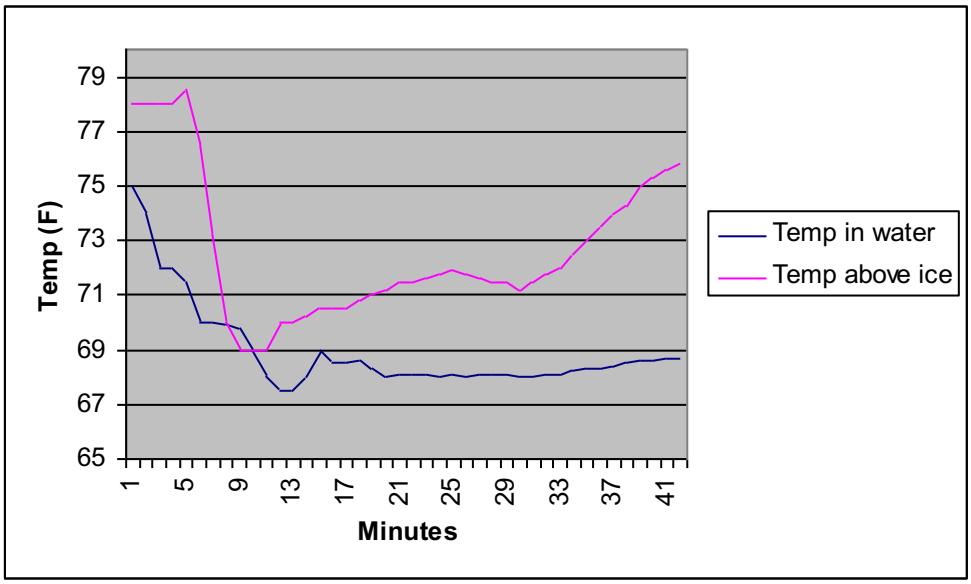
Within the second set of five minutes I noticed that as the ice melted it became easier to see through. And I noticed that the ice that was at a higher altitude relative to the water melted slower thus proving that water melts ice faster than light. I the third set of five minutes I noticed that as the ice melted, the water temperature increased because the ice stopped melting as fast and the water had more time to heat up from the sun without as much ice adding cold water. Also in the third set of five minutes I noticed that all the bubbles had escaped from the ice and for some reason the water temperature was staying close to the same.

I the fourth set of five minutes the ice was completely clear except for the elevated ice that had hardly melted thus not releasing the bubbles of air in it and making it harder to see through. Also in the fourth set of five minutes I noticed that you could very clearly see the separation between the salt water that was originally in the tank and the freshwater that the melting ice had created. In the fifth set of five minutes I noticed that the ice seemed to be sinking, I think that this is because there were less air bubbles in it that were causing it to float. And as it sank more of the ice is exposed to the water that melts the ice faster. The same thing is happening all over the globe. As ice melts sea

levels rise and the ice that is land based is forced to stay at the elevation that it is, and the water eventually surrounds the ice and melts it faster creating more water thus making a chain reaction and rising sea levels higher and the same thing happens all over again to the higher elevated land based ice with water surrounding it. I also noticed in the fifth set of five minutes that the line that separated the salt water and the freshwater (Salt water being on the bottom because it's denser) was distorted, but the only place it was distorted was under the ice that was melting.

At the sixth set of five minutes the ice had split into two pieces both remnants of the once higher elevated ice (which by then was the only ice left). At the seventh set of five minutes I noticed that the one of the chunks of ice had now melted and the last piece of ice had bubbles clenched to the side. At the eighth set of five minutes the ice was about ¾ by ½ inches. And the depth of the ice was too small to measure. At forty-two minutes the ice completely melted. I measured that the melted ice had added ½ and inch of freshwater to the tank that had 3 inches of salt water in it. As the ice disappeared the line separating the saltwater from the freshwater was no longer distorted. After the ice melted the bubbles that were once in the ice are now spread all over the tank. After the ice melted when the water is stirred the line that separates the salt water and the freshwater becomes distorted. This is a graph that shows the two temperatures that I measured.

Water Based Ice Graph



Land Based Ice:

In the first set of five minutes I noticed that the thinner ice melted first releasing the bubbles and became clearer. I also noticed that a small pool of water was forming on the ice as it melted. In the second set of five minutes I noticed that the soil melted the ice faster than the lamp did. At the third set of five minutes I noticed that the ice was becoming even clearer as the ice melted. At the fourth set of five minutes I noticed that the pool of water on the ice continued to grow larger. And puddles have formed on all the ice. No observations for the fifth set of five minutes.

At the sixth set I measured that at this time the ice had decreased around ¼ of an inch. The small ridges on the ice that were formed when freezing have now melted off at

the seventh set of five minutes. At the eighth set of five minutes I noticed that when the some ice melts on the higher elevated ice it flows down to the lower elevated areas and in doing so creates small indents in the ice. No observations for the ninth or tenth set of five minutes. In the eleventh set of five minutes I estimated that in the lower elevated areas the water collected a 1/32 of an inch high that hour. However this is only true in the first hour because as more water collects on the ice the faster it melts thus making the water on the ice increase by a certain percent of the water on the ice the previous hour.

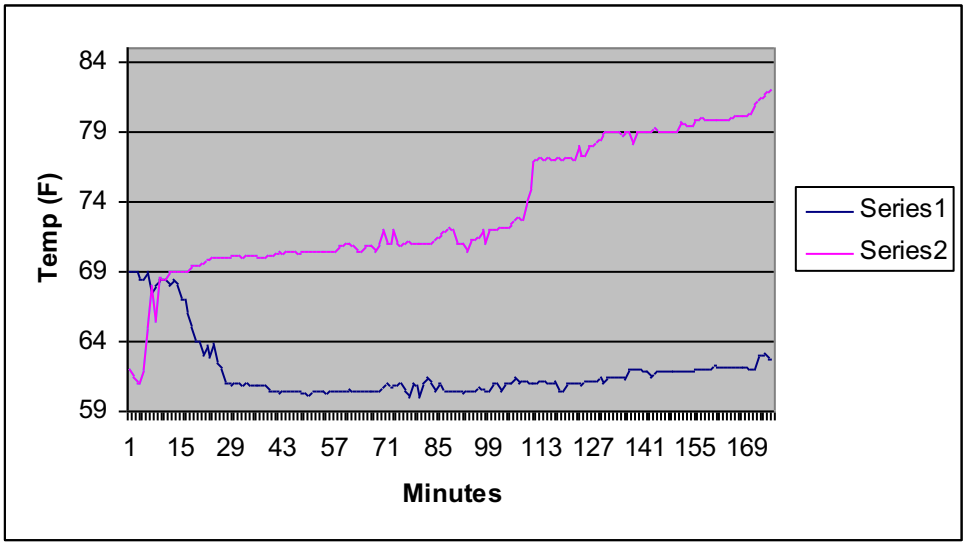
No observations the twelfth, thirteenth or fourteenth set of five minutes. In the fifteenth set of five minutes I noticed that the water was 3/32 inches high at the lowest elevation of ice. No observations in the sixteenth, seventeenth, eighteenth, nineteenth or the twentieth set of five minutes. In the twenty-first set of five minutes I noticed that the soil made indents in the bottom of the ice. No observations in the twenty-second set of five minutes. In the twenty-third set of five minutes I noticed that the ice had decreased in height 3/8^{ths} of an inch. At the twenty-fourth set of five minutes the height of the ice was ¼ of an inch. No observations from the twenty-fifth set of five minutes through the thirty-second set of five minutes.

I noticed in the thirty-third set of five minutes that the small indents that the water made from rushing down the higher elevated ice were becoming deeper, and I could see a crevasse forming. No observations from the thirty-fourth set of five minutes to the thirty-seventh set of five minutes. After three hours the ice remained 1/8th of an inch and it

melted around 7/8ths of an inch. This is a graph that shows the two temperatures that I measured.

This is a graph that shows the two temperatures that I measured.

Land Based Ice Graph



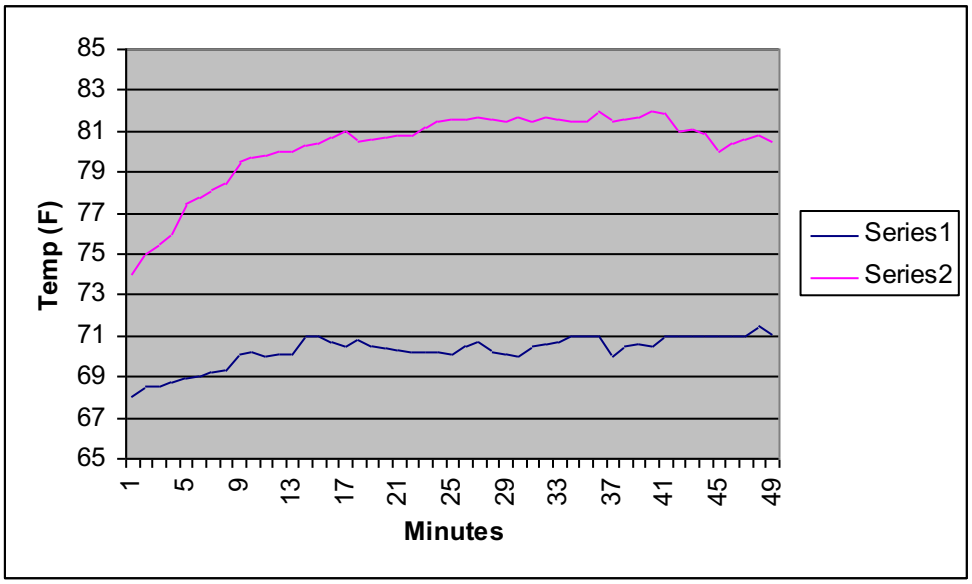
Water and land based ice:

In the first set of five minutes I saw a thin layer of water forming on the ice. No observations for the second or third set of five minutes. In the fourth set of five minutes I noticed that the water that was on the ice started erode the ice making small indents. No observations for the fifth set of five minutes through the eighth set of five minutes. In the ninth set of five minutes I noticed that the small indent that I saw earlier had become deeper and formed smaller indents that branched off of it. After forty minutes the ice is ¾

of an inch. In the tenth set of five minutes I noticed that the deeper water on the ice started to create a Moulin. The Moulin digs deeper.

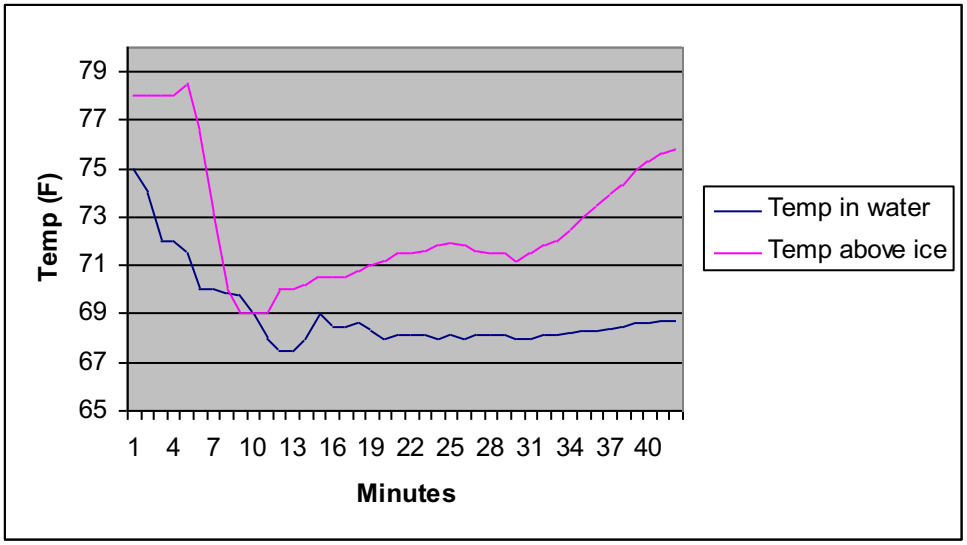
At fifty minutes the Moulin has traveled all the way through the ice. The almost melted but I had to stop the experiment. There was no sign that the water melted the ice faster than the land. After fifty minutes the ice it still around ¾ of an inch high. This is a graph that shows the two temperatures that I measured.

Water And Land Based Ice



DATA ANALYSIS:

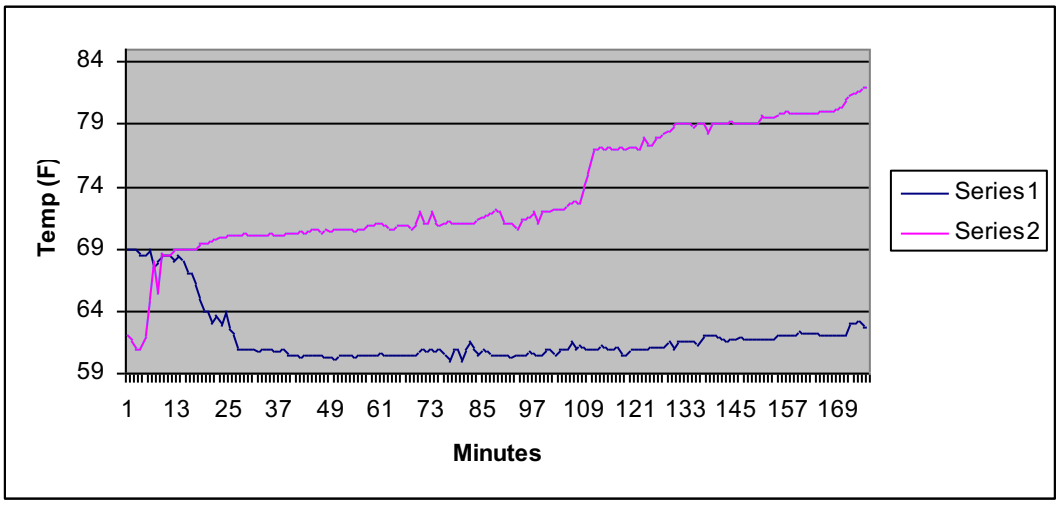
Water Based Ice Graph



This Graph clearly shows that there is a sudden drop of temperature above the ice. The reason why the temperature above the ice decreased at the beginning of the graph is because the thermometer starts measuring room temperature and it is suddenly exposed to the ice making its temperature drop rapidly. The temperature above the ice begins to rise gradually indicated at the end of the graph because the ice has decreased in height from melting which makes the surface of the ice closer to the warm water, the water is warmer than the surface of the ice because water absorbs 90% of the lamps sunlight and the ice reflects 90% of the lamps sunlight. And the water heats the ice to the point of melting, and because the water melts the ice faster than the sunlight the water based ice melts from bottom to top. The overall trend from the first recording of temperature to the last is a decrease of 2. 2 F, (78 F-75.8 F).

The temperature in the water starts at its normal temperature (which in this case is a little high considering that I used hot water to dissolve the salt easier) and is a steady decrease of 7.5F in approximately 12 minutes (75F-67.5F). The overall trend is a decrease of 6.3F degrees, which is because the water that the ice created by melting decreased the temperature of the water more than the light from the lamp increased the temperature.

Land Based Ice Graph

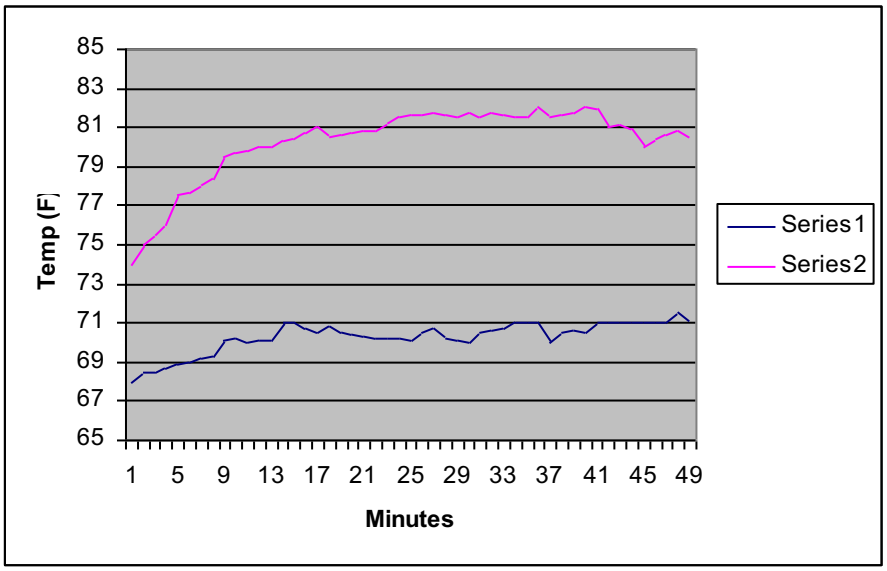


This graph shows that there is a clear decrease in the temperature of the land as soon as the ice is added to it. It continues until it reaches 60.5F which was the original temperature above the ice. So that means that the bottom of the ice remained around the same temperature, as the top of the ice increased in temperature. Which means that land based ice melts from the top to the bottom. As the light melted the ice it formed pools of water on the surface of the ice. This water absorbed 90% of the lamps sunlight causing it to melt the ice under it. As time progressed and the ice decreased in height the pool of

water on the surface of the ice got closer to the bottom of the ice (because land based ice melted from top to bottom) and increased the temperature of the land, (that gradual increase can be seen at the end of the graph). The gradual increase was 2.2 degrees in 81 minutes. The overall decrease in temperature of the land was 6.3 degrees in 177 minutes.

This graph also shows that there was a clear increase of the temperature above the ice. This is because the pool of water that formed on the surface of the ice absorbed 90% of the lamps sunlight and increased the temperature of the surface of the ice. Then there is a gradual increase of temperature on the surface of the ice. This is because as more and more ice melts the water on the surface builds up and the larger the area that the water covers, the more light it absorbs and the more light it absorbs the higher temperature the surface of the ice is going to be. The overall increase in temperature above the ice is exactly 10F.

Water And Land Based Ice



This graph clearly shows that there is a gradual increase in the temperature above the ice. This is because when the light from the lamp hit the ice even though it reflected 90% of the light it slowly melted the top of the ice. And water gathered on the surface of the ice absorbed 90% of the sunlight and heated the ice bellow it. This continued and this makes the surface of the ice warm up. The ices surface had a total increase of 6.5F.

The graph also shows that the temperature of the land increases. This is because the land absorbs more heat from the lamps sunlight that it absorbs cold from the ice sheet above it. The land had a total increase of 3F.

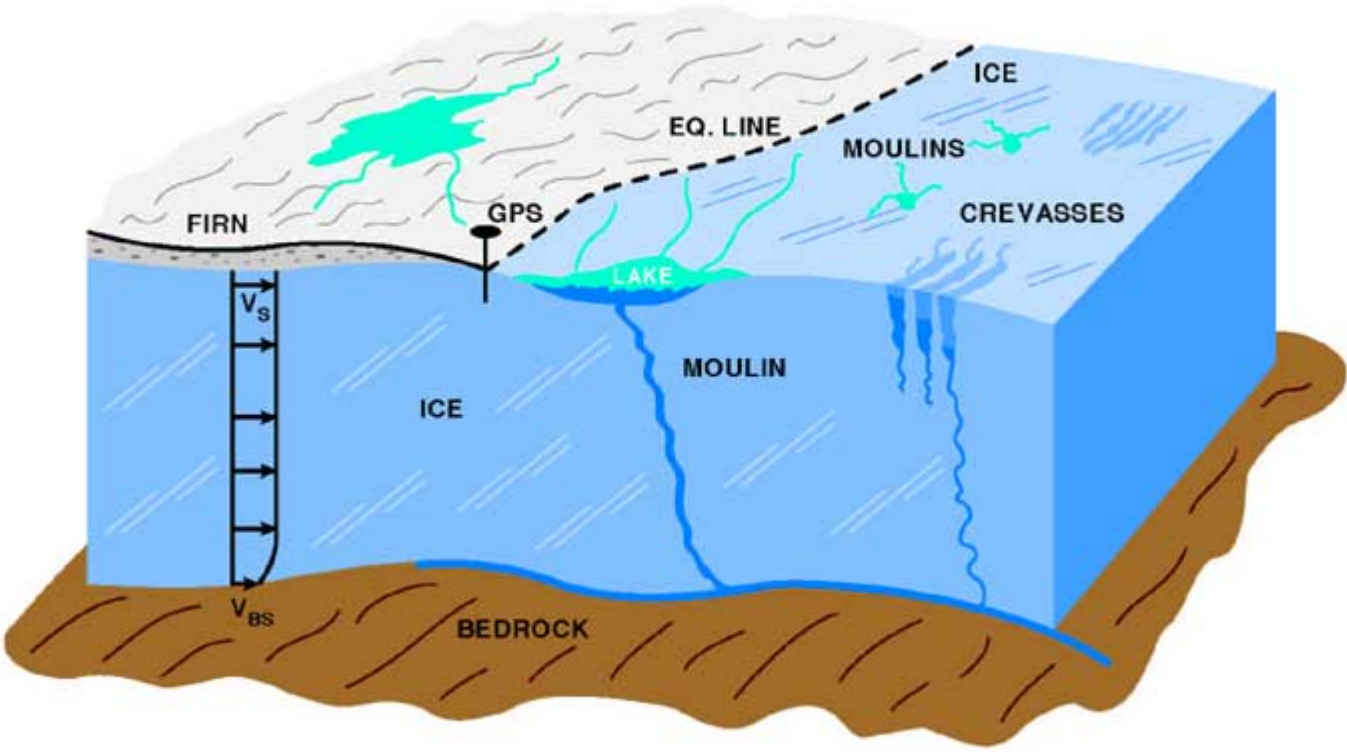
I measured the temperature over ice in different scenarios and I measured the temperature in the substrate. I took observations of how the ice melted and what part of the ice melted first. And doing this helped me understand how ice melts in the world.

Like how the North American Ice cap melted or how Greenland will melt if it does. It helped me better understand what is happening now to the Greenland Ice sheet. And what the consequences of Global Warming are. And most of all it helped me understand how fragile our environment is. I learned that Land based ice melts from the top of the ice sheet to the bottom. I learned that water based ice melts from the bottom of the ice sheet to the top. I learned that water and land based ice melts from the top and the bottom but the amount of melting from the bottom depends on how much water is under it.

My observational data indicates that the separation between the freshwater and the saltwater was distorted under the ice. This is because the ice that was melting was giving off freshwater, the water dripped down the side and was forced into the water and the freshwater that it was pushed into (because the freshwater was on above the saltwater) was forced into the salt water and the distortion was the two types of water mixing.

My observational data also indicates that a hole was forming through the ice. Scientists call these Moulin's. The same thing is found in Greenland. A lake is formed above the ice sheet, eventually the water finds a weak spot in the ice and starts making its way through the ice until it reaches the bedrock underneath. The water then makes its way between the ice and the bedrock and eventually slides the ice sheet into the water and in the water the ice sheet melts faster. This is a picture obtained from the book An

Inconvenient Truth:



It would be interesting to conduct further research see how long it would take for a thick piece of ice to completely melt and watch this process and record what happens to the ice and if at all resembles to what is going on in Greenland. It would also be interesting to perform another experiment that looks exactly like the diagram above only with water surrounding the bedrock. And see if a Moulin were to form would it separate the bedrock from the ice sheet, and if it would slide the ice into the water, which is exactly what is happening in Greenland.

It is worth noting that sunlight from the sun could have changed my results. It is also worth noting that I used warm water to dissolve the salt into the water, and that could have affected the speed of the ice melting. It is also worth noting that my experiment had it's limitations, because it is extremely hard to include all of the factors that apply in real life, such as an increase in Carbon Dioxide in winter and a decrease in summer, and if I were to include that factor there would have been and increase of temperature when the Carbon Dioxide was higher and there would have been a decrease in temperature when Carbon Dioxide levels were lower. And that fluctuation would have affected my ice melting pattern dramatically.

CONCLUCION:

I learned that Land based ice melts from the top of the ice sheet to the bottom. I learned that water based ice melts from the bottom of the ice sheet to the top. I learned that water and land based ice melts from the top and the bottom but the amount of melting from the bottom depends on how much water is under it. I was surprised to find that a Moulin formed in my experiment. I was also surprised to find that the water that formed on the ice created indents in the ice. I found this lab very effective. I have one additional question that won't be very easy to answer because it depends on the fate of Global Warming, which has yet to be determined:

What will be the fate of Greenland?