The Smallpeice Trust

ENGINEERING @HOME

10

The Drink Carbonator Challenge

#EngineeringAtHome

Suitable for ages:	Time needed:
11+	1.5hrs+

smallpeice
Dare to imagine

Curriculum links: Maths – shapes, measurement; Science – materials, experimentation, energy transfer, chemistry; D&T – design, make, evaluate

Skills learnt: Design, building, testing, evaluation

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Since our Smallpeice team can't visit schools, we've decided to challenge each other to make a drinks carbonator which you can test at home.

10

Objectives

Make your own fizzy drinks using baking soda and citric acid.

Explore energy transfer and learn what 'endothermic' means.

Familiarise yourself with scientific terminology and chemical formulae.

Select from a wide range of materials and use tools to perform practical challenges.

Develop your own experimental criteria and test against them.

Evaluate your designs.

Topics Covered

CHEMICAL ENGINEERING
https://tinyurl.com/ChemiEng

WHAT IS ENERGY?
https://bit.ly/2AhBCpp

WHAT IS CARBONATION?
https://bit.ly/3cfTYo5

WHAT MATERIALS TO USE

You will need three empty plastic bottles, some tubing, water, bicarbonate of soda and citric acid (alternatively you can modify the experiment and use liquid vinegar or citrus juice)+. Some measuring scales or a teaspoon are required to measure out the reactants.

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

HERE'S WHAT WE USED:

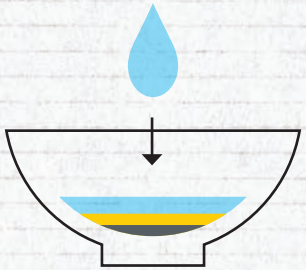
1. **THREE EMPTY PLASTIC BOTTLES**
2. **TUBING –** WE USED AQUARIUM HOSING
3. **A ONE-WAY VALVE**
4. **CITRIC ACID**
5. **BAKING SODA**
   (AKA SODIUM BICARBONATE, BICARBONATE OF SODA)
6. **KITCHEN SCALES**
7. **PPE – SAFETY GOGGLES, GLOVES**
8. **ZIPLOCK BAG**
9. **WATER**
10. **SOMETHING TO CARBONATE!**

TESTING THE REACTION

1.

Place sodium bicarbonate and citric acid powder into a bowl

Sodium Bicarbonate : Citric Acid ratio 1.5 : 1



2.

Add water

Water ~50ml

3.

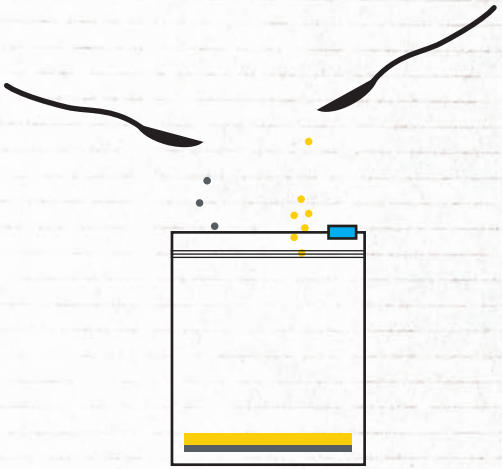
WATCH IT FIZZ

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 $3CO_2$

DO NOT INGEST THESE INGREDIENTS

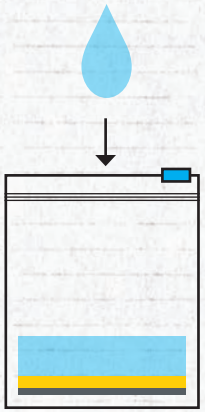
MAKE A COOL PACK



1.

Place sodium bicarbonate and citric acid powder into a Ziplock bag

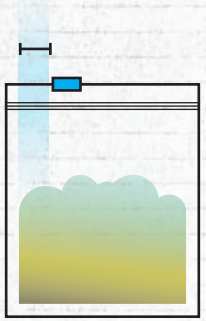
Sodium Bicarbonate : Citric Acid ratio 1.5 : 1



2.

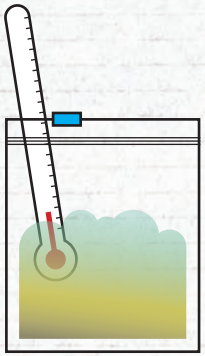
Add water

Water ~100ml



3.

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

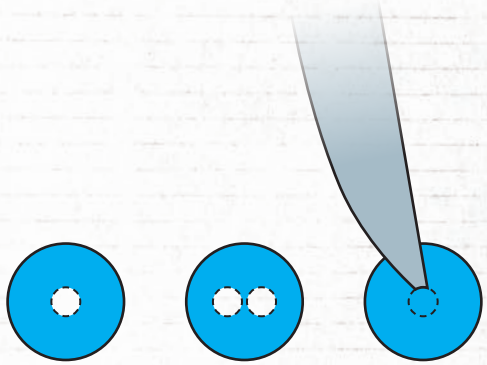


4.

Measure the temperature change using a thermometer

MAKE A DRINKS CARBONATOR 1 OF 4

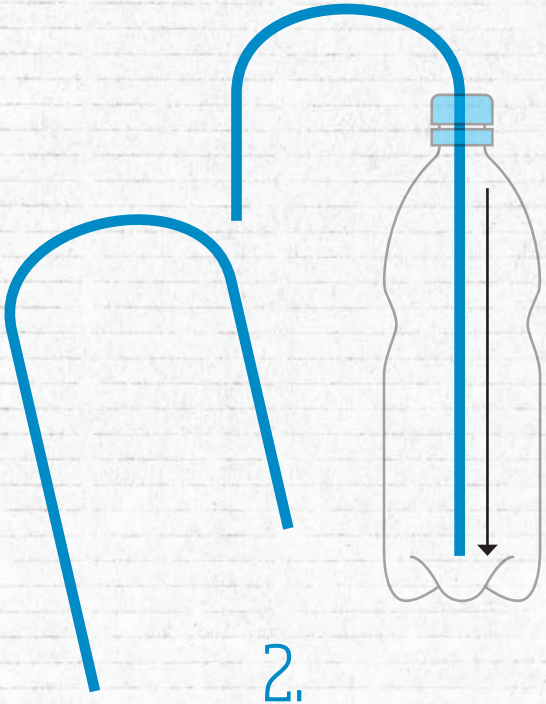
To make a drinks carbonator using the same reaction, follow the steps below. Make sure you have adult supervision



1.

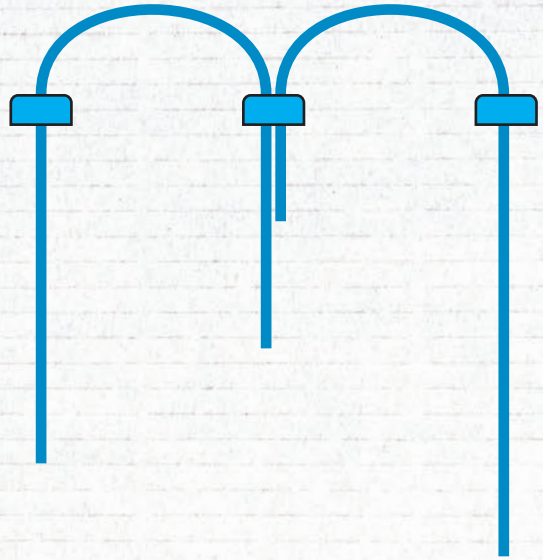
Very carefully make holes in the bottle caps using a sharp knife.

The middle cap will need two holes



2.

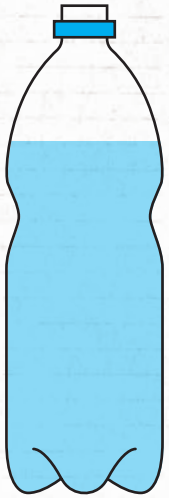
Cut the plastic tubing. Ensure that the tube is long enough to reach the bottom of the drink you wish to carbonate



3.

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

MAKE A DRINKS 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 listed in the table on page 10.

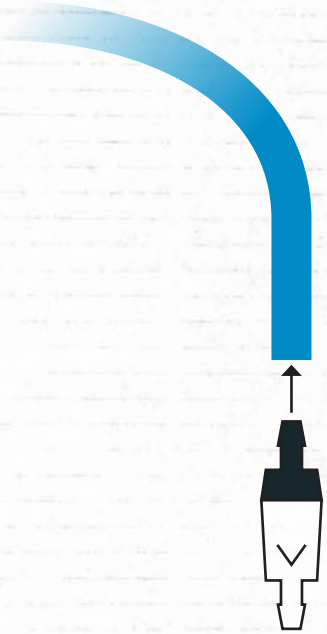
Make sure you very carefully increase the amounts (otherwise you might end up making a mess!)

6.

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

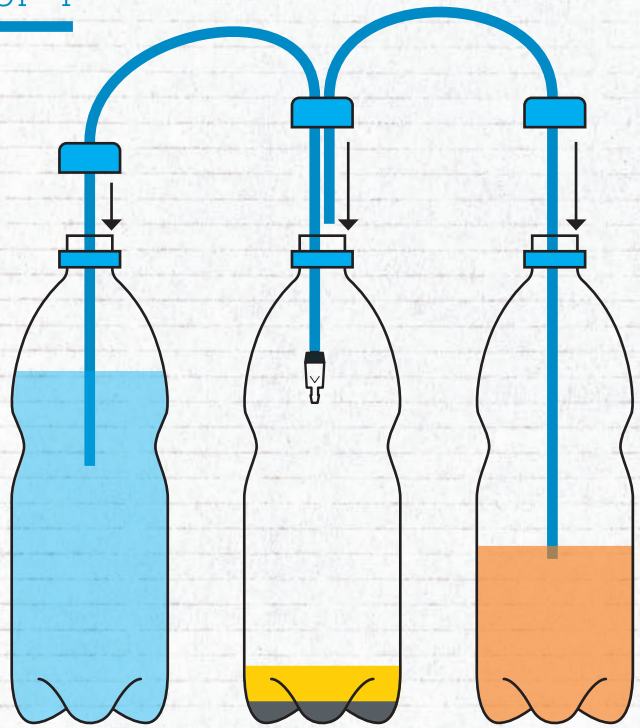
TIP: cool the liquid in the fridge first!

MAKE A DRINKS CARBONATOR 3 OF 4



7.

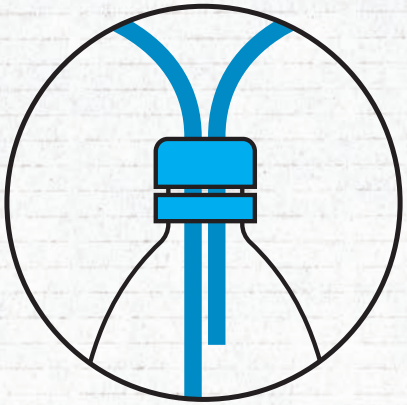
Add the value to the tube which connects the water bottle (left) to the reactants bottle (centre). This will stop the gas flowing back into the water bottle



8.

Tightly seal the caps to the bottles.

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



9.

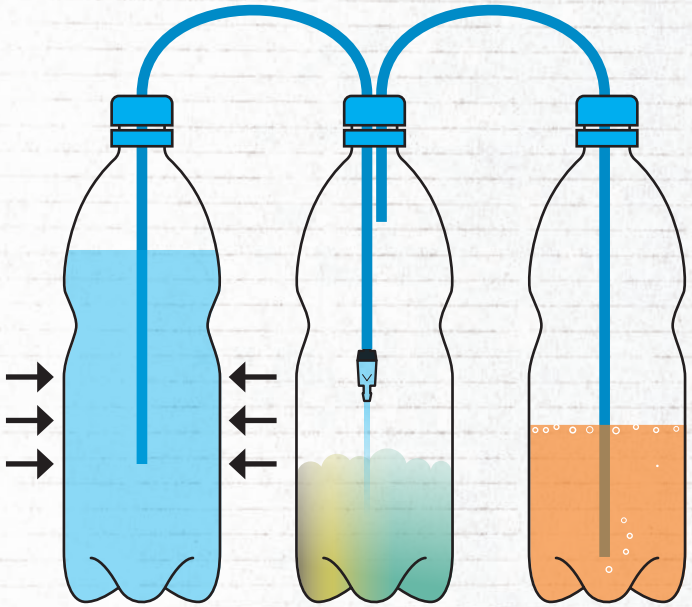
Before you start the reaction, ensure all the bottles are sealed tightly.

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

If the pressure gets too high in any of the bottles, loosen the caps to release some CO_2

REMINDER: ensure you wear your eye protection throughput the experiment

MAKE A DRINKS CARBONATOR 4 OF 4



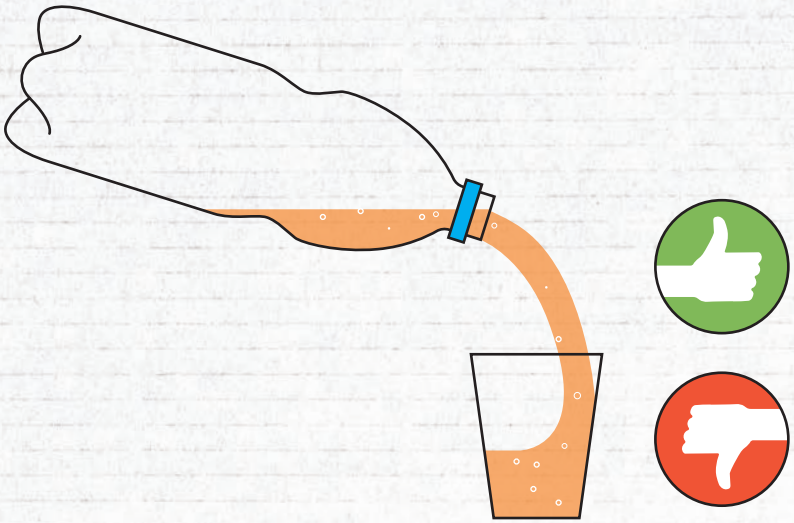
10.

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

Copy out the table below to run your own experiments

Test Label	Amount of Citric Acid (g)	Amount of Sodium Bicarbonate (g)	Observations & Results
Example	1	1.5	Reactants fizzed for 1 minute & 40 seconds; carbonation lower than desired; drink didn't fizz when shaken
A	2	3	
B	4	6	
C	2	5	
D	6	8	

NEED A CHALLENGE?

To extend the activity and challenge yourself further:

1. Make various concoctions for you and your family
2. Complete the table above and record your observations scientifically
3. How else can you use this chemical reaction? Could you combine it with Week 1 or Week 6's activities and make a CO_2-powered car or rocket?
4. Film a video and send it to us!

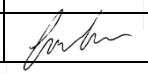
Once you've got your drink carbonator up and running, film it in action and share your video on:

www.facebook.com/TheSmallpeiceTrust

www.twitter.com/SmallpeiceTrust
Use the hashtag **#EngineeringAtHome**

www.instagram.com/TheSmallpeiceTrust

STEM Day Risk Assessment

Risk Assessment for	Engineering at Home 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