Water Unit: Lesson #3
Latent Heat

Lesson Plan

Subjects: Science, math, social studies, writing
Grades: 4-8
Duration: 1) Vaporization 2-3 hrs. 2) Fusion 1 hr.

OBJECTIVE

When a substance changes states of matter, there is a very significant amount of energy either required or released by that conversion. This lesson shows the real life applications of that quantity of energy. It permeates our daily lives in important ways.

Vocabulary

Latent heat	Hidden heat required to do a change in states of matter.
Vapor	Water in the air
Vaporization	Making a vapor.
Fusion	Making something solid (in this case, ice.)
Carb ice	When ice forms in a carburetor, usually above 32 degrees.
Dry ice	Dry ice isn't dry and isn't ice. It is solid carbon dioxide.
Ambient temp.	The temperature around the scene.
BTU's	British Thermal Units. A measurement of an amount of heat.

CONTENT READING

When water changes from a gas to liquid to solid, or solid to liquid to gas, there is a great amount of energy exchanged. Old time Alaskans understood the real life applications of this. It is important today as well. Understanding latent heat helps us understand everything from steam baths to weather, from extinguishing house fires to eating snow.

Condensation is when water vapor in the air is cooled and is converted to liquid, like water drops on a cold window.

Much heat is released when that vapor is condensed back into a liquid.

Evaporation is when a liquid is turned into a vapor, like water into steam.

Much heat is required to turn liquid water into a vapor.

Latent Heat of Vaporization: To heat water from the freezing point, 32°**F,** up to the boiling point, 212°**F** takes a steady application of heat. To bring 212° water to 212° steam takes a great amount of heat energy. This is called **latent heat** because it seems hidden. Even with supplied heat, the temperature doesn't go up until all the liquid has been converted to a vapor.

Activity: Put a thermometer into a pot of warm water. Watch the temperature rise until it gets to 212°. Continue to put heat into the pot and notice that the temperature does not raise above 212° in spite of the amount of heat applied.

When 212°F steam is changed to 212° water, it releases the same amount of latent heat that it took to convert it to steam.

To turn any liquid to a vapor takes a great amount of heat.

When a vapor is condensed into a liquid, a great amount of heat is given off.

Propane: One hot summer day I accidentally twisted the valve on a propane bottle while I was hauling it to my house in McGrath. Propane came out in a big fog. I reached through the stream of vaporizing propane to turn the valve off, and almost froze my hand! As the liquid propane turned into a vapor, it took heat to convert the liquid propane to a vapor, and that propane stole heat from my hand. It is possible to frostbite a hand in a stream of propane even if the ambient temperature is warm!

We also know that propane will not evaporate from liquid to vapor state and escape from the propane bottle if temperature is below -35°F. It takes heat to turn the liquid to a vapor, and at those low temperatures, there isn't enough heat to do so. Some heat source must be placed against the propane bottle to get the liquid propane to evaporate inside the bottle.

Sometimes we can spot the leak in a gas or fuel line by frost that forms on the fuel line. When the fuel escapes the line, it evaporates. That evaporation takes latent heat, and the outside air is cooled. The moisture in the air is condensed onto the fuel line by the cooling. If you watch for this, you will see evidence.

For the Teacher: *The next time you or a maintenance person connects a new propane bottle to the regulator, spray a little propane on a thermometer before hooking it up. Do you see a temperature reduction? (You should.) The propane is at ambient temperature, but when pressure is released, it becomes a vapor, and that process absolutely demands heat, and will rob that heat from anything around.*

Breakup: Before our river breaks up in the spring, days are long and the weather seems warm. After the river breaks, the air seems cold, though the days are longer and the sun is stronger. Why is this?

Before breakup, the amount of water exposed to evaporation in the country is relatively small. After breakup, the amount of water exposed to evaporation is huge. The whole country is covered with massive amounts of water. The heat coming from the sun is used to evaporate that water, and the latent heat of evaporation takes away from the sun's heat until the country dries out a bit. Once the country dries, it seems like the temperature takes a jump upward.

Later in the summer, much of the rain water will soak into the ground. But, right after breakup, the ground is frozen, so the water sits on the surface, evaporating and placing high demands on local heat sources.

Activity: *Record the mid-day temperatures from 2 weeks before breakup to 2 weeks after. Of course there will be other weather variables, but see if the temperature reduction from the latent heat of evaporation in the land is apparent.*

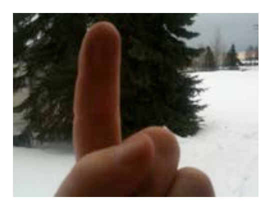
Breakup and a Shower: When we first step out of a shower, we feel chilly because the water on our skin is evaporating. The latent heat of evaporation chills us. As soon as we towel off, we are warm again. That same thing is happening to our whole land after breakup. Our country is covered with huge amounts of evaporating water, and that evaporation process cools the whole land until it becomes relatively dry several weeks after breakup.

Math Application: *One cup of water is 236 grams. It takes 540 calories of heat to convert 1 gram of water to steam. How many calories does it take to convert a cup of water to vapor?*

Observation: *The next time each student showers he/she should make the observation: Do you feel cold until you towel off. Did the bathroom temperature change? (No.) Toweling put an end to the process of latent heat of evaporation robbing your body heat.*

Brief Activity: *Pour alcohol onto your hand. Blow on it. Can you feel it cool your hand? (The evaporating alcohol robs its latent heat from your hand, in the same way vaporizing fuel robs heat from the carburetor.)*

Wet Your Finger: People wet their finger and hold it above their head to determine wind direction. Whichever direction the wind is blowing from feels colder. Evaporation of the water (saliva) requires latent heat. The upwind side of the finger is colder. The downwind side is warmer.



Carb Ice: Many airplanes and snowmachines have carb ice problems. Even outboards can have carb ice problems if run with the cowling off. How can the carburetor be colder than the outside air, especially when it is attached to a warm engine?

The answer is hidden in the understanding of latent heat. It takes a lot of heat to convert a liquid to a vapor. In the carburetor, fuel is sprayed into the carburetor throat through the small hole, called a jet. The fuel is turned into a vapor. But it takes heat to turn a liquid to a vapor. Where does the heat come from? It has to come from the carburetor body. It is therefore possible for the carburetor to get 15°-20°colder than the outside air.

When the outside air enters the carburetor, it is cooled in contact with the cold carb body. The air cools and releases its moisture as a liquid. Then the liquid turns into ice. That ice can block the flow of air into the carburetor and cause the engine to run very rough. And, that is the "carb ice" story.

Every engine in Alaska that has a carburetor has the possibility of developing carb ice, especially between 35°-50°F. Fuel injected engines don't have the problem.

Before landing, pilots pull the "carb heat" knob. This allows warm air to come into the carburetor, melting the ice that does exist. This keeps the engine running smoothly during critical moments. Why doesn't the pilot leave the carb heat on all the time? (That will remain a mystery until another lesson.)

Local Research: *Talk with airplane pilots and snowmachine owners about 'carbice.' At what temperatures do they have the most problems? Why does the engine run rough with ice in the carburetor? (The air is being choked off because the carb throat is full of ice. The engine therefore "sucks" too much fuel into the carburetor The mixture is far too rich, and almost chokes the engine to death.)*

Local Research: *Inquire if anyone in the village has had problems with carb ice in an outboard motor. (Probably not unless it was run with no cowling. Then they absolutely had carb ice problems.)*

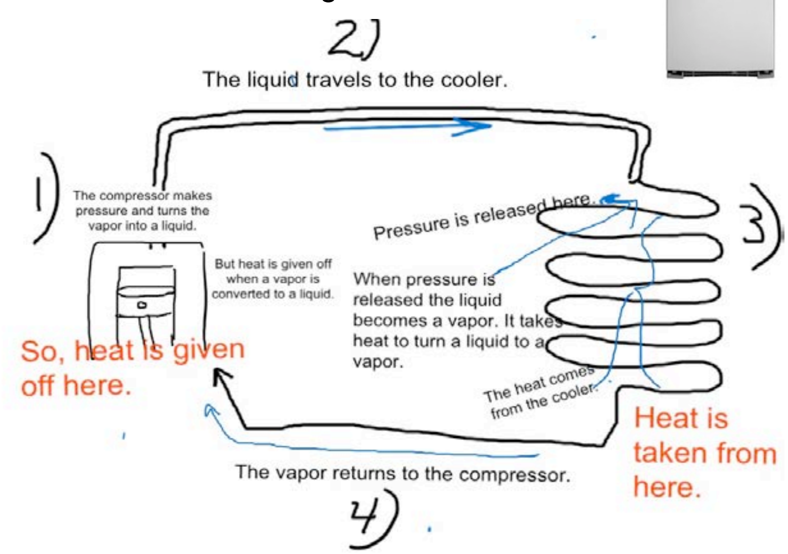
What does the airplane engine sound like when carb heat is first applied? (Sputters and coughs. It sounds terrible because the melting ice sends water into the carburetor.)

Follow the carb heat hose on an airplane that leads up to the carburetor. Where does the warm air come from? (The shroud around the muffler.)

Refrigerator or Freezer: This brings up another common example of latent heat. It is a little difficult to understand, but is well worth the effort to learn.

I always ask, "What is the difference between a carburetor and a refrigerator?"

The answer is "A fridge has food in it." A carburetor and a refrigerator work on the same principle!



The vapor in the refrigerator is compressed by an electric motor, turning the vapor into a liquid (1). A considerable amount of latent heat is released by turning a vapor into a liquid and is emitted behind the refrigerator.

(2) Then the compressed liquid is brought into the cooling part of the fridge. (3) The pressure is released, and the fluid evaporates into a gas. But, you now know that it takes heat to convert a liquid to a gas. Where does the heat come from? From the

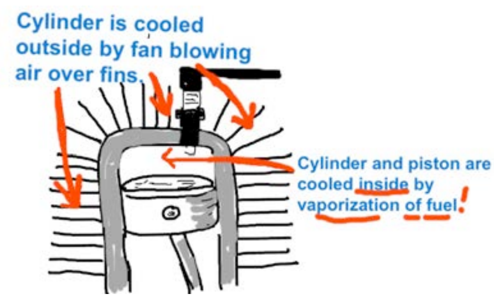
inside of the fridge! The same as the throat of the carburetor. (4) The vapor then returns to the compressor.

So, by compressing and decompressing the fluid, and giving off and taking in the latent heat required to turn a liquid to a vapor or a vapor to a liquid, the electric motor runs a compressor that pumps heat from your refrigerator into the room.

It is a form of heat pump. It pumps heat from one place and releases it in another.

Research: *Research the basics of refrigeration. What fluid is used in the refrigerator? (A form of freon.)*

Engine Cooling: All bush Alaskans depend on small and large engines. Those engines need to be cooled. Some of the cooling comes from air passing over the fins on the cylinders. However, much of the cooling of the cylinders comes from the vaporization of fuel *inside* the cylinder. When the fuel enters the cylinder, some is already vaporized, but much is still in the form of fuel droplets. When those droplets are heated, they vaporize. That heat of vaporization cools the cylinder from the inside.



Most mechanics know that a lean engine (one that isn't getting enough fuel) runs hot. What most don't realize is the fuel acts as part of the cooling system, and when the engine is short on fuel it is also short on coolant. A lean engine can overheat to the point of the piston scratching or even ceasing up in the cylinder (because it gets so hot it expands and can't fit in the cylinder.) No one wants to burn excessive fuel, but it is important to understand this principle and run the carburetor rich enough.

Some snowmachines have seized up from overheating when breaking trail. The answer would have been to enrich the carburetor by raising the jet needle in the slider.

Airplane pilots monitor the fuel/air mixture by watching the exhaust gas temperatures. If the EGT's get too high, it is time to enrich up the mixture. The vaporizing fuel cools the cylinders from the inside.

Local Inquiry: *The next time you are in a piston driven airplane that isn't fuel injected, ask the pilot to lean the engine. Watch the EGT's. (Exhaust gas temperature) What happens? (The EGT's go up as the engine is leaned out because there isn't as much fuel vaporizing to cool the engine. A lean engine runs hot, sometimes too hot.)*

Green Wood: There are as many BTU's in green wood as in dry wood, but green wood doesn't give our home as much heat as dry wood. Why? Because it takes latent heat to evaporate the water out of the green wood before it can burn. It takes a great amount of latent heat to convert that liquid water into vapor. So, green wood has as much heat as dry wood, but too much of that heat goes to boiling water out of the wood rather than heating our homes.

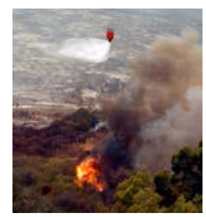
Another factor that enters in is that the steam coming off the wood acts as a shield keeping oxygen from the wood preventing an efficient burn.

***Activity**: Try to make a fire with green wood. It is difficult or impossible. Why? (You have to boil the water out of the green wood to get it to the kindling temperature around 420° F, a very difficult process.)*

Now make a fire with dry wood. What is the difference? The match has enough heat to raise the temperature of the drywood to kindling temperature. Everyone knows to start a fire with drywood, but everyone doesn't know the principle of latent heat involved.

***Activity**: Put a green spruce log onto a hot fire in the woodstove. Listen after 10-15 minutes. Can you hear the hissing and see the steam come out of the layer of wood just under the bark of the tree? (Some students should be able to do this at home and report back. Try to record the hissing sound on a cell phone and play it to the class.)* *See experiment #3 below.*

Firefighting: When firefighters spray water on a fire, the same principle applies. Three elements are required for combustion (fire) to occur: fuel, heat and oxygen.



Water from the firehose or chopper cools the fuel in two ways. First, the water is cooler than the fire, but *most importantly,* it takes a tremendous amount of latent heat to turn liquid water into steam (vapor.) The latent heat taken from the fire to do that is the greatest contribution to the extinguishing of the fire by water. At the same time, the steam also blocks oxygen from getting to the fire.

***Activity**: The next time you make a campfire out in the woods, listen as you spill water onto the fire when you leave. Do you hear the hiss? That is the sound of liquid water turning into steam. Latent heat is robbed from the fire to turn the water to steam. The fire is extinguished.*

Steambath: When people take a steambath, they splash water on the hot rocks. There is a hiss of steam, a short wait, then a tremendous amount of heat is released onto the people in the steambath. Why is this so?

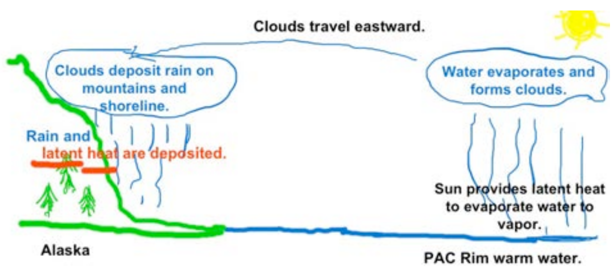
When the water hits the hot rocks, it takes a great amount of latent heat to convert the liquid water to steam. When that steam crosses the small room and contacts our skin, it condenses and releases the latent heat. It is far more than skin contacting hot steam. It is the release of the latent heat that gives the tremendous thermal impact.

In a very hot steambath, many people wear a stocking cap and put a ball of grass in their mouths. The steam condenses in the grass, releasing its heat there, rather than releasing it in the person's lungs where it could do considerable damage. The condensation and release of latent heat takes place in the cap rather than directly on the person's head.

The next time you take a steambath, notice the rise in temperature when the steam condenses on objects in the room. The steam literally carries the heat from the stove and deposits it around the room.

Local Research: *Talk with locals about how they protect their heads and lungs. What is the temperature before and after splashing water on the rocks? Does anyone have a thermometer in the steambath?*

Campfire Coffee: When we make tea or coffee outdoors, we often find it faster to make or find a water hole and boil liquid water rather than melting snow or ice. Why? It takes a lot of latent heat to change water as snow, to water as a liquid. Melting ice is quicker than melting snow.
Local Research: *Ask the local experts if this statement is true for them.*



Water Cycle: Most of us have studied the water cycle until we are sick of it. However, there is another consideration that most people haven't talked about.

Yes, the water evaporated from warm places in the ocean comes to us in Alaska and is released in our mountains creating streams and rivers.

But the *heat* that it took to evaporate the water is also released in our mountains!!!!!!

That is why snow melts so quickly in the mountains in the spring when clouds release rain there. The liquid water *and the heat required to evaporate that water* are both imported into Alaska.

Research: *Where does the water and latent heat come from that is deposited on the headwaters of Alaska's rivers? (From the warm ocean where the moisture was evaporated, probably the Japanese current.)*

Activity: *Watch Alaska TV weather every day for a week or two or go to http://pafc.arh.noaa.gov/tvwx.php*
Watch the weather patterns and note where the low pressure areas come from. Is that part of the ocean warm or cold? Research the ocean currents in that part of the world.

Damp Clothing: Every hunter knows what it is like to spend the day in a wet coat or sleeping bag. There are two chilling effects. First, damp insulation conducts heat much faster than dry insulation. Secondly, the latent heat of evaporation to evaporate that moisture must come from somewhere. Where does it come from? From our bodies. A damp coat chills twice.

***<u>Activity</u>**: Outdoors on a cold day, wrap one thermometer in a small dry towel. Wrap another thermometer in a small damp towel. Check periodically to see if there is a temperature difference. Do the experiment again with a fan blowing on both thermometers. Does damp insulation conduct heat away more quickly than dry insulation? Do you think latent heat of evaporation is cooling the damp thermometer as well?*

Wet Hair: Every young person has heard his/her mother say, "Don't go outside with wet hair. You will get sick." Why is this? When hair dries by evaporation the latent heat of evaporation must come from somewhere. Where does it come from? From the young person's head, quickly chilling him, making him susceptible to sickness.

Sweating: When we exercise, our body perspires. When the sweat from our body evaporates, it requires latent heat to evaporate that liquid water. The removal of that latent heat from our body cools our skin.

In Hawaii, field workers on pineapple plantations always drank warm water in the hot, hot sun. Why? If they drank cold water, it brought instant relief and cooling, but it shut down their perspiration process. They would then have to overheat again to get perspiration going. So field workers drank warm water. They relied on the latent heat of evaporation to continuously cool them rather than the shock and restart of their perspiration process by cold water.

***<u>Discussion:</u>** If you are hiking in the mountains, and the water in your canteen is warm, will it cool you to pour it on your head? Of course. The latent heat of evaporation will cool you even if the water is warm. (If there is a small cool stream let the cool water run over your wrists where much blood passes through. This cools the whole body. This doesn't use the principle of latent heat, but it is one of the quickest ways to cool off.)*

Log Cabin: The first time I built a log cabin, I was in a rush to get done before winter. I built with green logs. I was surprised and disappointed that the house was very cold for the first week or two. But, after a few weeks, the house warmed up considerably. Why? The green (wet) logs were drying out during the first few weeks. It took a lot of latent heat to convert the liquid water in the logs to a vapor. After the logs dried, all the heat in the room was kept in the room, and wasn't sidetracked into drying logs.

Produce: In a village store, the owner placed wet burlap bags on top of the produce. Why did he do this? As the moisture in the burlap bag evaporated, the latent heat required to evaporate the water was taken from the produce, helping to preserve it.

Short Activity: *Indoors, wrap one thermometer in a small dry towel. Wrap another thermometer in a small wet towel. Check periodically to see if there is a temperature difference.*
Do the experiment again with a fan blowing on both thermometers.
This is part of experiment #1 in Lesson #2.

In another store, the worker sprayed the produce with water. This keeps the produce from drying out, but also keeps it cool when evaporation occurs by removing the latent heat of evaporation.

Segment 2 Heat of Fusion

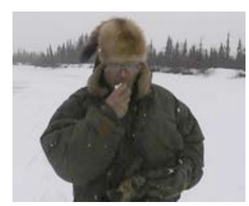
- Freezing is when liquid water is turned into a solid, like ice.
- Melting is when a solid, like ice, is turned into a liquid.
- Heat is required to turn ice into a liquid.
- Heat is released when a liquid is turned into a solid. It takes far more “cold” in the fall to create ice than we think. (Actually there is no such thing as “cold.” Cold is the absence of heat.)

Latent Heat of Fusion: Bringing 32°F degree ice to 32°F degree water takes a great amount of applied heat.

Going in the other direction, when 32° water is turned to 32° ice, a great amount of heat must be removed.

The latent heat required to melt ice to a liquid or turn a liquid into a solid is called the **latent heat of fusion.**

Latent heat is rather sneaky. You don’t think it’s there, but it is, and it is significant.



Eating Snow: Old timers always said, “Don’t eat snow when you are walking wintertime.” What science principle did they know about? They understood that it takes a great amount of heat energy to convert 32° snow to 32° water. The latent heat required to melt the snow will exhaust the person walking. Much of the energy required to walk all the way home will be taken up converting 32° snow to a small amount of 32° water. Eating snow makes the person walking feel exhausted.

Math Application*: It takes 80 calories of heat energy to melt one gram of 32° snow into 32° water.*
One cup of water is 236 grams. How many calories does it take to get a cup of water from 32° snow?
What percentage of an average daily diet is this amount of calories?

***Brief Activity**: Take a handful of snow, place it in a plastic bag, and melt it gradually at room temperatures. How much water does it make? (Not much) The latent heat required to melt that amount of snow is large considering the amount of water gained.*

If nothing else, this small fact about eating snow while walking wintertime is worth the price you paid for this course. It could save your life on the trail.

Don't eat snow. It will make you tired. Even white snow.

Dry Ice: Dry ice is actually solid carbon dioxide. Dry ice is "dry" because there is no water in it. It looks like ice, but isn't. When it is converted from a solid to a gas, the latent heat required to make the conversion greatly cools the surroundings. The carbon dioxide goes back into the atmosphere where it came from.

***Activity**: If you can get dry ice to the village, experiment with it. Use gloves while handling it. Put it in a small cooler with a thermometer. As the carbon dioxide vaporizes, does the temperature drop inside the cooler? There are many good dry ice experiments on Youtube.*

Fire Extinguisher: There are different kinds of fire extinguishers. One type is CO_2. Carbon dioxide is compressed in the cylinder of the extinguisher. When the solid CO_2 is sprayed onto the fire, the pressure is released and the solid CO_2 particles become a gas (vapor.) Since it takes heat to convert a liquid or solid to a gas, that latent heat comes from the fire, helping to extinguish it.

Additionally, the CO_2 acts as a blanket, keeping the oxygen of the air from the fire. CO_2 is heavier than most air molecules so it tends to settle down onto the fire.

When the CO_2 evaporates, it just goes into the atmosphere leaving no trace of its presence. CO_2 extinguishers are often found in kitchens. If water is sprayed on a grease fire it will spread, not extinguish, the fire. CO_2 extinguishes grease fires nicely, cooling and laying a blanket of CO_2 that keeps the oxygen away from the flames.

Ice Cream: If you have ever made homemade ice cream, you put the ice cream mix in the container in the middle of the maker. You put ice around the outside of the maker. Then you put salt on the ice and started cranking.

After everyone in the house was exhausted from cranking, you looked into the ice cream mix and it had frozen! How did this happen? How did it get cold?

Salt melts ice. But, we now know it takes latent heat to convert a solid (ice) to a liquid. The salt melted the ice, and that process requiring latent heat stole that heat from the ice cream mix, making it colder than anything around it.

The latent heat of vaporization (evaporation and condensation) is 7.5 times greater than the latent heat of fusion (freezing and thawing.) But both are far greater than we imagine.

Another way to describe latent heat is “When the addition or removal of heat to a liquid doesn’t bring about a temperature change. A change in the state of matter is happening instead.”

Experiment #1 Latent heat of fusion

Materials

- 1 indoor/outdoor thermometer
- 1 small metal pot.
- Water
- Stove
- Graph paper
- Oven thermometer.

Procedure:

1) Fill the pot with water.
2) Suspend the sensor of the indoor/outdoor thermometer in the middle of the water.
3) Put them out to freeze.
4) Once the water is completely frozen with the sensor embedded in the middle of the pot, bring them inside and put the pot on the stove at medium heat. Note the temperature every 3 minutes. Record on graph paper.

The temperature should remain at or near 32 degrees F until all the water is melted, then the temperature will rise steadily up to the limit of the thermometer.

What we observe is that the latent heat of fusion absorbs all the heat from the stove until all the ice is melted. Then, and only then, can the temperature of the water rise. From there it will rise steadily.

Realize that the stove provided steady heat input into the pot, but the temperature rise was stalled until the demand for latent heat was satisfied and all the ice was melted.

5) Once the temperature is at the upper end of the indoor/outdoor thermometer, put a cooking thermometer in the water, record the temperature at 3 minute intervals. What happens to the temperature increase once the water starts to boil?

Realize that the stove provided steady heat input into the pot, but the temperature rise was stalled until the demand for latent heat was satisfied and the water boils away.

Experiment #2 Ice Cream Maker

Materials needed.

- 1 glass
- Crushed ice
- A thermometer
- Salt

1. Crush some ice and put it in a clear glass.
2. Put a thermometer into the midst of the ice.
3. Note the temperature after a few minutes.
4. Now mix 6 tbsp. salt into the ice, and note the temperature when the salt starts melting the ice.
5. Record the temperature until all the ice is melted.

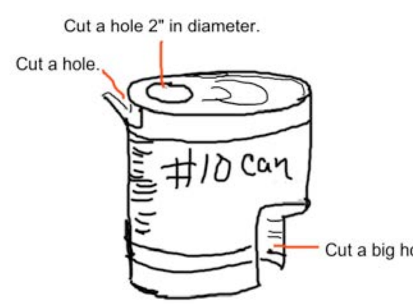
Where does the heat come from to melt the ice? (answer: from the surroundings.)

6. Do the experiment again using sugar. Does the ice melt? Does the temperature go down?

7. Do the experiment again using windshield cleaner for a car. Spoon the windshield cleaner onto the ice with the thermometer in the glass. Does the ice melt? Does the temperature go down?

Experiment #3 Calorimeter

The purpose of this experiment is to compare the available heat from equal amounts of dry wood and green wood. Keep the "calorimeter," as it will be handy for other experiments during the year.



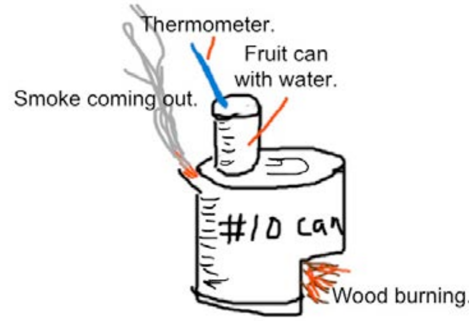
Materials needed.

- #10 can
- Empty fruit can.
- Thermometer
- Water
- Equal amounts of green wood and dry wood.

Make a calorimeter out of a #10 can and a smaller can.

1. Cut the #10 can as shown.

2. Cut two blocks of green spruce about 5” long from a green log 5” in diameter.
3. Finely split both blocks of green wood keeping them separate from each other.
4. Put the split pieces from one block in a large ziploc bag.
5. Dry the split pieces from the other block (over a wood stove or other dry place.)



You now have two identical piles of split pieces, with the only difference being that one is dry and the other is green.

6. Put the #10 can on a dirt surface outdoors where it is safe to make a fire.
7. Put the dry split pieces in the big opening of the #10 can.
8. Put 1/2 cup cold water in the empty fruit can.
9. Put that can over the hole in the top of the #10 can.
10. Ignite the dry split pieces of wood using a measured amount of newspaper.
11. Observe the temperature rise in the water in the fruit can. Record at 2 minute intervals until the wood has completely burned. You may move the burning pieces of wood around so they completely combust.
12. Repeat the process with green wood.
13. Put the green split pieces in the can.
14. Put 1/2 cup cold water in the empty fruit can.
15. Put that can over the hole in the top of the #10 can.
16. Ignite the dry split pieces of wood. Try to use the same amount of newspaper as above.
17. Observe the temperature rise in the water in the fruit can. Record at 2 minute intervals until the wood has completely burned. You may move the burning pieces of wood so they completely combust.

18. Create a graph showing the temperature increases of both the green and dry wood.

The dry wood should show a greater increase in temperature in the water than the green wood because the green wood must first boil the water out of the wood before it can reach kindling temperature >400 degrees F.

Experiment #4 Carbon Dioxide Puts Out a Flame

The purpose of this experiment is to demonstrate how carbon dioxide is heavy, can be poured, and can extinguish a flame. This process is not related to latent heat, but is related to carbon dioxide fire extinguishers which do maximize the principle of latent heat.

Materials needed:

- I short candle
- A bowl
- Small amount of vinegar.
- 8 tbsp baking soda.
- A small jar, perhaps 8-12 oz.

1. Put 1 1/2" vinegar in a small jar.
2. Add 8 tbsp. baking soda
3. Hold your hand or piece of paper over the top to trap the carbon dioxide generated by the fizzing reaction between the two.
4. Light the short candle and put it in the bowl.
5. Once the fizzing has stopped in the vinegar/baking soda container, pour the carbon dioxide of that container (not the liquid) onto the candle.
6. The candle should extinguish.
7. Why did this happen? The carbon dioxide, being heavy, settled to the bottom of the bowl, and displaced the oxygen necessary to for the candle to burn.

Writing

Write a clear story or description, at least half a page, about one of the following subjects:

- Tell why old timers said not to eat snow. Does anyone in the village have a story to tell about this?
- Tell a story about being very cold, wet in the wind.
- Write a description for someone who doesn't understand exactly what carb ice is, and what happened. Describe how the engine runs when it has carb ice, and how to fix the situation. What is the worst temperature range for carb ice?
- Do you know a carb ice story in an airplane? What happened?
- Tell the story of someone who burned up his snowmachine by running it too hot (lean). Explain to him what he should have done to keep his engine cool from the inside of the cylinder while working it so hard.
- Describe how to make a fire. Describe what happens when you try to burn greenwood to start the fire.
- Tell the story of the hottest steambath you have ever been in. Who was there? When? Why you got it so hot?
- Tell the story of the hottest activity you have ever participated in, one so hot you sweat more than you have ever sweat before or since. Weave into the story your new understanding of latent heat.
- If you have ever made homemade icecream, tell the story of how you did it, who was there and what the event was all about that you were making the icecream for. Was it a hand crank or electric model?
- Tell the story of a fire that was out of control that you helped put out. Weave into the story your new understanding of how latent heat robs a fire and helps extinguish it.

ASSESSMENT

1) It takes _____________ to convert a solid to a liquid and a liquid to a vapor.

2) _____________ is given off when a vapor is converted to a liquid, or a liquid to a solid.

3) Answer one of these two questions. Why do you feel chilly when stepping out of a shower until you towel off? Or, why does the country seem warm until breakup, and then seems chilly until the country dries up?

4) How is carb ice formed?

5) What is the difference between a carburetor and a refrigerator?

6) An engine is cooled two ways. Name them and where they occur.

7) To extinguish a fire, we often put water on it. Name three ways this helps put the fire out.

8) How does sweating cool us off? Why do some people working in the hot, hot sun drink warm water?

9) Why did the old timers say, "Never eat snow when you are walking wintertime"?

10) Explain how an ice cream maker freezes the ice cream mix.

STANDARDS

Cultural Standards

A.3: Provide opportunities and time for students to learn in settings where local cultural knowledge and skills are naturally relevant
A.4: Provide opportunities for students to learn through observation and hands on demonstration of cultural knowledge and skills.
B.1: Regularly engage students in appropriate projects and experiential learning activities in the surrounding environment.
B.3: Provide integrated learning activities organized around themes of local significance and across subject areas.
D.3: Seek to continually learn about and build upon the cultural knowledge that students bring with them from their homes and communities.

E.2: Provide learning opportunities that help students recognize the integrity of the knowledge they bring with them and use that knowledge as a springboard to new understandings.
E.4: Acquaint students with the world beyond their home community in ways that expand their horizons while strengthening their own identities.

Standards: Concepts of Physical Science

SB1) Students develop an understanding of the characteristic properties of matter and the relationship of these properties to their structure and behavior.
SB2) Students develop an understanding that energy appears in different forms, can be transformed from one form to another, can be transferred or moved from one place or system to another, may be unavailable for use, and is ultimately conserved.
SB3) Students develop an understanding of the interactions between matter and energy, including physical, chemical, and nuclear changes, and the effects of these interactions on physical systems.

Health Standards

A.2) The student understands that a person's well-being is the integration of health knowledge, attitudes, and behaviors.
D.4) The student identifies and evaluates the roles and influences of public and private organizations that contribute to the well-being of communities.
D.5) The student describes how volunteer service at all ages can enhance community well-being.

Math Standards

B. 3) The student formulates mathematical problems that arise from everyday situations.
E.1) The students explores problems and describes results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations.

Common Core English/Language Arts

#2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
#7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Social Studies/Geography

C1) A student should understand the dynamic and interactive natural forces that shape the Earth's environments and should analyze the operation of the Earth's physical systems, including ecosystems, climate systems, erosion systems, the water cycle, and tectonics.