5th Grade - Lesson 5.1 **Name _____**
Activity Sheet
Engineering Design **Date _____**

Safety: Wear safety goggles and be sure to follow all safety instructions given by your teacher. Wash your hands after completing the activity.

Define the Problem

Imagine that you are riding in a boat enjoying the sunshine with your friends. You tell a great joke or funny story and at the punch line you spread your arms out wide. As everyone starts to laugh, you notice your cell phone flying through the air. You look in horror as the phone hits the water and begins to sink.

Have you ever dropped anything in the water and lost it? This can happen to anyone. If you are near a pool, lake, river or ocean your cell phone could be in danger. If the phone begins to sink, maybe there's a way to protect and save it from the watery depths.

1. You've been asked to design a device that uses a chemical reaction to rescue a sinking cell phone and help solve this problem.

   What type of products should the chemical reaction produce, and how can these products help a possible cell-phone flotation device work if a phone falls in the water?

   The chemical reaction needs to produce a gas. The gas will inflate a bag which can be attached to a cell phone to make it float.

Develop Possible Solutions

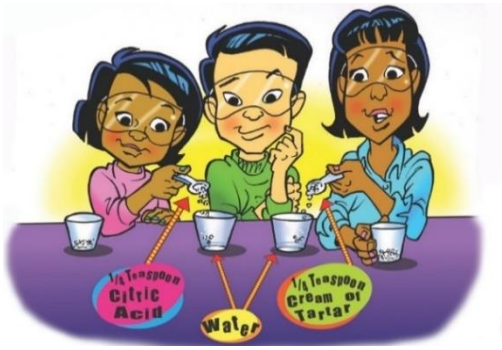
Question to investigate

Which acid produces more gas when it reacts with baking soda?

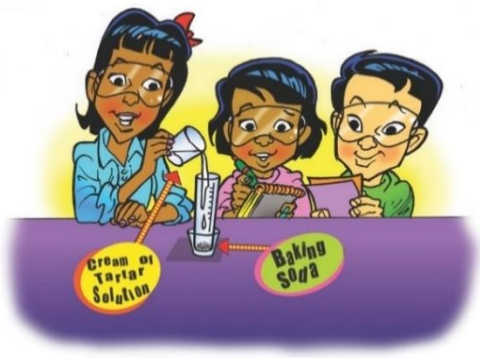
Materials

- Goggles
- Citric acid
- Cream of tartar
- Baking soda
- Detergent solution
- Water
- 2 small clear plastic cups
- 2 wide clear plastic cups
- Graduated cylinder (50- or 100-mL)
- Dropper for detergent solution
- Paper towel

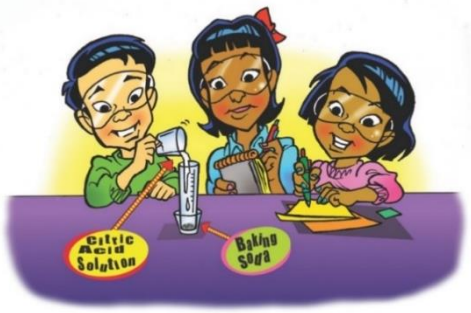
Procedure



1. Pour 10 mL of water into each of two small clear plastic cups.
2. Add ¼ teaspoon of citric acid to one cup.
3. Add ¼ teaspoon of cream of tartar to the other cup.
4. Carefully swirl each cup until the powder dissolves as much as possible. (The cream of tartar will not dissolve completely and the resulting solution may look milky white)
5. Add 1 drop of detergent solution to each cup and gently swirl to mix.
6. Add ¼ teaspoon of baking soda to the graduated cylinder and stand the cylinder upright in a wide clear plastic cup.
7. Carefully pour the cream of tartar solution into the graduated cylinder containing the baking soda. Observe and record the amount (level) of foam produced in the graduated cylinder.



8. Rinse out the graduated cylinder, dry it with a paper towel, and add ¼ teaspoon of baking soda to the cylinder.
9. Carefully pour the citric acid solution into the graduated cylinder containing the baking soda. Observe and record the amount (level) of foam produced in the graduated cylinder.



2. Did the citric acid solution or the cream of tartar solution produce more gas when added to the baking soda?

   The citric acid solution produced more gas when added to the baking soda.

3. When testing to see which acid produced more gas, why was it important to use the same amount of citric acid and cream of tartar in each experiment?

   If you want to see which acid produces more gas when reacted with baking soda, you need to use the same amount of acid or it's not a fair test.

4. Which acid do you think you should use in your cell phone rescue device? Why?

   I would use citric acid. It makes more bubbles faster and could rescue the phone more quickly.

Make a prototype

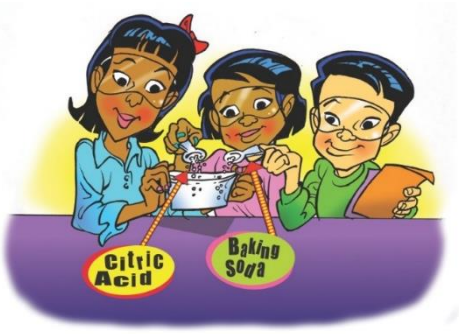
Question to investigate:

How full will a bag be inflated when citric acid, baking soda, and water are combined in a sealed plastic bag?

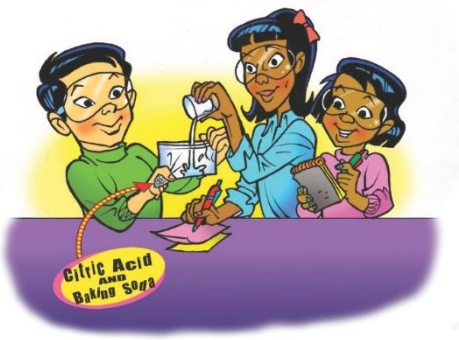
Materials

- Goggles
- Citric acid
- Baking soda
- Water
- Graduated cylinder
- Snack size zip-closing plastic bag

Procedure



1. Open up a snack-size, zip-closing plastic bag. Working with a partner, add ¼ teaspoon of citric acid to one corner of the bag.
2. Add ¼ teaspoon of baking soda to the same corner of the bag. Using your fingers, gently knead or rub the outside of the bag to mix the powders together.
3. Use your fingers to hold or close off the corner of the bag containing the powders in order to keep these solids separate from the rest of the bag. Have your partner carefully add 10 milliliters of water to the other corner of the bag. Try to be sure that the water does not yet touch the powders in the other corner.
4. Get as much air out of the bag as you can and seal the bag securely. Let go of the corner and tilt the bag back and forth so that the water and the powders mix.
5. Lay the bag on a table and observe how much gas is produced and how much the bag expands.



5. Describe about how much the bag inflated.
   The snack bag inflated a lot. It was completely full.

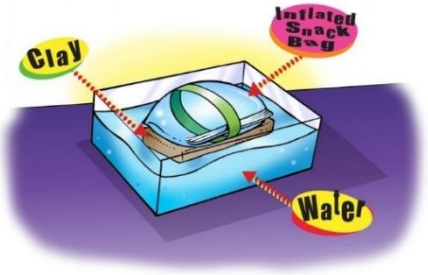
Try to make a model cell phone float

Materials

- Clay model of a cell phone
- 1 piece of tape (about 25–30 cm)
- Water
- Bucket or large plastic container

Procedure

1. Attach the inflated plastic bag to the clay model by wrapping a piece of tape around the bag and clay.
2. Place the taped bag and clay in a container of water.



6. Did your inflated bag make the model cell phone float?
Yes or **No** The inflated bag did make the cell phone float.

Optimize the Design

Question to investigate:

Can smaller amounts of ingredients still produce enough gas to inflate the plastic bag and make the cell phone float?

Materials for each group

- Goggles
- Citric acid
- Baking soda
- Water
- Graduated cylinder
- Snack size zip-closing plastic bag
- 1/8 teaspoon
- Clay model of a cell phone
- 1 piece of tape (about 25–30 cm)
- Water
- Large bowl or bucket

Procedure

1. Open up a small, snack-size zip-closing, plastic bag. Work with a partner to add 1/8 teaspoon of citric acid to one corner of the bag.
2. Add 1/8 teaspoon of baking soda to the same corner of the bag. Using your fingers, gently knead or rub the outside of the bag to mix the powders together.
3. Use your fingers to hold or close off the corner of the bag containing the powders to keep the solids separate from the rest of the bag. Have your partner carefully add 10 milliliters of water to the other corner of the bag. Try to be sure that the water does not yet touch the powders in the other corner.
4. Get as much air out of the bag as you can and seal the bag securely. Let go of the corner and tilt the bag back and forth so that the water and the powders mix.
5. Lay the bag on a table and observe how much gas is produced and how much the bag expands.
6. Test the partially inflated bag to see if it still allows the clay cell phone model to float when placed in water.

7. Did the smaller amounts of citric acid and baking soda produce enough gas to inflate the bag enough to make the model cell phone float?
   The smaller amounts of citric acid and baking soda filled the bag about half-way. This was still enough gas to make the cell phone float.

8. If a chemical reaction like this was incorporated into an actual cell phone flotation device, what other features would the device need?
   There would need to be a way to keep the powders and the water separate. There would also need to be some kind of sensor or way to allow them to mix when the cello phone was in water of a certain depth.