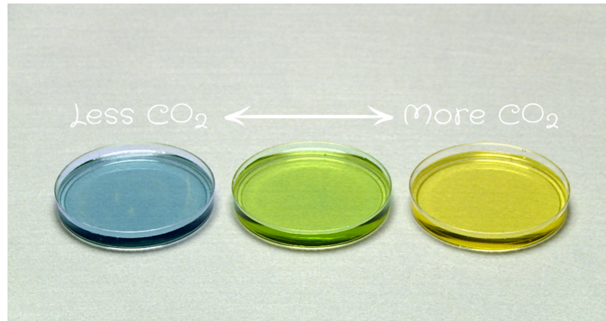
BTB Information and Instructions Handout

BTB stands for "bromothymol blue." In *Carbon TIME* we use BTB to detect CO_2. When CO_2 dissolves in water, it forms a weak acid (carbonic acid), which makes the pH of pure water as low as 5.5. In solutions with pH < 6.4 BTB is yellow. In solutions with less dissolved CO_2 (pH > 7.1), BTB is blue.



Credit: FableVision

Here's how to mix BTB solutions for your investigations:

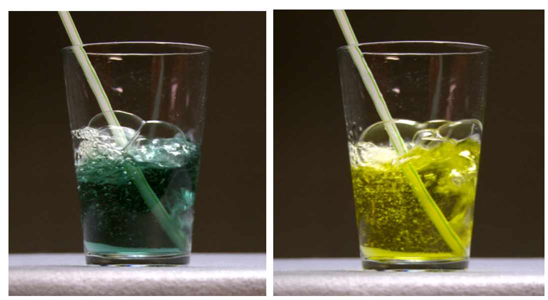
- Most tap water has many ions in it that react with CO_2, making it slow to acidify with added CO_2, so use distilled water for dilution.
- Most commonly, purchased stock solutions are 0.04% aqueous BTB. We recommend diluting the BTB in a 1:100 solution with distilled water. BTB will work the same way when it is more diluted, but the color will appear lighter. If the color is too light when you have BTB in shallow Petri dishes, then you can use more concentrated BTB.
- One quick way to make a batch is to use a plastic gallon (3.78L) jug of distilled water, remove about 100mL of water to make space, then add about 40mL of stock BTB.
- Because the pH of distilled water is less than 7, the color of the resulting solution may be green or even yellow-green. Green BTB will work just fine in the investigations, but you can also add a base to increase the pH to make a blue color. You will need to add a dilute strong base. (A weak base like baking soda will buffer the solution and it will not acidify as easily with exposure to CO_2.) A gallon of distilled water and BTB needs just a couple drops of 0.1M NaOH, so add them one at a time and mix the solution between drops until the color just turns blue and persists.

Influence of carbon dioxide on the pH of water:

Carbon dioxide can change the pH of water. This is how it works:

Carbon dioxide dissolves slightly in water to form a weak acid called carbonic acid, H_2CO_3, according to the following reaction:

$$\mathbf{CO_2 + H_2O \dashrightarrow H_2CO_3}$$



Credit: FableVision

After that, carbonic acid reacts slightly and reversibly in water to form a hydronium cation, H_3O+, and the bicarbonate ion, HCO^{3}-, according to the following reaction:

$$\mathbf{H_2CO_3 + H_2O \dashrightarrow HCO_3^- + H_3O^+}$$

pH measures the concentrations of H_3O+ ions, with lower pH meaning more ions. Distilled water, which normally has a neutral pH of 7, has an acidic pH of approximately 5.5 when it has been exposed to air with more concentrated CO_2.

Recipes for 0.1M NaOH and 0.1M HCl:

0.4g/ 0.1L x (mol / 40g) = 0.1M NaOH

Approximately 8 drops of concentrated (12M) HCl into 100mL will make a solution that is about 0.1M HCl. This is only needed if you add too much base to your solution and need to restore it to desired conditions (blue but needing only a little bit of CO_2 to turn green).