Turmeric Twist

Participants add single drops of baking soda solution and swirl a small cup of yellow turmeric solution until it turns and remains a rusty red color. Then they react baking soda and vinegar to find out whether the carbon dioxide gas produced will be able to return the red solution back to its original yellow color.

Ages	Activity Time	Group Size
8 - 11 years	Preparation • 45 minutes in advance • 15 minutes on-site Activity: 10 minutes	Number of participants: 6 per hour per station Ratio of facilitators to participants 1:1

Concepts to Explore

- Acids & Bases
- Using an indicator solution to recognize when a solution has been neutralized
- Some spices, such as turmeric add aroma, taste, *and color* to food.

Safety Requirements & Other Considerations

- Participants and facilitators must wear safety glasses at a minimum.
- Turmeric solution stains clothing and skin. Wear an apron as you make the indicator solution to protect your clothes. You may choose to wear gloves to prevent your fingers and fingernails from turning yellow.
- Use small amounts of liquid in the cups to prevent spilling.
- Conduct the activity within the confines of a spill tray. If there is a splash or spill, the liquid will only stain the spill tray.
- Use paper towels to soak up any spilled indicator solution.
- Alcohol and indicator solutions made with alcohol are flammable. Keep both liquids away from heat sources and flames.

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Question to Investigate
How many ways can I change the color of a turmeric indicator solution?

Materials Required

- turmeric indicator solution
    - 6 bottles of 99% isopropyl alcohol, 473 mL
    - ground turmeric, 1 g per 473 mL alcohol
- baking soda, 2-pound container
- 200 mL of baking soda solution, 1%
- vinegar, 5% acetic acid solution
- 4 filter papers or coffee filters
- 2 beakers, 500 mL or larger
- 6 screw top bottles with vinegar
- 12 dropper bottles
- 4 sleeves of 100 small clear plastic cups
- 36 tall clear plastic cups
- 40 wide clear plastic cups
- 6 ¼-teaspoon measuring spoons
- 6 medicine cups
- wax paper sheets, 2 boxes
- paper towels
- 4 tabletop buckets (no handle) shiny yellow
- 4 UV flashlights
- 12 AAA batteries
- labels: **baking soda**, **baking soda solution**, **vinegar**, **turmeric indicator**
- White plastic serving trays

Preparation

Prior to Activity

- Make a turmeric indicator solution.
    - Pour the entire contents of one bottle (473 mL) of isopropyl alcohol into a 500 mL beaker.
    - Add 1 gram of turmeric and stir until as much dissolves as possible
    - Place a piece of filter paper over an empty beaker and push it down to make a dent in the paper. Then slowly pour the turmeric and alcohol over the filter. Replace the filter paper as needed. Dispose of the used filter papers.
    - Return the turmeric stained alcohol to the original bottle and label it, **turmeric indicator**. Continue this process for all 6 bottles.
- Label 4 wide clear plastic cups, **baking soda**.

- Fill and label six 60-mL screw top bottles and 6 dropper bottles with **vinegar**.
- Label 6 dropper bottles **baking soda solution**.
    - Make the baking soda solution by dissolving 1 grams of baking soda in 100 mL of water. Not all will dissolve, so after a good effort, decant the solution and pour it into 6 labeled dropper bottles.

On-Site

- Arrange 6 white serving trays across the front of the table.
- Fill 6 wide clear plastic cups with baking soda. Place a ¼-teaspoon measuring spoon in each cup. Place one cup on each tray.
- Add a dropper bottle of baking soda solution and a dropper bottle of vinegar to each tray.
- Place one 60 mL screw top bottle containing vinegar and a medicine cup on each tray.
- Place one small clear plastic cup, one wide clear plastic cup, and one tall clear plastic cup toward the front and center of each tray.
- Add 10 mL of turmeric solution to each small clear plastic cup. For easy measuring in between participants, notice the level of solution in one cup and pour others to match that amount. There is no need to be exact with this, and you will not have much time between participants.

Facilitation Instructions & Questions

1. Introduce the spice, *turmeric*.

Instructions

- Show the sample of turmeric and explain that turmeric is used to add aroma, flavor, *and color* to food. It is used in some yellow rice recipes, gives curry a yellow color, and is an ingredient in macaroni and cheese.
- Turmeric has long been used in traditional medicine throughout Asia. People drink "golden milk" or find other ways to consume turmeric because it reduces inflammation (or swelling) in the body.

Questions

- Which plant part does turmeric come from?
  Participants may say root, which may be close enough for young children. It is a rhizome, which is a kind of underground stem that the roots grow from on this plant.
- What are some yellow-colored foods you have eaten before?

2. Introduce the turmeric indicator solution.

Instructions

- Turmeric is tasty, colorful, good for your body, and does something very interesting.
- Shine a UV flashlight on the turmeric.
- As you can see, turmeric is more than just a spice! Let's see what else it can do?

Questions

- Can you see how turmeric glows when you shine a UV light on it?

3. Add single drops of baking soda solution to turmeric.

Instructions

Direct participants to:

- Add one single drop of baking soda to the turmeric solution.
  There will be a red spot where the drop lands. As you swirl to mix the contents of the cup, the solution becomes yellow again.
- Swirl to see if the red color stays.
- Add single drops and swirl until the red color stays.
  It should take around three single drops for red color to stay.
- Shine a UV light on the red form of turmeric.

Questions

- What changes do you notice?
- Does the turmeric glow when it is in its red form? *No.*

4. Optional for children ages 9 and up: Introduce the concept of an indicator.

Instructions

- Tell participants: When turmeric turns red, you know that a particular type of liquid was dropped in it. Red means that the liquid is a basic solution.
- Acids and bases are chemical opposites.
- Explain that turmeric mixed in alcohol is an "indicator" because it changes color when an acid or base is mixed with it.
- The color of an indicator can tell you whether an acid or base has been added to it.

Questions

- Do you think the baking soda solution might be a base?
- Can you name a food that is very acidic?
  Hint: Acidic foods taste sour.

5. Put the turmeric solution aside for a moment and practice making the "dome of science" with the cups.

Instructions

- Let's turn the turmeric yellow again!

Direct participants to:

- Add ¼ teaspoon of baking soda to the wide clear plastic cup.
- Hold the tall clear plastic cup upside down and practice putting it over the wide cup like a lid.

Pictures showing how to make the "dome of science" are at the end of this document.

Questions

6. Start the chemical reaction between baking soda and vinegar.

Instructions

- Tell participants that we are going to witness a chemical reaction between baking soda and vinegar.
- Pour 10 mL of vinegar into the medicine cup.

Direct participants to:

- Pour the vinegar on top of the baking soda with one hand while holding the upside-down cup with the other.

Act quickly to stand the small clear plastic cup up in the wide clear plastic cup and on top of the forming foam. Then tell participants to place the tall cup over the cups like a lid.

Questions

- Have you ever mixed baking soda and vinegar together before?
  What happened?

7. Show participants how to swirl the stack of cups.

Instructions

- While keeping the bottom of the "dome of science" on the tray, move the stacked cups in a circular motion.

Direct participants to:

- Move the "dome of science" in a circular motion.
- Continue swirling until the color of the turmeric returns to yellow.

While the participant swirls:

- Explain that tiny bubbles of carbon dioxide are being formed in the chemical reaction.
- Swirling mixes the carbon dioxide gas throughout the air in the cups.

Questions

- Have you ever mixed baking soda and vinegar together? What happened?
- What changes do you notice?
- What do you notice about the color of the turmeric indicator?

- Because carbon dioxide gas is more dense air it sinks down.
- The carbon dioxide near the surface of the turmeric liquid gets mixed into the turmeric liquid.
- When carbon dioxide dissolves in water, it becomes acidic.
- Because acids and bases are chemical opposites, they neutralize each other and made the turmeric indicator turn yellow again.

8. Shine a UV light on the turmeric and invite exploration.

Instructions

- Remove the small cup from the "dome of science" and shine a UV light on it. The turmeric solution will fluoresce again.

Invite participants to:

- Add single drops of baking soda solution and swirl until the turmeric solution is red.
- Then add single drops of vinegar and swirl until the turmeric solution returns to yellow again.
- Continue until they feel done with this activity.

Questions

- How many ways did you change the color of turmeric indicator solution?

Clean Up

- Get ready for the next participant by emptying the liquids in both the small and wide plastic cups into a bucket.
- Stack the small clear plastic cup with other used cups and place a new clean cup on the tray.
- Pour 10 mL of turmeric solution into the fresh small cup.
- Rinse the wide cup with water and place it back on the tray. If turmeric solution has stained the cup, put this cup aside and use a fresh cup. This wide cup can be rinsed and reused later.
- The tall clear plastic cup can be reused indefinitely. Leave it on the tray.
- **At the end of the event:** If the plastic tablecloth is dry and not stained, fold it and place it on top of the bin.
- Carry the bin over to the trunks and take the buckets to the dedicated sink to empty the liquid. The empty buckets will also be collected near the trunks.

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Explore the Chemistry

Turmeric contains a chemical, curcumin, that is bright yellow in an acidic or neutral solution and is rusty red in color in a basic solution.

- Curcumin, in the red form, readily accepts H^+ ions from an acid, such as carbonic acid or vinegar, and turns yellow.

- Curcumin in the yellow form, donates H^+ ions to a base, such as baking soda solution, and turns red.

When baking soda and vinegar react, carbon dioxide and other substances (sodium citrate and water) are formed. As you swirl the stacked cups, the carbon dioxide mixes into the air in the cup and, because it is denser, sinks down to the area just above the turmeric indicator. As you continue to swirl the cups, the carbon dioxide mixes into the water of the indicator solution, forming carbonic acid.

Carbon dioxide is challenging to keep in solution.

- For example, soda pop left out uncapped on a countertop will "go flat". This term refers to a lack of carbon dioxide bubbles.
- Both low temperature and increased pressure help keep carbon dioxide dissolved in water longer.
- Therefore, to keep soda pop fresh, people store it in a cool place with the cap tightly secured on the bottle.

If left out long enough, the carbonic acid in the small cup of turmeric indicator will come out of solution. Small bubbles of carbon dioxide gas float to the surface and enter the air. The turmeric indicator that has been recently neutralized will eventually return to its rusty red color if left alone.

Interestingly, turmeric dissolved in an alcohol solution fluoresces when in the presence of a UV light. The red form of this solution does not fluoresce.

References

- *A Spice Isn't Just for Cooking*, Jesse Bernstein
  Chemical educator retired from Miami Country Day School and member of the ACS Committee on Community Activities

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How to make a “Dome of Science”

1. Place the small clear plastic cup standing up inside the wide clear plastic cup.




2. Then place the tall cup over the wide clear plastic cup like a lid.


