TEACHING PHYSICS WITH FOOD AND DRINK

Making sweet, static electricity: (above) charging with sugar and discharging; the equipment (bottom).

You can make sweet electricity in your kitchen

Static electricity is everywhere, so it must be in my kitchen. It took me some time, but finally I found it – and plenty of it, as you'll see.

For this demonstration you will need:

- a plastic plate;
- a metal can;
- aluminium foil;
- a 1 litre plastic bottle;
- some sugar;
- a Pyrex beaker;
- an enamel-coated metal pan with a plastic handle.

Take a clean, dry metal can and put it on a plastic plate, which has been placed upside-down on a table. Cut some strips of aluminium foil and hang them round the rim of the can. Cut a 1 litre plastic bottle in half – you will use the upper part as a funnel and the lower part as a container for sugar.

Put about 150 g of sugar into the bottom part of the bottle and pour it through the funnel into the can. The aluminium strips should rise outwards, indicating that the can has become charged (as with a school electroscope). Touch the can and the strips will go back down again. You may hear a spark and feel a small shock, depending on the weather outside and the humidity in your kitchen.

Empty the can and this time pour the sugar from an enamel-coated pan with a plastic handle directly into the can. The foil strips will rise again, possibly even higher this time.

What happened? The can is insulated from the table by the plate, so charge enters the can with the sugar. When the sugar moves against the funnel walls, it takes charge from the walls or charge is removed from the sugar by the wall. Precisely what happens depends on the combination of materials involved (sugar and plastic or enamel, in this case). This phenomenon is known as triboelectric charg-

ing and it has been known about for more than 200 years, but it is still not completely understood.

I determined the sign and size of the charge on the can using a coulombmeter. The measurements showed that when the sugar was poured through the plastic funnel, the can obtained *positive* charge (~50 nC). However, when the sugar was poured from an enamelled pan, the can obtained *negative* charge (~−65 nC). I also measured negative charge of about the same amount when I poured the sugar from a Pyrex beaker, but not when I used a kitchen glass. The can was 13 cm high and 8.5 cm wide.

Here's a homework exercise: think of an experiment that will demonstrate that the charges in the two cases above really are of opposite sign.

Students are more familiar with volts than coulombs. There is too little charge on the can to measure voltage directly, but you can estimate it. This is a good opportunity to remember the relationship between charge (Q), voltage (V) and capacitance (C) ($Q=CV$) and to estimate the voltage between the charged can and the ground.

First you need to estimate the capacitance of the can. You can approximate the capacitance of the cylindrical can with the capacitance of a sphere of equal volume ($C_{\text{sphere}} = 4\pi\varepsilon_0 r$), where r is the radius of the sphere). In my case $C_{\text{sphere}} = 7$pF, which gives the voltage between the can and the ground as about 9 kV. I felt the spark when I touched the charged can, so I believe that the order of magnitude of this approximation is correct.

This activity can be used to introduce electrostatics or as an accompanying experiment when dealing with capacitance in problem solving.

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