

Acids and Bases Experiments

NaHCO_3 and vinegar will be used to shoot a cork out of a bottle to show that some acid-base reactions generate gases like CO_2 . All students in the class will participate in a voice-activated chemical reaction. Students will remove a stopper and speak into a flask containing base and an indicator that will change color once enough CO_2 is introduced from the students' breath. Further color changes from basic to acidic conditions will be shown using a basic solution, universal indicator and solid CO_2 . Reaction of metals and acid will be shown with Mg and Sprite.

Supplies Needed:

For the **rocket reaction**:

You provide all of the following except for the cork:

- * **empty 1 L plastic soda bottle with label removed**
- * **tissue paper**
- * **vinegar**
- * **sodium bicarbonate (baking soda)**
- * **measuring cup**
- * **teaspoon**
- * **scissors**
- * **water**

cork with streamers attached by a thumbtack

For the **voice-activated chemical reaction**:

- * **water (you provide)**

250 mL Erlenmeyer flask (will be provided)

dropper bottle containing phenol red (will be provided)

For the **basic solution with universal indicator and CO_2** :

- * **empty 1 L plastic soda bottle with label removed (you provide)**

0.1 M NaOH solution (will be provided)

dry ice (solid CO_2) (will be provided)

Universal indicator (will be provided)

3 beakers (will be provided)

For the **Mg in Sprite reaction**:

- * **flat Sprite or 7-up (you provide)**

- * **jar (you provide)**

magnesium turnings (will be provided)

Safety: Students should wear safety glasses. Most of the chemicals used are dilute and not particularly dangerous. Needless to say, none should be consumed (except for the Sprite). If students get any of the chemicals used on their clothes or skin it can be simply washed off in the bathroom. The sodium bicarbonate is not dangerous (but should not be consumed) and can be used to neutralize any vinegar or NaOH solution that gets spilled. The Dry Ice (solid CO_2) is very cold, -78°C or -108°F . It can give anyone touching it frostbite relatively quickly. **DO NOT LET THE STUDENTS TOUCH OR PLAY WITH THE DRY ICE!** All chemicals, except for the dry ice, can be safely washed down a bathroom sink.

Objectives/Chemistry:

First explain to the students that scientists write down what they observe and that they must do the same when you perform the demos. As you perform the demos, you should ask the students for examples of acids

and bases. If they need help, explain that every day we come into contact with some weak acids (like vinegar, citrus juices, Vitamin C and soft drinks) which are usually sour tasting and weak bases (like soaps, detergents and many cleaning products) which feel slippery to the touch.

Next, explain that acids and bases are chemical opposites. When we add them together, they may react violently. Then do the **rocket reaction** (see the procedure section). Tell them that vinegar is an acid and baking soda (NaHCO_3) is a base. Explain why the cork shoots out of the bottle because of the production of CO_2 gas which increases the pressure.

For your information, the chemical reaction that takes place is:



Ask the students what gas do they exhale? It is carbon dioxide (CO_2). Tell them that we can use their breath to carry out an acid-base reaction. Explain that we use indicators (things that change color) to determine if we have an acid or a base or if we have something that is neutral like water. Do the **voice-activated chemical reaction** and explain that the initial color of the basic solution changes when enough CO_2 is introduced to make the solution turn acidic. Explain that CO_2 dissolved in water is one of the reasons that carbonated drinks are acidic.

Further demonstrate the color change from basic to acidic, using a **basic solution with universal indicator and adding solid CO_2 (dry ice)**. Ask the students to compare the result to the basic and water solutions. Explain that during the reaction, the solution goes from basic to neutral to acidic.

Finally, show them the reaction of **magnesium turnings in Sprite** and explain that the acid in a soft drink can react with certain metals. Ask what metal is a soft drink can made out of? Answer: aluminum that won't react with the acid in the soft drink (actually the aluminum is plastic coated to make sure that it doesn't react).

Procedures:

Rocket reaction: In a 1 L soda bottle that has been rinsed and had the label removed, make a solution of half vinegar and half water that fills the bottle about 1/3 to 1/2 full. Make streamers out of regular paper and attach with a thumbtack to the cork. Place a teaspoon of baking soda (NaHCO_3) in the middle of a 4 x 4 inch piece of tissue paper and roll the tissue paper into a tube twisting the ends. When you are ready to do the demo, drop the tissue paper tube of baking soda into the vinegar solution and put the cork into the mouth of the bottle. **DO NOT** aim the bottle at the students or the light fixtures.

Voice-activated chemical reaction: Place 100 mL of water in the 250 mL flask and add about 2 drops of phenol red indicator so that the color is light pink (you may need a sheet of white paper behind the flask so that the students can see the color). Stopper the flask. Before you do the demo, announce to the class that this reaction can be activated by just the right person's voice. As you carry the flask around the classroom, remove the stopper for each student and let them speak to the solution. Stopper the flask and swirl after each student. The indicator color will change when enough CO_2 is blown into the flask. You can repeat this demo by pouring out the solution and starting over.

Basic solution with universal indicator and adding CO_2 : Pour ~ 500 mL of 0.1 M NaOH into two beakers and put ~ 500 mL of water in a third beaker and ask the students what they think the solutions are. Add a few drops of universal indicator to all three beakers. Add dry ice (CO_2) to one of the beakers with base and tell the students to record the color changes.

Magnesium turnings in Sprite: Fill the jar ~ 3/4 full with Sprite (or 7-Up) the night before the demo and leave uncovered. The soda needs to be flat for this experiment to work well. When doing the demo, add the vial of provided magnesium turnings and let the students observe what occurs. The gas being produced is H_2 . Discuss how many of the things we drink are acidic – they are not dangerous because they are dilute weak acids.