Professor Brainstorm's
Acid Rain & The Bouncing Egg

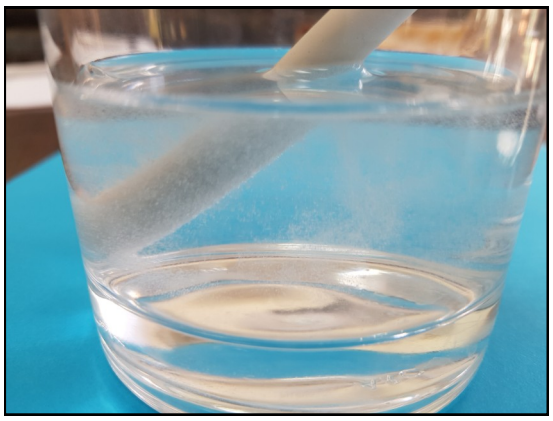
About this Activity
(Information for Parents and Teachers)

These activities look at Chemical Change. They are both intended as qualitative experiments - we are looking to see what happens, rather than taking measurements. However, Acid Rain can be done as a quantitative experiment - we will say more about this later.

The experiments are aimed at children between the ages of 9 and 11 years (i.e. Years 5 and 6).

Acid Rain - What you Need

- A clear plastic tumbler. (If you are careful, you could use a glass tumbler. Or you can always make your own tumbler - by cutting the top off a plastic bottle.)
- Chalk. (Some brands of chalk work better than others. I use Crayola Anti-Dust chalk in this experiment as that always works, but you can try other brands of chalk.)
- Vinegar. Clear (distilled) malt vinegar is best, because you can see what is happening, but you could use ordinary (brown) malt vinegar. Or you can also do the experiment with lemon juice.)



The Acid Rain Experiment

- Pour some vinegar in to your tumbler - to a depth of about 3 to 4 cm. Make a note of the time - and then place the stick of chalk in the vinegar. (Ideally about half of the stick of chalk will be submerged in the vinegar and half will be sticking out.)
- Straightaway you should see small bubbles forming on the part of the chalk stick which is in the vinegar. (See photo top left.)
- After a few minutes the vinegar will have turned cloudy, and you may see large bubbles on the surface of the liquid. (See photo bottom left.)
- After about 10 minutes, take the stick of chalk back out. You should be able to see that the half of the chalk stick which was in the vinegar is now noticeably narrower than the half which was sticking out.
- Replace the chalk stick in the vinegar - being careful to make sure that you place the same end in the vinegar again - and keep checking on the width of the chalk every 10 minutes.
- If you leave it for several hours, you will find that the stick of chalk disappears completely. All that is left is some white sludge at the bottom of the tumbler!

Note - if you do the experiment with ordinary (brown) malt vinegar or with lemon juice, it is harder to see the small bubbles forming on the chalk initially, but you should still be able to see the liquid turning cloudy after a few minutes. (In fact, if you use lemon juice you may see quite a thick froth forming on the surface of the liquid after a few minutes.)

How does it work? (This is the science bit)

- Vinegar and lemon juice are **acids**. (Acids can be very dangerous chemicals, but vinegar and lemon juice are very weak acids.)
- Chalk is traditionally made from **calcium carbonate.**
- When you combine calcium carbonate with an acid, a **chemical reaction** occurs. Amongst other things the reaction produces **carbon dioxide** gas. (These were the bubbles of gas that you saw on the side of the chalk stick early in the experiment - and the larger bubbles of gas that you may have seen on the surface of the liquid after a few minutes.)
- As the calcium carbonate of the chalk stick is converted into other substances (in the example with vinegar it turns in to carbon dioxide gas and calcium acetate - which dissolves in the vinegar), so the chalk stick gradually begins to disappear.
- Eventually all of the calcium carbonate reacts with the acid, and the chalk stick disappears completely. (The white 'sludge' that you are left with in the bottom of the tumbler is usually clay or some other substance which was used to hold the chalk stick together.)

I called this experiment 'Acid Rain' because a similar reaction occurs in nature.

- Chalk is also a type of rock. (It is what the White Cliffs of Dover are made from). Limestone and marble are other types of rock made from calcium carbonate.
- Acid rain is the result of water droplets falling through polluted air. As the falling raindrops absorb gases such as sulphur dioxide, the rainwater becomes acidic.
- And when this acidic rain falls on to chalk or limestone or marble surfaces, the same reaction occurs that we have just seen in this experiment.
- Since acid rain is usually a much weaker acid than vinegar or lemon juice, the effect is not quite as dramatic as in our experiment, but over a period of years and decades acid rain can have a devastating effect on marble buildings and sculptures.

I recommended that you use Crayola Anti-Dust chalk in this experiment because it is made from **calcium carbonate**. Some brands of chalk are not made from calcium carbonate, but instead are made from calcium sulphate. Since calcium sulphate does not react with a weak acid, nothing much happens when you put one of these chalk sticks into vinegar or lemon juice.

Acid Rain as a Qualitative Experiment

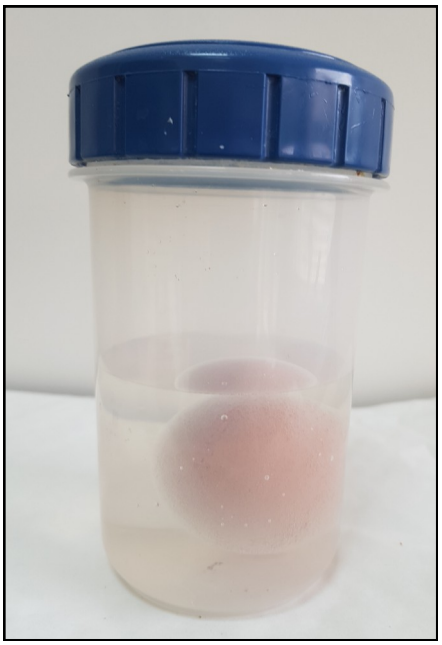
Is it possible to measure how quickly the chalk reacts with the acid? One way to do this would be to weigh the stick of chalk at the start of the experiment, and then to weigh it again every 10 minutes.

However, the problem with this approach is that a stick of chalk only weighs about 10 grams. If you are doing this experiment at home your weighing scales probably only measure to the nearest gram. So you would not get very accurate results.

One way around this problem is to use several sticks of chalk. So for example, start by weighing 10 sticks of chalk. (Let's suppose that the reading is 98 grams.)

Place all 10 sticks of chalk into a tumbler. (You need to make sure that the sticks of chalk are not touching one another, so you may need several tumblers.) After 10 minutes weigh all 10 sticks of chalk again. (This time the reading might be 93 grams.) You can keep taking measurements in this way every 10 minutes.

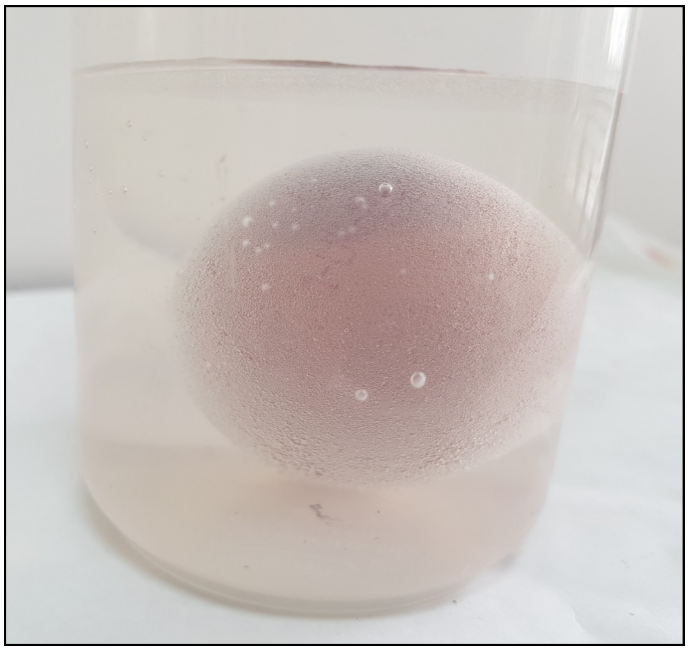
The Bouncing Egg - What You Need



- A raw egg
- Vinegar. Again clear (distilled) vinegar is best if you have some, but any vinegar will work.
- A small plastic jar or container with an air-tight lid. (It needs to be large enough to hold the egg - but not too large.)

The Bouncing Egg Experiment

- Carefully place the egg in the plastic jar - and pour in some vinegar until the egg is completely covered.
- Look carefully around the sides of the egg. You will see small bubbles forming on the surface of the egg - and you may see some bubbles of gas rising up through the liquid. (See photo below left.)
- Fix the lid tightly on to the jar - and leave it for several hours. (Don't worry - this experiment will not produce enough gas to make the container explode! But if your lid is not airtight, after a few hours everything will stink of vinegar!)



- After a couple of hours you can check on your egg. You might notice a scum beginning to form on the surface of the liquid. You can keep checking on your egg every few hours if you wish - but I would leave it for a full 24 hours in the vinegar.

After 24 hours:

- First of all, reach into the jar and feel the egg. Urgh! Instead of a hard eggshell, it is now soft and squishy!
- Carefully remove the egg from the jar. (I would suggest that you do this in the kitchen - over the sink.) You can pick the egg up in your hand. It feels disgusting! You can squeeze it gently. But don't squeeze it too hard! It is still a raw egg - and if it bursts it will make a big mess !!
- Now place the egg in to a bowl. Lift the egg - to a height of just a few centimetres - and then let it drop into the bowl. It should bounce! (But don't drop it from too great a height - or it will burst!)

How does it work? (This is the science bit)

An eggshell is mostly made from calcium carbonate. So when we place an egg in vinegar, the calcium carbonate in the eggshell reacts with the vinegar to produce carbon dioxide and calcium acetate. After about 24 hours all of the calcium carbonate will be used up - and there will be no eggshell left. All that is a thin membrane. Inside this membrane, the egg is still raw. So if you puncture the membrane it will make just as much mess as if you drop a raw egg!

Both this experiment and the Acid Rain experiment are examples of **irreversible change**. Once the eggshell (or stick of chalk) has reacted with the vinegar, there is no way that we can get the eggshell (or stick of chalk) back again!

