IF ANTARTICA IS SO COLD, HOW COME ALL THE WATER ISN'T FROZEN?

Antarctica is the coldest, driest, windiest continent on the planet. Temperatures can plummet to -58°F, which is 90°F below freezing (32°F is freezing). Antarctica is so cold that most of the ice there never melts; the continent is permanently covered in ice. Yet, Weddell seals can live there even in the middle of winter, when the water is at its coldest. They can do this because some water remains unfrozen, and they can dive and re-surface through these holes in the ice. How do these holes stay open? How come they don't immediately freeze over? Well, the answer is, it's a joint effort between the seals and the properties of the water.

Weddell seals have specialized teeth that allow them to chew through the ice and keep their breathing holes open when they begin to freeze closed. But the temperature at which these holes freeze is influenced by how much salt is in the water. Pure water (water with no salt in it) freezes at 32°F. As you begin adding salt to the water, the freezing point of the water goes down. The more salt you add, the lower the temperature at which the water will freeze. Antarctica has some of the saltiest ocean water on Earth. But how did it get that way?

Antarctica's temperatures are so cold that glaciers form around the continent. Glaciers are HUGE pieces of ice that form from old snow. Icebergs are the smaller chunks of ice that break off from glaciers and float in the ocean. When water freezes, it forms tiny structures that look like crystals. You've seen this if you've ever looked closely at snowflakes. When these tiny crystal structures form, they form only out of water without salt in it. Therefore, when glaciers and icebergs form, they are almost pure water, and the salt gets left behind in the unfrozen water. The more ice that forms, the more salt that gets left behind, which makes the ocean water in Antarctica much saltier than in most other oceans around the world. The high concentration of salt in the water makes the water heavy (sort of like adding objects to a cardboard box makes the box heavier). Heavier liquids freeze at lower temperatures than lighter liquids (like water without salt in it). Therefore, the saltier the water is, the colder the temperature has to be to freeze it.

Are you ready to test this? Here's a simple experiment that demonstrates how adding salt to tap water can lower its freezing point.

Materials (an asterisk indicates that each group will need these supplies. Some supplies, like the salt, measuring devices, and masking tape, can be shared between groups):

- Three sturdy plastic cups ($1.50 each)*.
- One 1 tbsp measuring spoon ($1.19)
- One 1 cup measuring cup ($1.99)
- Masking tape ($2.79)
- Sea salt (available at grocery store - $1.79)
- One plastic spoon*
- Tap water*
- One freezer (probably located in the teacher's lounge)

Total: $12.26

Procedure:

This activity will take two days to complete. You'll work in groups of two or three to set up your water samples. You'll need to set up your samples on one day, and then check on them 24 hours later (the next day around the same time). For this activity, we'll need a "control" cup of water, to which no salt will be added. Then we'll have a cup of water to which we'll add 1 ½ tablespoons of salt, and lastly we'll have a cup to which we'll add three tablespoons of salt. We'll compare how the water freezes after the samples have been in the freezer for 24 hours.

Day one:

1. Rip off three small pieces of masking tape.
2. Label one piece "control," label another piece "1 ½ tbsp," and label the last piece "3 tbsp." Tbsp is an abbreviation for tablespoon.
3. Put your names on the labels for each cup.
4. Stick one label on each of the three plastic cups.
5. Measure out exactly one cup of tap water and put it into one of the plastic cups. Do this for next two cups, as well.
6. Place the cup labeled "control" aside. This will be the cup with no salt in it, and we'll use it to compare to the cups to which we add salt.
7. Measure out 1 tbsp of salt and place it into the cup labeled "1 ½ tbsp." Be careful not to get the measuring spoon wet, because that will make the salt stick to the spoon. Then, using the same spoon, measure out ½ tbsp salt (you'll have to estimate) and place it in the same cup. Set this cup aside.
8. Measure out three tablespoons of salt and place them in the cup labeled "3 tbsp."
9. Using a plastic spoon, stir the water in both cups until the salt has dissolved. Don't stir too fast, because you don't want to spill any of the water.
10. Give all three cups to your teacher, who will place them in the freezer. Record the time that the cups were placed in the freezer here:
    Time cups were placed in freezer: _____

Day two:

1. At the same time you placed your cups in the freezer, remove them from the freezer and take them back to the classroom.
2. Answer the following questions:

<u>Questions:</u>

1. Describe the water in your control cup. Is it frozen solid, almost frozen, slushy, not frozen?

2. Describe the water in the cup with 1 ½ tbsp salt.

3. Describe the water in the cup with 3 tbsp salt.

4. If you have time, repeat the experiment and add different amounts of salt to the water samples. What's the least amount of salt you can add and still have the water not freeze overnight? What's the maximum amount of salt you can add and still have the water freeze overnight? What about adding other substances to your water samples instead of salt? Try adding sugar, or baking soda, or flour. Do these items affect the freezing points?