

Woosh Bottle

Kitchen Table Demonstration

The Rundown

Time: 5 minutes

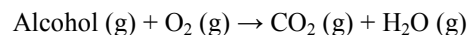
Content: Combustion, Activation Energy, Exothermic Reaction, Limiting and Excess Reactants

Safety Concerns: Moderate

Materials Availability: Common

The addition of a flame into a water jug containing alcohol vapors results in a dramatic reaction that produces flames and a loud noise. Students are impressed by the explosion and are surprised to learn that it will not occur twice within a short period of time.

of oxygen to produce carbon dioxide and water according to the following general equation:



The reaction also releases a considerable amount of heat, making it **exothermic**.

Oxygen is the reactant that is used up first in the reaction, making it the **limiting reactant**. Since alcohol remains, it is referred to as the **excess reactant**. After the combustion has been carried out in the water jug, additional burning splints fail to ignite the vapors. This is because the jug is now filled with carbon dioxide gas, with an insufficient amount of oxygen for the reaction to take place. The jug must be inverted to for up to 30 minutes to allow the carbon dioxide to drain out of the container before the combustion reaction will occur again.



Content Application

- Combustion
- Activation Energy
- Exothermic Reaction
- Limiting and Excess Reactants



Enduring Understandings

- Combustion reactions occur when alcohols react in the presence of oxygen to produce carbon dioxide and water.
- Combustion reactions are exothermic.
- The limiting reactant is completely used up in a reaction, while the excess reactant remains.



Chemistry

Alcohols are volatile, meaning they readily evaporate to form vapors. These vapors are extremely flammable and ignite much more quickly than their respective liquid. This is due to the relatively low amount of **activation energy** required to start the reaction.

When a lit wooden splint is introduced to the water jug, the vapors inside immediately ignite in a combustion reaction. **Combustion reactions** occur when an alcohol (or other fuel) burns in the presence



Materials

- Large water jug (pictured above)
- Alcohol such as methanol or ethanol
- Wooden splints
- Flame (burner, lighter, or match)



Safety

- Goggles
- Do not use an excessive amount of alcohol.
- To avoid burns, use a wooden splint that has been lit at a distance from the jug.
- Never invert the water jug before lighting.
- Test the demonstration outside or in an area with high ceilings before attempting inside.
- Students should stand 15-20 feet away.



Procedure



Figure 1. Ethanol vapors igniting

1. Pour a small amount of alcohol into a large water jug. Start with 2 or 3 mL and increase after you become familiar with the demonstration.
2. Roll the jug on its side to allow the liquid to spread over the walls of the container. Do not allow any liquid to exit through the opening on top.
3. Light a wooden splint at a distance from the jug.
4. Ensure that all students are at least 15-20 feet from the jug.
5. Quickly drop the lit splint into the jug. **WARNING:** The explosion can be loud. It can also produce flames that shoot from the opening of the bottle as shown in Figure 1. Practice outside or in a room with high ceilings before attempting in a classroom.
6. Repeat steps #1-5. The combustion will not take place this time as discussed in the “Chemistry” section. It may be necessary to put out a small flame on top by covering the jug opening with a beaker.
7. Once all flames are extinguished, invert the jug in a sink to drain out the carbon dioxide. This process can take up to 30 minutes.



Disposal

- Invert the jug in a sink and allow all of the ethanol to drain out. Flush any remaining ethanol down the sink with water.



Follow-Up and Student Participation

This demonstration is only recommended for trained professionals and should not be completed by students.

Try the following follow-up activities:

1. Write and balance the equations for the combustion of methanol and ethanol.
2. Draw a rough sketch of the reaction coordinate for the reaction. Label the activation energy and the heat of combustion.
3. Ask students to calculate the heat released when given the approximate volume of O_2 and the heat of combustion for the alcohol.