

# PAUL BUNYAN "WICKED WINTER!"

## X-TREME ICE CREAM X-PERIMENT

Paul Bunyan experienced a winter that was so cold that Lucy the Purple Cow's milk turned into ice cream! Although "Wicked Winter" is a tall tale, it is true that cold temperatures freeze liquids into solids. Your freezer at home takes water and freezes it into ice. We will find out how to lower the temperature of cream without a freezer. This is the best kind of science experiment – the kind you can eat!

### Concept

We know that water freezes at 32 degrees Fahrenheit (0 degrees Celsius). But different substances can have different temperatures at which they freeze. Adding a substance to a liquid can lower a freezing point. This is called "freezing point depression". The freezing point becomes negative – it gets "depressed" – get it? The freezing point is the temperature at which there is an equilibrium between the solid and liquid phases of a substance.

Let's make ice cream using freezing point depression!

#### Cream Mixture:

1/2 cup	whole milk or cream
1/2 teaspoon	vanilla
1 tablespoon	sugar

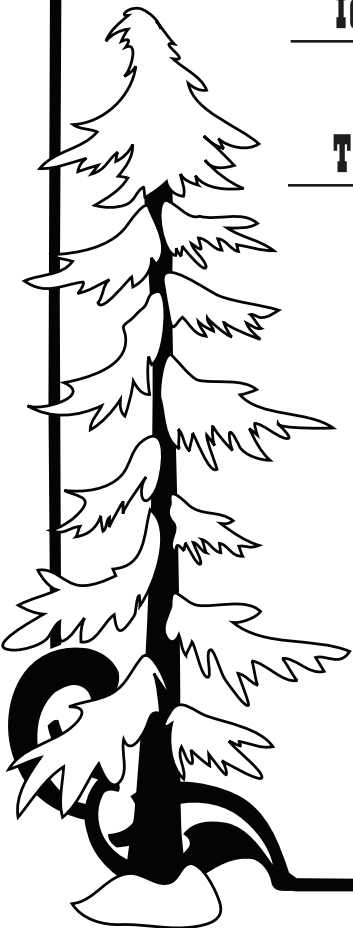
#### Ice Mixture:

4 cups	crushed ice
6 tablespoons salt:	Sodium Chloride / "Rock Salt" is best

#### Tools:

2 quart size "zipper lock" style bags  
1 gallon size "zipper lock" style bag  
(Try to get the thick "freezer" bags as there's lots of handling)  
Measuring Cups  
Measuring Spoons  
Thermometer to measure your temperature drop  
Winter gloves so you can handle the snow  
One adult to supervise

Teaches: lots  
Serves: 1



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### Preparation:

In one of the smaller bags, mix together the cream, vanilla and sugar. Seal it tightly, with no air trapped inside – you don't want to pop it! Double bag this bag in the other small bag so the ice doesn't pierce it, gently press the air out and seal tightly as well. You don't want salt flavor ice cream! Fold the bag around your thermometer and write down the temperature.

Fill the larger bag with ice, then sprinkle salt on top. Put the smaller double bag inside the gallon size bag and let all the air out and seal the bag tightly. Put on your gloves and knead the bag with both hands, mixing the ice and salt and making sure the ice mixture goes all around the cream mixture.

Knead the bags (like dough) for up to ten minutes but for a minimum of five minutes. The cream should be thickening and freezing. Take turns if your hands get cold and tired, or plop the bag down on the counter first one side then the other.

Once it's frozen open the bags and eat your ice cream right out of the bag!

### What we learned:

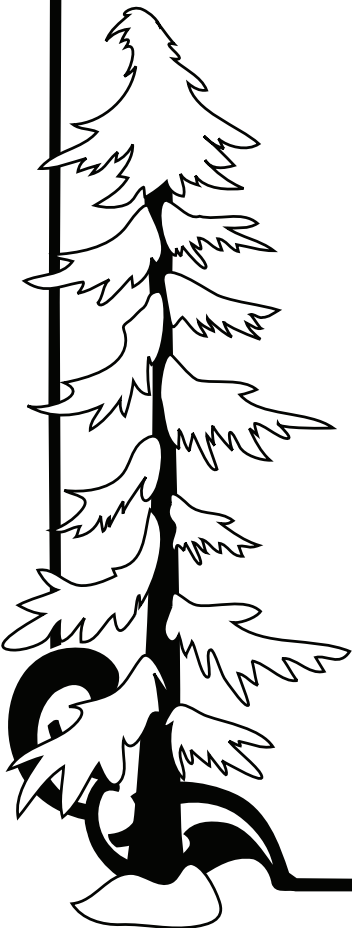
Adding salt to ice makes the ice freeze at a lower temperature. When salt is added to ice it forms a concentrated salt water solution called "brine", which has a very low freezing point.

Where water freezes at 32 degrees F (0 degrees C), a 10% salt solution will freeze at 20 degrees F (minus 6.67 degrees C), a 20% solution will freeze at 2 degrees F (minus 16.67 degrees C).

So more ice melts to add more water to the brine, to try to match the freezing point of the brine to the outside temperature (to reach equilibrium).

This is the same reason why road crews put rock salt on roads when it snows – it keeps ice from forming by lowering the temperature at which it would freeze – by "depressing the freezing point".

The heat of the melting is absorbed by the solution, lowering its temperature. The heat of the cream in the inner bag is also being absorbed by the brine, which is how the temperature of the cream drops enough to freeze it into ice cream. The drop in temperature in the outer bag allows it to get cold enough quickly enough to freeze the cream in the inner bag.



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Why would the cream not freeze at regular 32 degrees F (0 degrees C) like water?

Because we added a substance to it! Remember, we dissolved sugar in the cream – so the cream solution already has a depressed freezing point. But the ice / salt combination can drop the temperature more, if we use enough salt.

Is it possible to add too much salt or would it just get colder and colder?

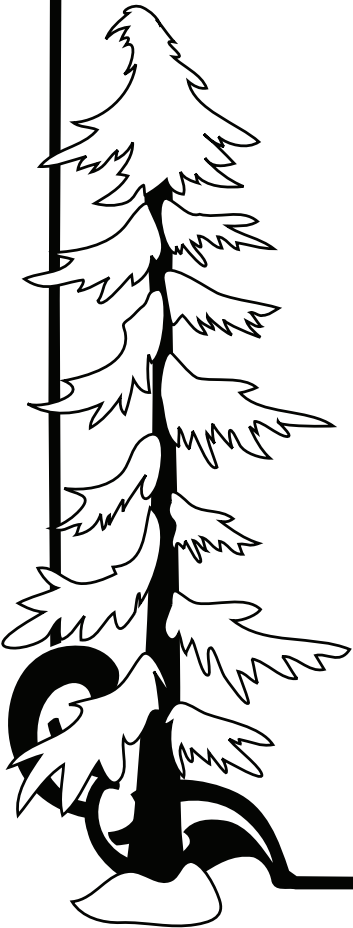
It is possible to add too much salt. 20% is ideal. If you add more than about 23% salt to your solution, you might get salt crystallization instead of dissolving.

### Curriculum Alignment & Learning Outcomes:

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Science:

- Introduction to Chemistry
- Change in materials by heating or cooling them
- Different temperatures make substances take different states
- Design a device to make something cold
- Freezing point and depressed freezing point



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