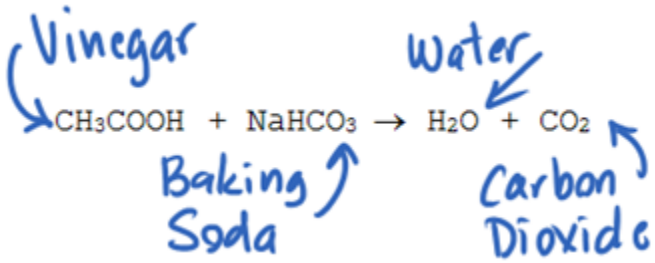
Invisible Fire Extinguisher

Amount of time Demo takes: 1-2 minutes

Try this at home!

Lesson's Big Ideas

- The flame on the candle requires oxygen (O_2) to burn.
- Baking soda (sodium bicarbonate) reacts with vinegar (acetic acid) to produce carbon dioxide (CO_2) in concentrated amounts.



- Concentrated carbon dioxide is denser than air, because air is made up of multiple gases, which keeps the carbon dioxide in the cup.
- The dense carbon dioxide "pushes" away the oxygen around the flame. Without oxygen the flame can not burn.
- Carbon dioxide fire extinguishers contain compressed carbon dioxide and work the same way.

Materials

- Tall clear plastic cup or pitcher
- Long handled spoon for stirring
- Baking soda (1 tbsp/demo)
- Vinegar (1 tbsp/demo)
- 2 tablespoon measuring cups
- Taper candles and stand (1 candle/day)
- Kitchen lighter
- Bucket for waste

SAFETY!

- Safety glasses
    - Prevents vinegar from getting in eyes
- Use appropriate fire safety precautions with an open flame.
    - Long hair tied back
    - Loose articles of clothing secured
- A gaff tape boundary should be put down around the table. Students should not be allowed in front of the tape boundary while the candle is lit.

Background Information

- Fire needs 3 things to keep burning: fuel, oxygen, and heat. If one of these things is removed the fire will not be able to continue burning.
- The density of carbon dioxide is 1.98 kg/m^3.
- The density of air is 1.225 kg/m^3.
- Density is the amount of mass a substance has per unit volume. IE: Pretend you have 2 balloons and one was filled with air and one filled with carbon dioxide. If both were filled to the same size and then weighed, the balloon filled with carbon dioxide would weigh more.

Setup Instructions

1. Place the candle into the candle holder.
2. Arrange your supplies for easy access throughout the demonstration
3. Add 1 tbsp baking soda to the plastic cup.

Instructional Procedure

- Use the lighter to light the candle.
- Pour 1 tbsp vinegar into the cup holding the baking soda.
- Allow the reaction to commence, indicated by bubbling (you do not need to wait for the reaction to complete)
- Slightly tip the cup over the candle to pour the carbon dioxide that is formed onto the flame (Do Not pour the liquid onto the flame, you are pouring the air out of the cup).

Tips & Tricks

- Use a tall cup or pitcher so the CO2 is captured inside and it is easier to pour over the candle.
- You can't wait too long to pour the CO2 over the candle as it will start to mix with the surrounding air atmosphere.

Assessment Questions

- What puts the flame out?
    - The carbon dioxide “pushes” the oxygen away.
- What is the gas in the cup?
    - Carbon dioxide
- What other things could put out the flame?
    - Water, snuffer (hollow metal cone with a handle), fire-retardant blankets

Careers & Real World Applications

- Although most fire extinguishers don’t use carbon dioxide, they are based on the principle of separating the flame from the oxygen fueling it.
- Careers:
    - Firefighter
    - Environmental Engineer
    - Aviation Engineer

Clean Up

- The waste from the demonstration can be poured down the sink. It is a weak solution of sodium acetate.
- **Recycle** empty plastic vinegar containers
- Clean up spills as needed. When completely finished gather all materials listed for this demo and make sure everything is accounted for.
- If something was used up, broken, or damaged, let someone know so it can get replaced or fixed.
- Make sure everything is dried before packing away!

References

- https://www.thoughtco.com/equation-for-the-reaction-of-baking-soda-and-vinegar-604043

Related Next Generation Science Standards

- K-5
    - 2-PS1 Matter and Its Interactions
    - 4-PS3 Energy
    - 5-PS1 Matter and Its Interactions
- 6-8

- MS-PS1 Matter and Its Interactions