10

The Smallpeice Trust

ENGINEERING @SCHOOL

The Drink Carbonator Challenge

Subject: STEM/Engineering

Year group: 6-7

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#EngineeringAtSchool

THE DRINK CARBONATOR CHALLENGE TEACHER GUIDANCE

This activity can be used as one of eight towards students obtaining the CREST SuperStar Award.

What Is CREST?

CREST is a nationally recognised scheme for student-led project work in the STEM subjects (science, technology, engineering and maths).

CREST gives young people aged 5–19 the chance to choose their own subject and methodology when completing their hands-on investigation.

CREST provides activities and project ideas for a range of ages, group size and abilities. From off-the-shelf, one-hour long challenges through to large-scale, student-led projects of over 70 hours work or more, CREST can be done by anyone.

What is CREST SuperStar?

SuperStar level is designed to be easy-to-run and low-cost for children typically aged 7-11 years. Children gain an Award by completing eight challenges.

You can download a CREST SuperStar passport template for your students to track their progress once you create an account via

www.crestawards.org/crest-star

ENTRY FEE per child: £1 UK / £4 International*

Within four weeks of payment, you will receive certificates and fabric badges to give out to your class.

LENGTH OF LESSON: 1-2 HOURS

How to make your Drink Carbonator:

https://bit.ly/3iFFQc1

LESSON OVERVIEW

Students work in teams of "engineers" to design and build their own drink carbonator.

Learning Objectives

During this lesson, students will:

- Design and construct a drink carbonator
- Test and refine their designs
- Communicate their design process and results

Learning Outcomes

- To develop an understanding of drink carbonation
- To develop an understanding of endothermic reactions
- To design and build models by using different materials and to test selected functional characteristics of the model built with the chosen materials

Key Vocabulary: CARBONATION, ENDOTHERMIC, CHEMICALS, ENGINEERING

Curriculum links

SCIENCE KEY STAGE 2

- Working scientifically: asking relevant questions and using different types of scientific enquiries to answer them
- Working scientifically: setting up simple practical enquiries, comparative and fair tests
- Working scientifically: making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers
- Working scientifically: gathering, recording, classifying and presenting data in a variety of ways to help in answering questions
- Working scientifically: recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables
- Working scientifically: using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions

SCIENCE KEY STAGE 3

- Conservation of mass changes of state and chemical reactions
- Endothermic chemical reactions (qualitative)

DESIGN & TECHNOLOGY KEY STAGE 2

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at individuals or groups
- Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided design
- Select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing], accurately
- Apply their understanding of how to strengthen, stiffen and reinforce more complex structures

DESIGN & TECHNOLOGY KEY STAGE 3

- Select from and use a wider, more complex range of materials, components and ingredients, taking into account their properties
- Test, evaluate and refine their ideas and products against a specification, taking into account the views of intended users and other interested groups

INTRODUCTION

What is a drink carbonator?

Explain to students that: A drink carbonator turns still drinks into fizzy drinks using a chemical reaction that makes dissolved carbon dioxide.

What is chemical engineering?

Explain to students that: Chemical engineering is the application of science and maths to the process of converting chemicals into more useful or valuable forms.

What is a chemical reaction?

Explain to students that: A chemical reaction is a process where a set of substances undergo a chemical change to form a different substance.

Materials

1. **THREE EMPTY PLASTIC BOTTLES**
2. **TUBING** – WE USED AQUARIUM HOSING
3. **A ONE-WAY VALVE**
4. **CITRIC ACID**
5. **BAKING SODA**
   (AKA SODIUM BICARBONATE, BICARBONATE OF SODA)
6. **KITCHEN SCALES**
7. **PPE – SAFETY GOGGLES, GLOVES**
8. **ZIPLOCK BAG**
9. **WATER**
10. **SOMETHING TO CARBONATE!**

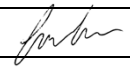
MAIN ACTIVITY

1. Students will need to work in pairs for this activity.
2. Explain that students must develop a drink carbonator from everyday items.
3. Show students the student activity sheet and explain that they will need to follow the instructions to make their drink carbonator
4. Student groups next execute their plans and build their drink carbonator using the materials they have chosen. They may need to rethink their plan, request other materials, or start again if the materials chosen are not working.
5. Next, teams will test their drink carbonator.
6. Teams complete an evaluation / reflection worksheet, and present to the class.

PLENARY (QUESTIONS TO ASK STUDENTS)

1. **Did you succeed in creating a drink carbonator?**
2. **Which materials did you use for your drink carbonator?**
3. **If you could have had access to materials that were different than those provided, what would your team have requested? Why?**
4. **If you had to do it all over again, what would you do differently?**
5. **Do you think you would have been able to complete this project easier if you were working alone? Explain…**

STEM Day Risk Assessment

Risk Assessment for	Engineering at School Projects
Assessment undertaken on	31/03/2020
Assessment undertaken by	Jessica Lee
Signed	

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
1	General Activity and Workspace	**Slips, trips and falls:** Injury due to tripping over items	Students and adults	Activity supervised by adult supervisor. Deliverer reminds students about safety in video introduction.	M	Students and adults
2	Use of Materials: paper/card, plastic containers	**Injuries:** Injury due to paper cuts, cuts from sharp edges **Injuries:** Injury due to misuse	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
3	Use of materials: elastic bands, sellotape, glue stick, blu-tack, small toys, paper fasteners, LEGO pieces, nuts & bolts or equivalent.	**Injuries:** Injury due to use as a missile **Slips, trips and falls:** Injury due to slipping on dropped items **Injuries:** Ingestion risk of choking.	Students and adults Students and adults Students and adults	Activity supervised by adult supervisor. Activity supervised by adult supervisor. Activity supervised by adult supervisor.	L	Students and adults
4	Use of materials: plastic, corrugated carboard	**Injuries:** Cuts from sharp edges	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
5	Use of sharp tools: Scissors, craft knives	**Injuries:** Cut to self	Students	Activity supervised by adult supervisor.	M	Students and adults
		Behaviour: Cut to others	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Behaviour: Vandalism of property	School or home	Activity supervised by adult supervisor.	L	Students and adults
6	Testing of projects: bathtub, drop from height, items on floor	**Spillage of water on floor**: damage and injury due to slip	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Slip, trip or fall: Injury due to falling from testing area, tripping over items in testing space	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

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The Drink Carbonator Challenge

#EngineeringAtSchool

Suitable for ages: 11+

Time needed: 1hr+

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DESIGN A DRINK CARBONATOR

You are a team of engineers who have been given the challenge to design your own drink carbonator.

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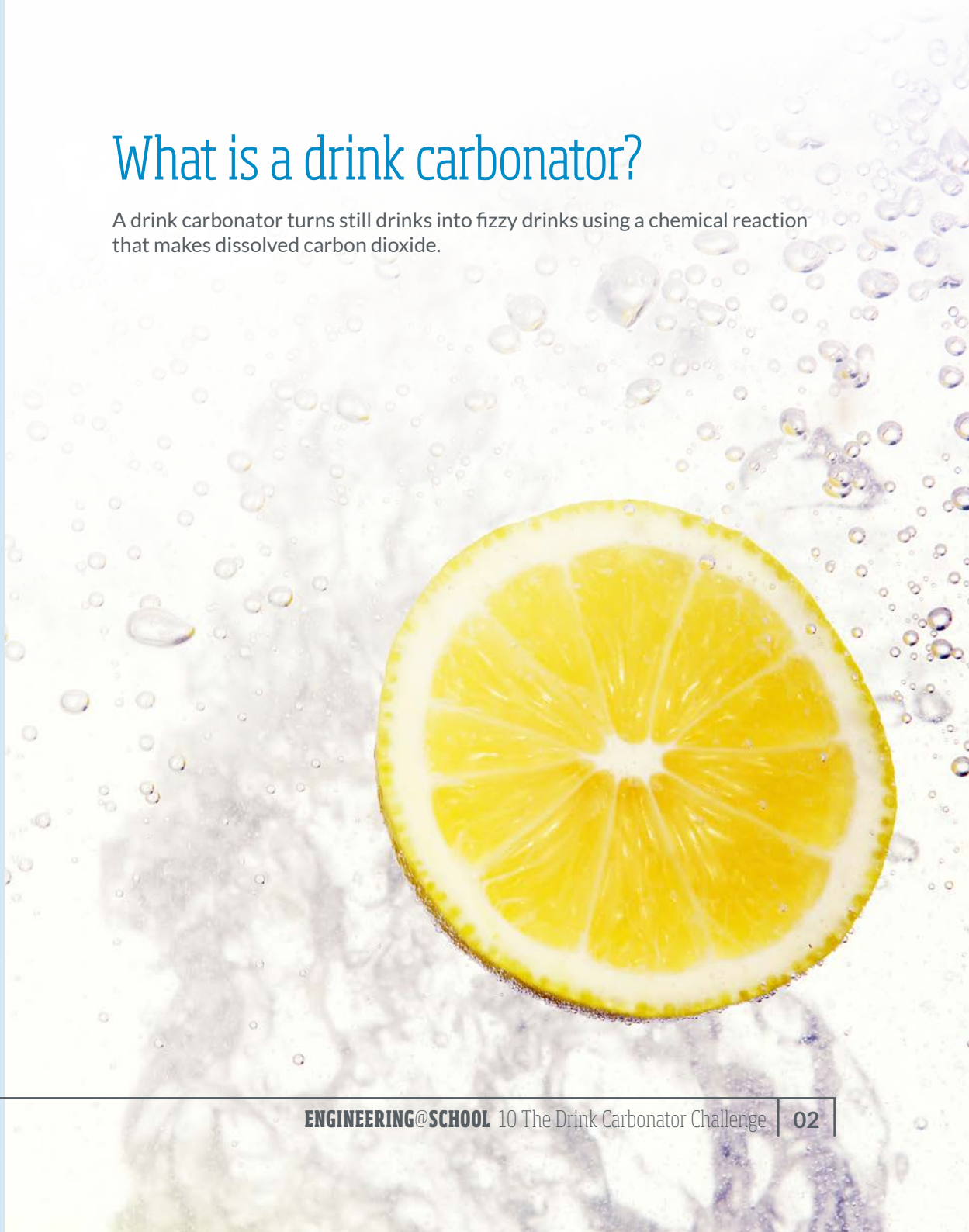
What is a drink carbonator?

A drink carbonator turns still drinks into fizzy drinks using a chemical reaction that makes dissolved carbon dioxide.



MATERIALS

1. **THREE EMPTY PLASTIC BOTTLES**
2. **TUBING –** WE USED AQUARIUM HOSING
3. **A ONE-WAY VALVE**
4. **CITRIC ACID**
5. **BAKING SODA**
   (AKA SODIUM BICARBONATE, BICARBONATE OF SODA)
6. **KITCHEN SCALES**
7. **PPE – SAFETY GOGGLES, GLOVES**
8. **ZIPLOCK BAG**
9. **WATER**
10. **SOMETHING TO CARBONATE!**

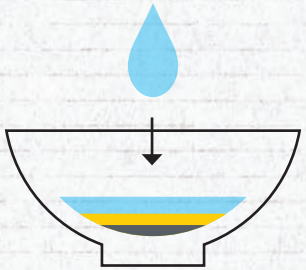
Personal protective equipment (PPE) is really important – goggles are necessary, as are protective gloves if using a glue gun.

TESTING THE REACTION

1.

Place sodium bicarbonate and citric acid powder into a bowl

Sodium Bicarbonate : Citric Acid ratio 1 : 1.5



2.

Add water

Water ~50ml

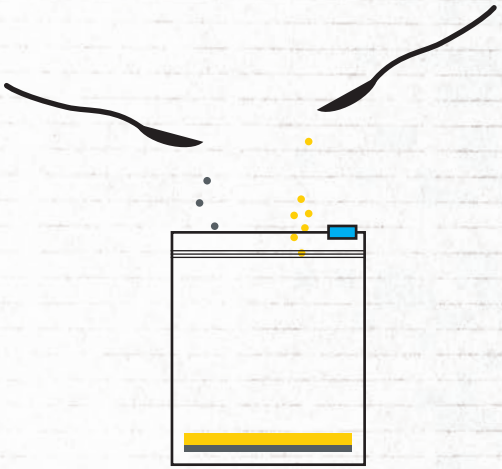
3.

WATCH IT FIZZ

The reaction is expressed by the following chemical formula:

Citric Acid $C_6H_8O_7$ + Sodium Bicarbonate $3NaHCO_3$ → Sodium Citrate $Na_3C_6H_5O_7$ + Water $3H_2O$ + Carbon Dioxide $3CO_2$

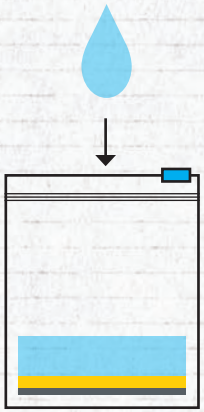
MAKE A COOL PACK



1.

Place sodium bicarbonate and citric acid powder into a Ziplock bag

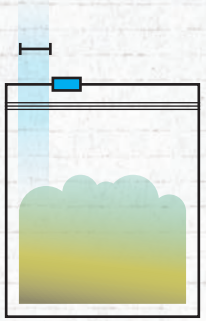
Sodium Bicarbonate : Citric Acid ratio 1 : 1.5



2.

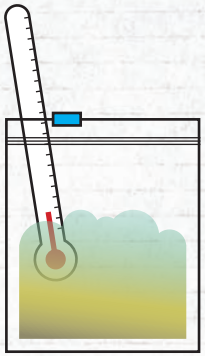
Add water

Water ~100ml



3.

Leave a small vent in the bag for the CO_2 to escape

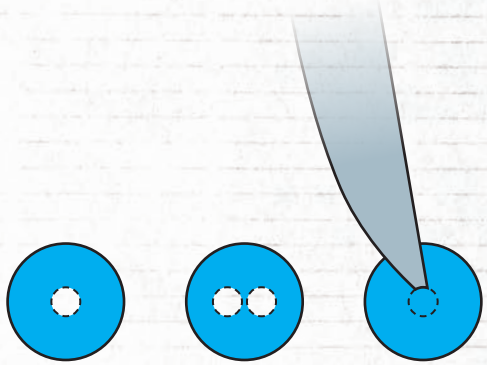


4.

Measure the temperature change using a thermometer

MAKE A DRINK CARBONATOR 1 OF 4

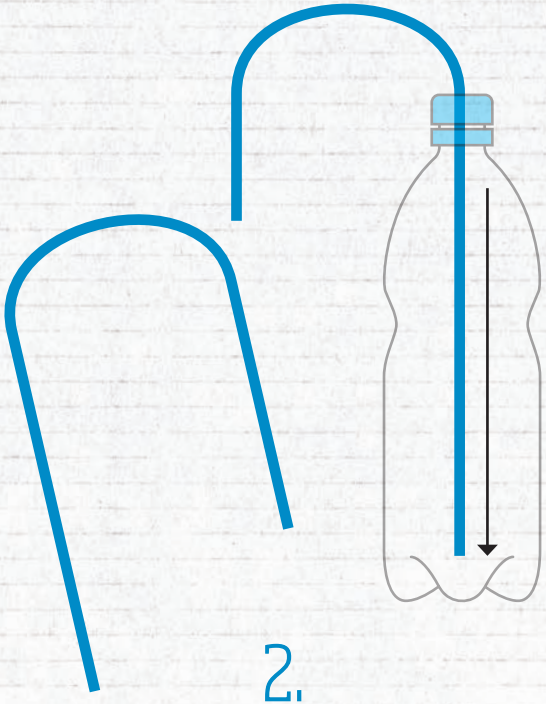
To make a drink carbonator using the same reaction, follow the steps below. Make sure you have adult supervision



1.

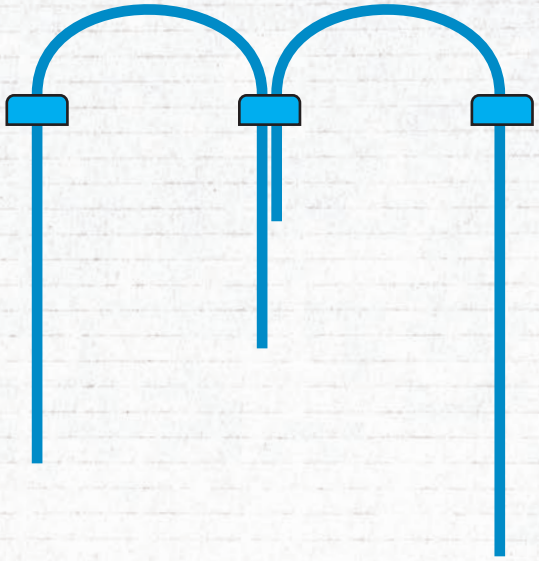
Very carefully make holes in the bottle caps using a sharp knife.

The middle cap will need two holes



2.

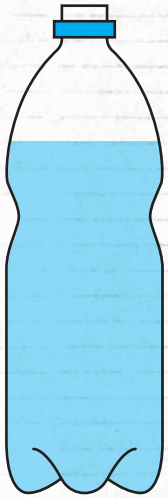
Cut the plastic tubing. Ensure that the tube is long enough to reach the bottom of the drink you wish to carbonate



3.

Feed the tubing through the bottle caps and seal tightly with a glue gun

MAKE A DRINK CARBONATOR 2 OF 4



4.

Fill the left bottle to the top with water

5.

Add dry sodium bicarbonate and citric acid to the centre bottle.

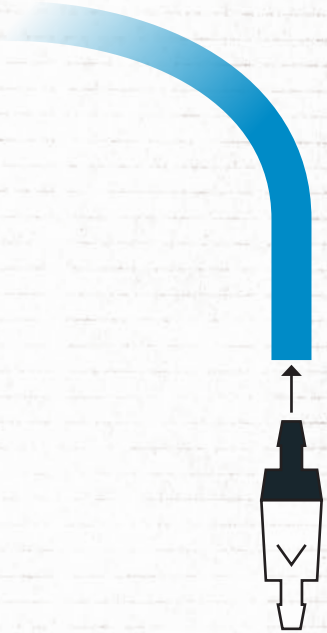
Experiment with different amounts and make sure you very carefully increase the amounts (otherwise you might end up making a mess!)

6.

Add the liquid you wish to carbonate to the right bottle.

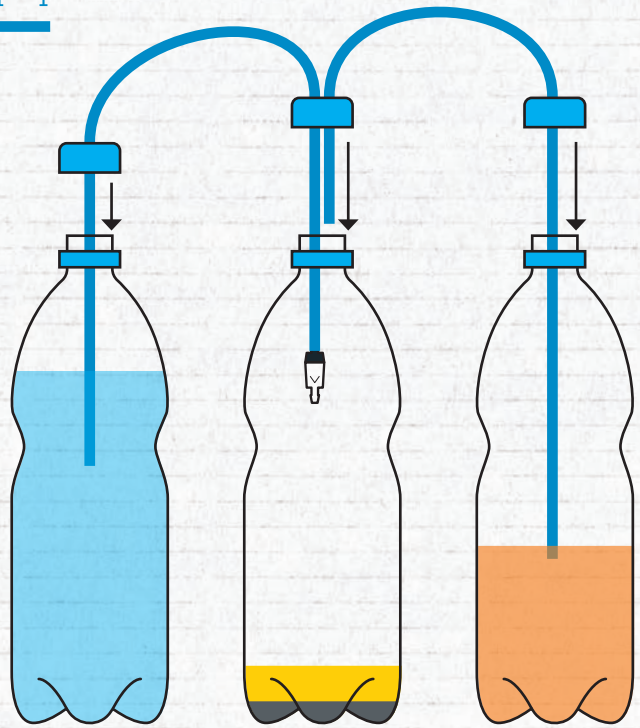
TIP: cool the liquid in the fridge first!

MAKE A DRINK CARBONATOR 3 OF 4



7.

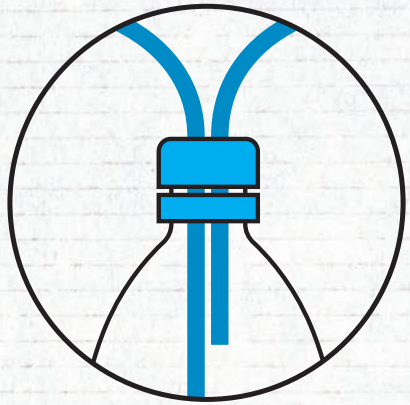
Add the one-way valve to the tube which connects the water bottle (left) to the reactants bottle (centre). This will stop the gas flowing back into the water bottle



8.

Tightly seal the caps to the bottles.

TIP: you can use a rubber band or a balloon to help improve the seals

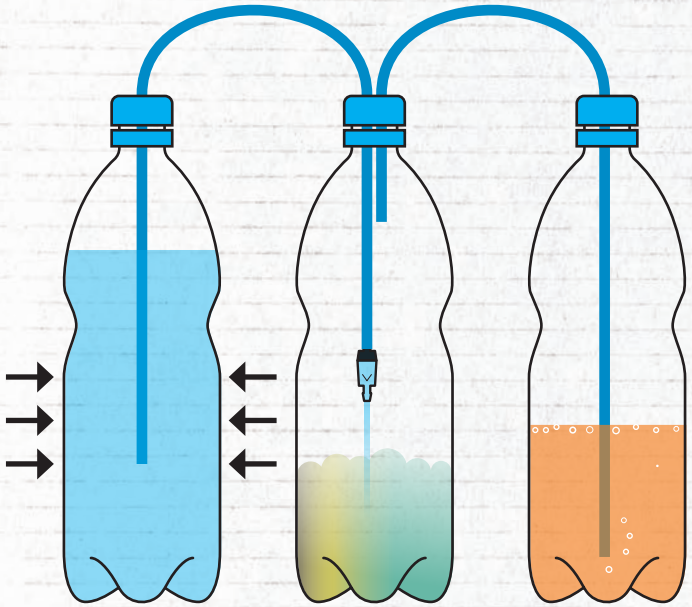


9.

Before you start the reaction, ensure all the bottles are sealed tightly.

This is a good opportunity to make any last-minute adjustments or re-seal any loose connections

MAKE A DRINK CARBONATOR 4 OF 4



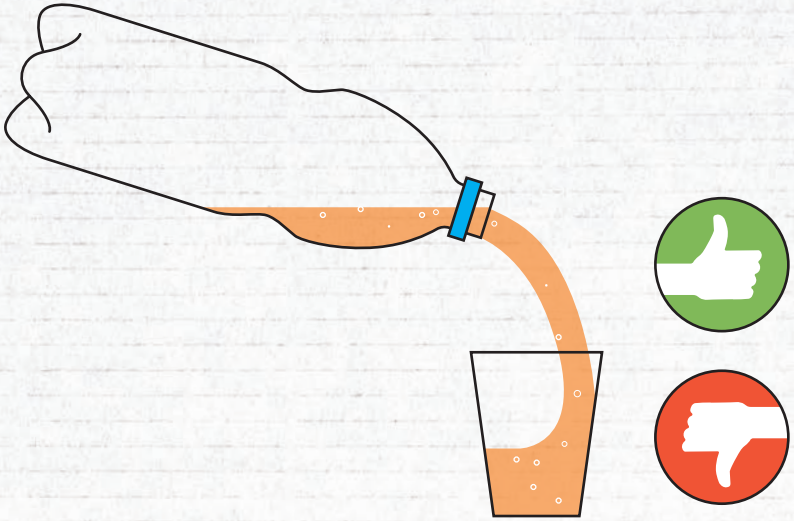
10.

When you're ready to start the reaction, squeeze the water bottle.

This forces the water into the centre bottle and starts the reaction

11.

Wait until the reaction stops (when the reactants stop fizzing)



12.

Test your beverage.

You may want to repeat steps 10-11 with increased quantities of reactants until you reach the desired level of carbonation

EVALUATION STAGE

Evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the Drink Carbonator Challenge.

1. **Did you succeed in creating a drink carbonator?**

2. **Which materials did you use for your drink carbonator?**

3. **If you could have had access to materials that were different than those provided, what would your team have requested? Why?**

4. **If you had to do it all over again, what would you do differently?**

5. **Do you think you would have been able to complete this project easier if you were working alone? Explain…**