



Lemonade and Mentos; Henry's Law and Boyle's Law

THE SCIENCE

Lemonade or any carbonated drink is a mixture of chemicals, one of which is dissolved carbon dioxide gas. When sparkling lemonade is made, the carbon dioxide is forced into solution under pressure and the bottle is sealed. The CO_2 stays dissolved as long as the pressure is kept constant – this is an example of Henry's Law which states:

the pressure of the gas determines the concentration of a gas dissolved in a liquid.

When the bottle is opened the pressure is lowered and the CO_2 becomes less soluble, and comes out of solution – which is why if you look at the side of the bottle when you unscrew the cap, you see thousands of bubble appear apparently from nowhere.

The CO_2 comes out of solution gradually; if you look at a glass of lemonade, you see bubbles appearing at a fairly constant rate. What increases the rate of bubble production is the introduction of nucleation sites, ie any sharp edges or irregularities in the lemonade.

When you take a mouthful of lemonade you feel the bubbles form on your tongue because the rough texture of your tongue acts as a bed of nucleation sites. This also explains why you often see a constant stream of bubbles coming from one particular point on the inside of a glass of lemonade; there is likely to be a tiny scratch at this point and even if the glass is washed and refilled, the bubbles will still come from this point.

Scuba divers can get the 'bends' for the same reason – as they dive deeper, the pressure of air in their lungs increases and the nitrogen which they are breathing becomes more soluble in blood plasma. If they surface slowly, the dissolved nitrogen has a chance to come out of their blood plasma and slowly into their lungs, but if they surface too fast the nitrogen comes out of solution within the body and damages organs. The bends are treated by putting the diver in a decompression chamber which causes the nitrogen bubbles to redissolve temporarily and the pressure later released more slowly.

In this experiment, a whole packet of Mentos is put into a bottle of lemonade at once. Mentos have a rough surface, which means millions of nucleation sites. These allow all the CO_2 to come out of solution at once, causing a large change in the pressure inside the bottle which forces the liquid out in a spectacular fountain.

MATERIALS

You will need:

- a 2 l bottle of lemonade (or any carbonated drink, the cheaper the better);
- a tube of Smarties;
- a playing card or piece of stiff card of the same dimensions;
- a packet of Mentos mints.

HEALTH & SAFETY

There is a risk of eye splash from fast moving lemonade so do all the tasks at arm's length, and use safety glasses. The experiment should be done outside because it does produce a sticky mess.

METHOD

Put all the Mentos into the Smarties tube. (The Smarties tube is used to add the Mentos to the lemonade.) Carefully unscrew the cap of the lemonade bottle and place it on a flat surface. Put the playing card over the open top of the Smarties tube and invert the tube directly over the open bottle top. The card should now be the only thing stopping the Mentos falling into the lemonade. When you are ready, making sure your head is not directly over the bottle, slide out the card from between the bottle and Smarties container, allowing all the Mentos to drop into the bottle. There will be a short delay of a second or so and then a spectacular 3–4 m fountain of lemonade followed by a shower.

