



DRY ICE COLOR CHANGE EXPERIMENT

MATERIALS:

Dry Ice	Tall Clear Plastic Cups	Safety Goggles
Hammer	Red Cabbage	Colander
Cooler	Distilled Water	Cutting Board
Thick Gloves	Large Pot	Knife
Vinegar	Ammonia	Baking Soda
Lemon Juice	Pot Holders	Large Bowl
Portion Cups		

VOCABULARY:

Sublimate	ph	ph Indicator
Acid	Base	Chemical
Solid	Liquid	Gas
Solution	Dissolve	Carbon Dioxide
Neutral	Anthocyanin	Molecule
Dry Ice	Melt	

DIRECTIONS:

**** This experiment should only be done with adult supervision due to the use of boiling water and dry ice.**

1. With adult supervision, cut the head of red cabbage into small pieces.
2. Fill a large pot with distilled water.
3. With adult supervision, heat the water to boiling.
4. Add the pieces of cabbage.
5. With adult supervision, allow to boil for 15 minutes.
6. Place the large bowl in a sink and the colander on top of the bowl.
7. With adult supervision and using pot holders, remove the pot from the stove.
8. Pour the contents into the colander. Allow the purple liquid to fill the bowl below the colander.
9. Dispose of the cabbage pieces in the colander.
10. Allow the cabbage water to cool to room temperature.
11. Fill a portion cup with the cabbage water, another with vinegar and another with ammonia.
12. Label the portion cups with ammonia and vinegar.
13. Fill a plastic cup ½ full of distilled water.
14. Add 1/2 a portion cup of cabbage water to the water. Observe the color (it should be purple).
15. Put your safety goggles and gloves on.
16. Lay the dry ice, still in the bag, on the ground. Use the hammer to break up the dry ice into smaller chunks.
17. Rip open the bag and remove a chunk of dry ice with a gloved hand.
18. Place a chunk of dry ice in the distilled water/ cabbage water. Observe the color change (it should start to turn more pink).
19. Add 1/2 a portion cup of ammonia to the cup. Observe the color change (it should turn blue/green).
20. Add 1/2 a portion cup of vinegar to the cup. Observe the color change (it should turn bright pink).



THE STEAM BEHIND THE EXPERIMENT:

When dry ice is placed in water, it sublimates rapidly since the water is so much warmer than the dry ice. The solution appears to boil. As the dry ice sublimates to gaseous CO₂, some of the gas bubbles away quickly and some dissolves in the water. A heavy white cloud of condensed water vapor forms above the liquid (due to the coldness of the escaping CO₂ gas). As the CO₂ gas dissolves in the

water, the solution becomes more acidic from the production of carbonic acid (H_2CO_3), a weak acid, according to the following equation: $H_2O + CO_2 \leftrightarrow H_2CO_3$.

Acids create hydronium ions when in contact with water and have a sour taste. Lemon juice and vinegar are both acids. Bases release (or create) hydroxide ions in water and taste bitter. Many soaps and cleaning products are bases. When hydroxide ions and hydronium ions combine, they create water again which is neutral.

Cabbage juice contains a special molecule called anthocyanin (an organic compound called a flavin), which gives red cabbage its color. Anthocyanin is also found in blueberries, grapes and lots of other plants. When anthocyanin comes in contact with the hydronium ions in an acid it turns pink, and when it comes in contact with the hydroxide ions in a base it turns blue or green. We refer to cabbage juice as a pH indicator because it can tell us if a substance is acidic or basic by changing color.

Dry ice is solid carbon dioxide. At its surface temperature of -109.3 degrees Fahrenheit (-78.5 degrees Celsius), a frozen block of dry ice transforms directly into a gas, skipping the liquid phase entirely. Because it doesn't melt, and because it can be formed in solid blocks or pellets, it's already a popular choice for shipping certain foods and medicines.

Despite its many benefits as a refrigerant, dry ice must be handled properly or it poses health risks. Because it's so cold, insulated clothing and gloves should be worn when handling it, and it should never be touched directly, as it can "burn the skin similar to frostbite. It should also never be placed in closed containers as the rapidly expanding gas can cause the container to explode.

MAKE IT AWESOME:

Try the experiment again, but use phenol red instead of cabbage water. It should turn shades of yellow for acidic solutions and red for basic solutions.

EXTENSIONS:

1. What happens when you change the amount of vinegar or ammonia you add to the solution?
2. What happens when you leave the solution alone and allow the dry ice to sublimate more?
3. What other changes can you come up with for this experiment?

WEBSITES AND VIDEOS:

1. Video of Cabbage Juice Indicator Experiment: <https://youtu.be/VN6XnCrihEo>
2. Video of Dry Ice and Cabbage Juice Experiments: <https://www.facebook.com/stevespangler/videos/spooky-color-changing-potions-dry-ice-science/857727891431172/>

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