Method 3 (carbon dioxide)

Aim:

Observing the production of carbon dioxide gas from chemical raising agents.

Equipment

- Digital scales
- 5 measuring jugs or tall glasses
- Kettle
- Additional measuring jug
- Digital timer / stopwatch / clock with a second hand

Ingredients

- Bicarbonate of soda
- Hot water (freshly boiled)
- Cold water
- Baking powder
- Cream of tartar

Method

- **Control** – Weigh 5g of bicarbonate of soda into a measuring jug or tall glass, and add 30ml freshly boiled water from the kettle. Watch what happens and time the reaction.

Repeat the above experiment with the following variations:

- **Variation 1** – Weigh 5g of bicarbonate of soda into a measuring jug or tall glass, and add 30ml cold water. Watch what happens and time the reaction.
- **Variation 2** – Weigh 5g of baking powder into a measuring jug or tall glass, and add 30ml freshly boiled water from the kettle. Watch what happens and time the reaction.
- **Variation 3** – Weigh 5g of baking powder into a measuring jug or tall glass, and add 30ml cold water. Watch what happens and time the reaction.
- **Variation 4** – Weigh 5g of bicarbonate of soda and 5g cream of tartar into a measuring jug or tall glass, and add 30ml freshly boiled water from the kettle. Watch what happens and time the reaction.
- **Variation 5** – Weigh 5g of bicarbonate of soda and 5g cream of tartar into a measuring jug or tall glass, and add 30ml cold water. Watch what happens and time the reaction.

Results

Compare your findings in the table below:

Control	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5
Effervescence occurs **immediately**. It lasts for 5 seconds.	No reaction.	Effervescence occurs **immediately**. It lasts for 30 seconds.	Effervescence occurs approximately 2 seconds after the cold water is added. It lasts for 30 seconds.	Effervescence occurs **immediately**. It lasts for 15 seconds. The bubbles are more vigorous than Control, Variation 2 and Variation 3.	Effervescence occurs immediately. It lasts for 30 seconds. Bubbles are not as vigorous as Variation 4.

Conclusions

Summarise your findings here.

Which sample produced the greatest amount of bubbles? (This bubbling effect is referred to as effervescence.)

Variation 4 produced the greatest amount of bubbles, although the effervescence did not last as long as Variation 2, Variation 3 and Variation 5.

Explain the reactions taking place, and relate this to how this knowledge is useful when cooking.

Control

When hot moisture is added to bicarbonate of soda, carbon dioxide gas is released. This results in small fizzy bubbles. They don't last very long, so this method is not that useful in cooking unless you can use the bubbles immediately.

The chemical reaction taking place is as follows:

Sodium hydrogen carbonate	With moisture and heat →	Carbon dioxide	+	Water	+	Sodium Carbonate
$2NaHCO_3$	With moisture and heat →	CO_2	+	H_2O	+	Na_2CO_3

Variation 1

As nothing happened, you can deduce that the liquid must be hot in order for the bicarbonate of soda to produce CO_2.

Variation 2

When hot water is added to the baking powder a chemical reaction is achieved, producing carbon dioxide gas. In cooking, such as when making a cake, the CO_2 released from the baking powder is trapped in tiny air pockets in the cake batter. When heat is applied, the carbon dioxide gas expands and makes the mix rise.

Sodium hydrogen carbonate	+	Cream of tartar (potassium hydrogen tartrate)	With moisture and heat →	Carbon dioxide	+	Water	+	Sodium potassium tartrate
$NaHCO_3$	+	$KHC_4H_4O_6$	With moisture and heat →	CO_2	+	H_2O	+	$NaKC_4H_4O_6$

Variation 3

There is a similar reaction to Variation 2, with a brief time delay when the cold water is added – but it's not significant. Therefore, the method used in Variation 3 has the same applications in cookery to Variation 2.

Sodium hydrogen carbonate	+	Cream of tartar (potassium hydrogen tartrate)	With moisture and heat →	Carbon dioxide	+	Water	+	Sodium potassium tartrate
$NaHCO_3$	+	$KHC_4H_4O_6$	With moisture and heat →	CO_2	+	H_2O	+	$NaKC_4H_4O_6$

Variation 4

Similar reactions to Variations 2 and 3, expect this time the bubbles are more vigorous and don't last as long.

Sodium hydrogen carbonate	+	Cream of tartar (potassium hydrogen tartrate)	With moisture and heat →	Carbon dioxide	+	Water	+	Sodium potassium tartrate
$NaHCO_3$	+	$KHC_4H_4O_6$	With moisture and heat →	CO_2	+	H_2O	+	$NaKC_4H_4O_6$

Variation 5

Similar reactions to Variation 4, expect this time the bubbles are not as vigorous as Variation 4.

Sodium hydrogen carbonate	+	Cream of tartar (potassium hydrogen tartrate)	With moisture and heat →	Carbon dioxide	+	Water	+	Sodium potassium tartrate
$NaHCO_3$	+	$KHC_4H_4O_6$	With moisture and heat →	CO_2	+	H_2O	+	$NaKC_4H_4O_6$

Therefore, to conclude, if you need a chemical raising agent you can use either baking powder or bicarbonate of soda with cream of tartar. Baking powder is actually bicarbonate of soda with cream of tartar and a filler. Although the degree of bubble strength and length of time that the effervescence lasts varies, it doesn't really affect the rising of recipes too much. Hot water activates the CO_2 quicker than cold water, but again, it doesn't make a significant impact.

Extension task

Find a video for making honeycomb, and watch the honeycomb being made. Write a description of the chemical changes that take place. Ask your teacher if they will demonstrate making honeycomb to your class. **WARNING: hot sugar burns – it needs to be made under carefully controlled conditions and by an adult who is aware of the health and safety issues when working with caramel.**