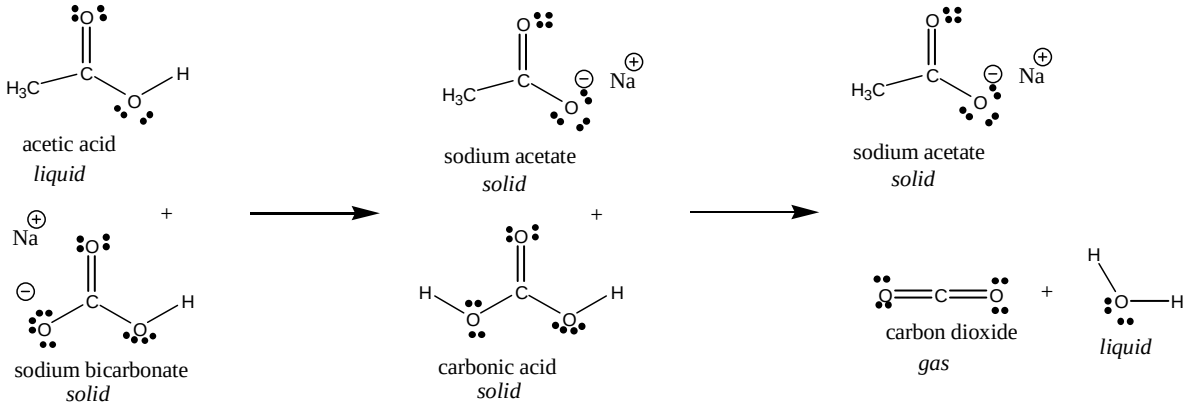
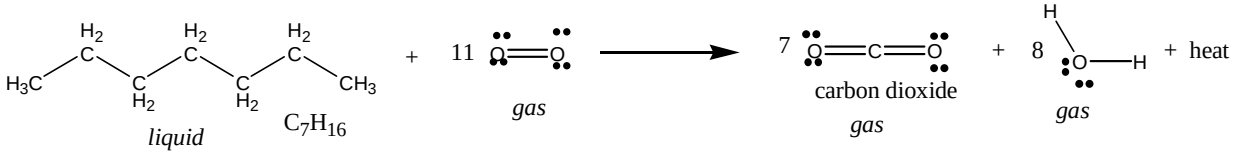
The classic Mentos and Diet Coke geyser is an explosive phenomenon. An explosion can be simply defined as a chemical or physical reaction, liberating a large amount of gas, that is confined in some way. An explosive device is usually made by confining a mix of chemicals that react to form a large amount heat and gas in an enclosed vessel such as a metal or glass container. A well known reaction that liberates carbon dioxide gas is the acid-base reaction between an acid such as acetic acid (vinegar) and sodium bicarbonate (baking soda). The carbonic acid formed by this reaction is easily decomposed into water and carbon dioxide.



If the gas is confined in a vessel and the pressure builds up to a point that the confining vessel breaks apart, then an explosion will occur.

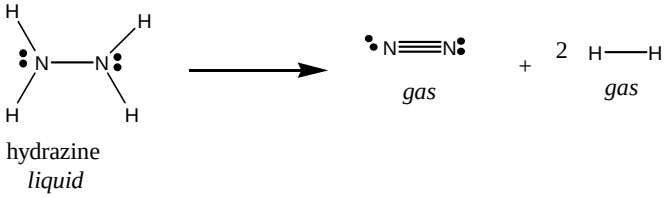
An explosion can also occur without a chemical reaction through a physical change of state. Heating a container with water inside over a fire will eventually cause the vessel to explode when the pressure of the steam reaches the point where the vessel breaks apart. This is the principle by which popcorn pops! When the kernel is heated the small amount of water stored inside the starchy endosperm turns into steam causing it to expand. As the steam expands it puts pressure against the hard starch in the endosperm. Eventually, this causes the pericarp of the kernel to give way causing it to explode as it flips inside out allowing the steam to escape and expose the soft white fluffy starch known as popcorn.

Explosions that are done under controlled conditions are very useful. The car you drive, most likely, has an internal combustion engine that is powered by exploding a mixture of gasoline and air within the engine block. The chemical reaction for this explosion is the following.

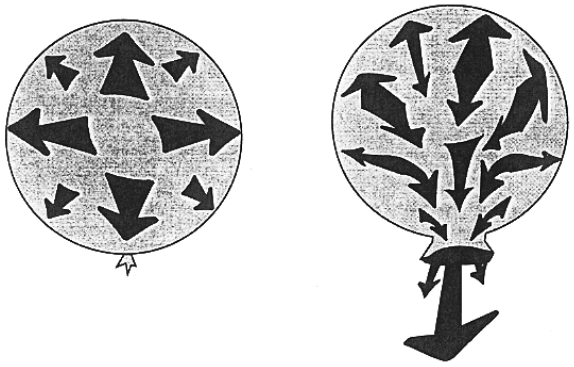


Because this chemical reaction generates a large quantity of heat, the water in the product is in the form of steam. This causes the volume of the mixture to expand rapidly and displace the piston.

A controlled explosion can also be used to propel an object such as a rocket. One chemical rocket propellant is hydrazine (N_2H_4). Hydrazine is a liquid that burns to form gaseous nitrogen and hydrogen. The release of gas is so forceful that the reaction can propel a large object through the air. Of course, considerable engineering is necessary to control the production and release of gas. That is why they call it "rocket science."



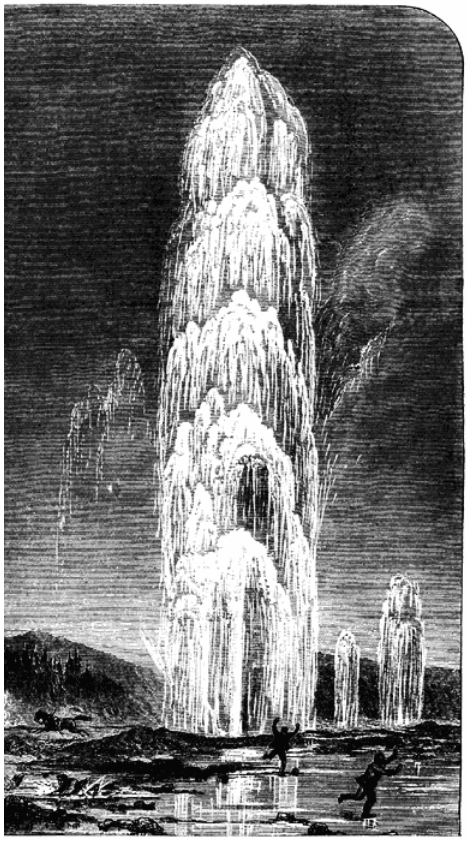
Propulsion can also be created by the release of gas that has been put under pressure. If you blow up a balloon and let go of the stem, the escaping air will push the balloon around the room. Model rockets (and paintballs) are propelled by a carbon dioxide canister that can be recharged with pressurized carbon dioxide.



If the gas released by a chemical or physical reaction is surrounded by a liquid or solid, we call it foam. Foam is created by releasing a gas in a medium that traps the bubbles. It's hard to imagine modern living without foam products such a foam rubber, Styrofoam, shaving cream, and many other foam products.

Finally, we have gotten around to Mentos and Coke! This phenomenon may be classified as a "foam producing propelled explosion." The back of the "geyser tube" package explains the effect in detail: "Each Mentos chewy mint has thousands of tiny pits all over the surface. These tiny pits are called nucleation sites - perfect places for carbon dioxide bubbles to form. As soon as the Mentos hit the soda, bubbles form all over the surface of the candy. Couple this with the fact that the Mentos candies are heavy and sink to the bottom of the bottle and you've got a double-whammy. When all this gas is released, it literally pushes all of the liquid up and out of the bottle in an incredible soda blast."

In the this lab we are going to explore the Mentos and Diet Coke phenomenon by apply the scientific method to understanding the geyser effect. This week we are going to have small group discussions at the beginning of class to determine which experiments we will do. Each group will propose one experiment. Every group will perform their own experiment as well as everybody else's experiment. The data will be recorded, and reported on.



Mint Mentos ingredients: sugar, wheat glucose syrup, hydrogenated coconut oil, rice starch, gum arabic, sucrose esters of fatty acids, gellan gum, and natural flavors. See <http://www.kyrene.org/staff/sreed/Science/Scientific%20Method/Mentos%20Ingredients.html> for more information.

Diet Coke ingredients: carbonated water, caramel color, aspartame, phosphoric acid, potassium benzoate, natural flavors, citric acid, caffeine

http://quest.nasa.gov/aero/planetary/atmospheric/images/openballon.gif
http://etc.usf.edu/clipart/53700/53785/53785_giant_geyser_lg.gif

Prelab:

I assume that you are all aware of the Mentos and Diet Coke phenomenon, if not personally familiar with the geyser effect. According to the geyser tube package, adding seven Mentos to a 2-liter bottle of Diet Coke will produce a 25 foot high soda geyser.

1. (1 point) What ingredient(s) in Mint Mentos do you think would have the greatest effect on the geyser phenomenon?

2. (1 point) How could you test your answer to question 1?

3. (1 point) What ingredient(s) in Mint Mentos do you think would have the least effect on the geyser phenomenon?

4. (1 point) What ingredient(s) in Diet Coke do you think would have the greatest effect on the geyser phenomenon?

5. (1 point) How could you test your answer to question 4?

6. (1 point) What ingredient(s) in Diet Coke do you think would have the least effect on the geyser phenomenon?

Small group discussion (you do not have to answer these before coming to lab):

1. Describe in your own words the cause of the Mentos and Diet Coke geyser. This is your central hypothesis.

2. Propose at least one test that will give you some information about the central hypothesis.

3. How will the proposed test(s) confirm, disprove, or extend the central hypothesis?

Small group discussion (you do not have to answer these before coming to lab):

4. Describe a secondary hypothesis about Mentos and Diet Coke geyser.

5. Propose at least one test that will give you some information about the secondary hypothesis.

6. How will the proposed test(s) confirm, disprove, or extend your secondary hypothesis?

7. What other things about this phenomenon can be measured in addition to 1) the volume of Diet Coke at the beginning of the test, 2) the number of Mentos, and 3) the height of the geyser?

Lab Report.

Description of test 1
Data Gathered
Observations
Interpretation of Data

Description of test 2
Data Gathered
Observations
Interpretation of Data

Description of test 3
Data Gathered
Observations
Interpretation of Data

Description of test 4
Data Gathered
Observations
Interpretation of Data

Description of test 5
Data Gathered
Observations
Interpretation of Data

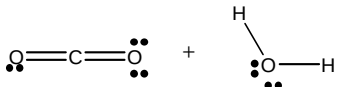
Description of test 6
Data Gathered
Observations
Interpretation of Data

Lab Report Questions:

1. (1 point) Are people who simultaneously drink Diet Coke and swallow Mentos in danger?

2. (1 point) Could someone create a delayed-action-bomb by freezing Mentos in ice cubes, adding the ice cubes to a bottle of Diet Coke, and screwing a cap back on the bottle?

3. (1 point) Explain why carbon dioxide is soluble in water. Hint: the first experiment we did this semester.



carbon dioxide *gas* + *liquid*

4. (1 point) Propose an experiment that you would like to try to further test the Mentos and Diet Coke geyser phenomenon.