Title of Workshop: The Science of Ice Cream

Objectives:

1) Understand the phases of matter
2) Understand the effect of temperature on particle movement

Learning Outcomes:

1) There are three phases of matter: solid, liquid, and gas
2) Solids, liquids, and gases change with heating (e.g., boiling point, melting point [melting chocolate]) and cooling (e.g., freezing point [making ice cream]). These physical changes are reversible.

Target Audience: Chemistry, Grade 4, recommended group size of 10-20 children

Duration of Workshop: 20-30 minutes

Delivery Method: Face-to-face and/or online instruction

Materials Required:

- Measuring spoons
- Measuring cup
- Sugar
- Half-and-half works best. Alternatively, milk or heavy whipping cream may be used.
- Vanilla extract
- Salt
- Ice cubes
- Small, sealable bags, such as Ziploc sandwich bags (2)
- Gallon-sized sealable bags, such as Ziploc freezer bags (2)
• Oven mitts or a small towel  
• Timer or clock

Allergy risks/Safety Protocols: Lactose/milk products used

Introduction:

There is a lot of interesting chemistry that is involved with making food. In this activity, we will explore how matter changes phase in the process of making ice cream. There are three phases of matter: solid, liquid, and gas. In this chemistry activity, students will make their own ice cream in a bag and explore the optimal environments to obtain the appropriate liquid to solid phase changes to make the perfect ice cream! We recommend presenting the short YouTube video (link in references section) before beginning the activity in order to introduce phase changes. We also recommend a short pre-activity discussion highlighting some key observations students can make during the activity. Encourage them to think about how you begin with refrigerated, or even room-temperature, ingredients and need to cool these ingredients down to create ice cream. How do the ingredients change during this process? At which temperature do these processes occur?

Procedure/Instructions:

1) In each small sealable bag place:
   - one tablespoon of sugar
   - ½ cup of half-and-half/milk/heavy whipping cream
   - ¼ teaspoon of vanilla extract, and then seal both bags.

2) Place four cups of ice cubes in one of the large bags. Add ½ cup of salt to the bag.

3) Put one of the sealed small bags into the large bag with the ice cubes and salt.

   ✏️ NOTE: The bag will be very cold! Use oven mitts or towels to protect your hands.

4) After you put on oven mitts, or wrap the bag in a small towel, gently shake the bag for five minutes. Feel the smaller bag every two minutes while shaking, viewing the phase change. Make sure that the small bag does not open!

5) Add four cups of ice cubes to the other large bag, but do not add any salt.

6) Put the other small bag into this large bag.
**Thought question:** What do you think will happen without using salt?

7) Put on oven mitts or wrap the bag in a small towel and shake the bag for five minutes. Again, feel the smaller bag every two minutes while shaking, viewing the phase change.

8) You can VERY carefully touch the outside of the bags of ice cubes. Don’t touch them for very long – only 2 seconds! Compare how cold the different ice cube bags feel. Does one feel much colder than the other?

9) Have an adult help you remove the small bag with your milk mixture from the large bag filled with ice.

10) Remove your ice cream from the smaller sandwich bag and enjoy!

**Feedback/Discussion:**

Students should have seen that the ice cubes in the large bag with salt melted much more, and felt much colder, than the ice cubes in the large bag without salt. The ice cube bag with salt should reach several degrees below freezing. This means that it should have been able to cool the ingredients enough to harden them and turn them into solid ice cream. The ice cube bag without salt was not cold enough to reach the required freezing temperature. The salt allows the ice and salt mixture to get colder than pure water ice. This extra-cold mixture of salt and ice can freeze the ingredients in the bags and turn them into ice cream. This is closely related to the process employed to de-ice roads by spreading salt. While pure water freezes at 0 degrees Celsius, water mixed with salt will freeze below 0 degrees Celsius.

The ingredients in the ice-only bag should have remained much more fluid. However, you can turn the liquid mixture into ice cream by transferring the small bag from the ice-only bag to the ice + salt bag and shaking for another five minutes.

Finally, emphasize that the physical phase change is reversible. If we leave ice cream at room temperature the ice cream will eventually reach its melting point, transitioning from a solid back into a liquid. Just don’t eat it too fast – brain freeze!
Readings/references:

https://www.sciencebuddies.org/stem-activities/ice-cream-bag#summary

https://www.youtube.com/watch?v=CMUmQRgJAo0