Can Implosion

Objectives:

Students will:

- Understand that molecules in a high-volume area will try to move to an area where the concentration of molecules is low.
- Learn that adding or removing thermal energy increases or decreases kinetic energy of particles, and that a change of state could occur.

Standards:

- NGSS: MS-PS1-4, MS-PS3-3, CSS: gr.5 4.e/ gr. 6 7.a

Primary Vocabulary:

-Atmospheric Pressure- The force per unit area exerted on an object's surface by the weight of the atmospheric gases surrounding it. The mean atmospheric pressure at sea-level on Earth is about 14.7 psi (pounds per square inch).

- **Thermal Conductivity-** How rapidly an object transfers thermal energy by conduction

- **Conduction**- Transport of thermal energy through an object by a series of collisions between adjacent atoms, molecules or electrons.

-**Implosion**- When objects are destroyed by collapsing inward on themselves.

Secondary Vocabulary:

-**Diffusional Equilibrium**- When particles no longer move from an area of high concentration to an area of low concentration due to the concentration of particles in both areas being equal.

-**Molecular Diffusion**- The thermal motion of all liquid or gas particles at temperatures above absolute zero. Explains why particles will move from an area of high concentration to one of low concentration.

Materials:

- Bowl
- Ice
- Water
- Empty soda pop cans
- Propane
- Lighter or striker
- Tongs

Preparation:

Fill the bowl with water and ice.

Introduction:

Sometimes, the best introduction to this activity is none whatsoever. The implosion will get their attention and then you can have them guess what happened, and then explain in greater detail, with them excited about the experiment.

Procedure:
SAFETY FIRST!

1) Students should be a safe distance away from fire source at all times. ***NEVER LET THE CHILDREN HOLD THE CAN OR PARTICIPATE IN THIS EXPERIMENT BEYOND OBSERVATION OR HOLDING THE COOLED CANS.***
2) Instructor will light the blow torch and, using the tongs, will hold the can with a tiny bit of water inside.
3) When a large amount of steam is billowing from the mouth of the can, quickly turn the can over into the ice water, completely submerging the opening. This will implode the can.

Explain:

The blow torch is transferring thermal energy to the water in the can, which in turn transfers the thermal energy into the air in the can. Water is able to absorb a lot of energy without heating, so it will absorb the energy in the aluminum, so it won't burn. It also retains heat very well, so it will start to heat up the air/gas above it, allowing more movement in the molecules without burning the aluminum. Since the can is open at the mouth, the molecules can escape, resulting in steam leaving the can.

Since there is more movement in the can, the pressure has gone up, but equalized by escaping out the top of the can. When submerged in the ice water, there is a drastic drop in energy and the molecules suddenly condense and stop moving so dramatically. Since the molecules are no longer moving as quickly, the pressure from the outside of the can is then greater than the pressure from the inside of the can. The can implodes! The reason a large amount of water comes out of the can once it is lifted from the water is because it also creates a vacuum while trying to reach equilibrium of pressure.

You can explain that the Earth has an atmosphere that extends about 62 mi. from the surface. That much atmosphere above exerts a force known as atmospheric pressure. At sea level, the air pressure is about 14.7 psi. The reason that the atmosphere does not crush us, though, is because we have an equal amount of pressure inside of us, pushing out, and reaching something called diffusional equilibrium.

At this point you can also take a can with no water in it, and show them how the aluminum melts quickly, creating a hole that the pressure can equalize through, so it does not crush the can.

Have the students choose how much water goes into the can, how long you hold it over the flame, etc., and hypothesize what will happen. How can we change our experiment and what does that do?

Be mindful about how many cans are available and make sure those behind you will have enough for the experiment. If there is an abundance, don't be afraid to crush as many as needed to get the points across!

Evaluation:

-What is Diffusional Equilibrium?

-When two connected areas contain the same concentration of particles and thus there is no lopsided movement of particles from one area to the other.

-Why does the can implode?

-The atmosphere has been replaced by water vapor inside the can which then condenses suddenly back into water. The atmospheric pressure is greater and crushes it!

-Why does the water "jump" into the imploding can?

-The can is attempting to once again reach diffusional equilibrium by taking on water.