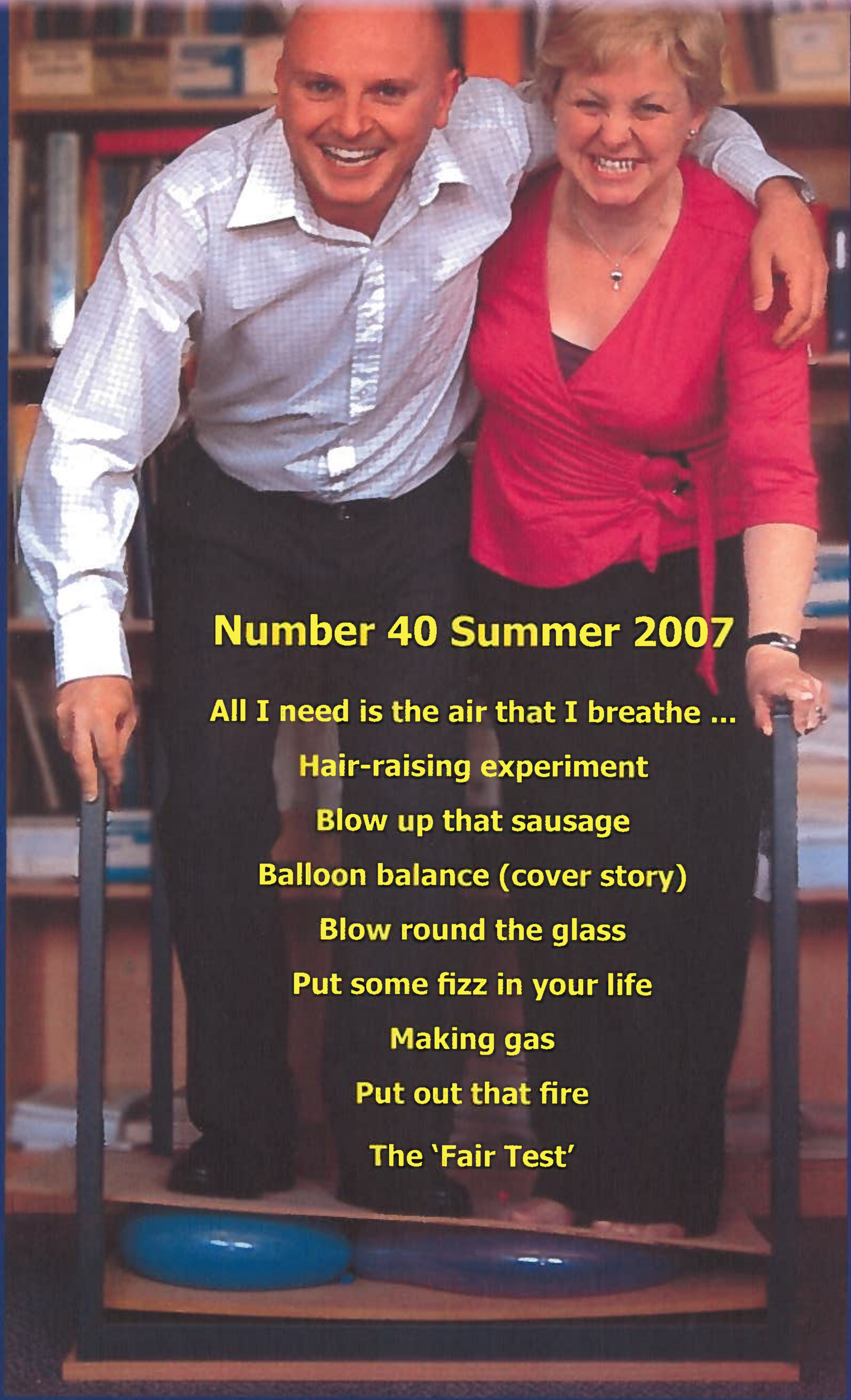
Primary Science & Technology Bulletin

Ideas & inspiration for teachers in Primary Schools & S1/S2



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All I need is the air that I breathe....

"The air that I breathe" - Hollies 1974 single, highest chart position 2.

Introduction

The air that surrounds us is a mixture of gases. Many children think that the most abundant gas in air is oxygen because they know that we need oxygen to stay alive. Because of its high media profile, the other constituent of air that they may have heard of is carbon dioxide although they are likely to be surprised at the tiny percentage of carbon dioxide in air. The main constituents of air are nitrogen (78%), oxygen (21%) argon (0.9%) and carbon dioxide (0.04%).

These numbers are hard for children to picture so you can suggest that they think of a car park (Figure 1) with 100 vehicles, 78 green cars (nitrogen), 21 blue cars (oxygen) and 1 yellow car (argon). At this scale the proportion that is carbon dioxide would be represented by a Dinky-sized toy car (red, at about 1:40 scale.)

The relative proportions of the different gases remain the same at higher altitudes although the air is "thinner" (less dense) the further you move away from the Earth's surface. For instance, at 2500 metres (8000 ft), you are only getting 66% of the oxygen in any breath compared to sea level. Anyone entering a controlled atmosphere room, such as those used for the storage of fruit, must wear breathing apparatus if the oxygen level is below 17%. Humans cannot survive in an atmosphere which contains much less than 17% oxygen.

This also applies to keeping a flame alight. It goes out when the available oxygen drops below a critical percentage, not when all the oxygen has been used up.

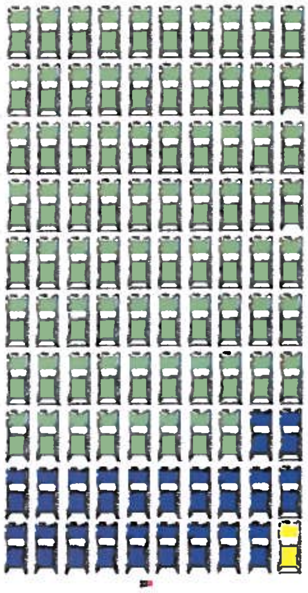


Figure 1 - Proportions of gases in the air (Green - nitrogen, Blue, oxygen, Yellow - Argon & Red - carbon dioxide - look closely for the wee red car!)

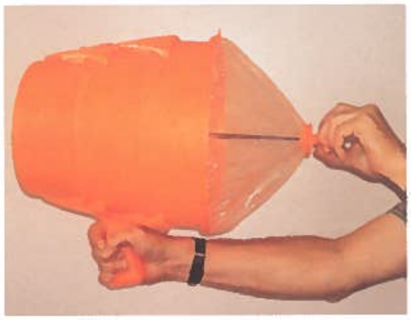
This information is used to prevent the danger of explosion in aircraft fuel tanks. Scientists came up with a surprisingly simple idea: if you reduce the amount of oxygen in the fuel tank to below 12%, even if a spark were present, burning wouldn't be supported.

Figure 2 - Some fuel tanks are in the wings of aircraft. Limiting the concentration of oxygen in them can limit the risk of explosions.

A hair-raising experiment

There is a toy available called an "Airzooka" which can fire a focused (but harmless) ball of air up to 6 metres (available for around £10). This can demonstrate to children that air is an entity. The air leaves the gun and travels in a ball to the target, you can see the localised impact if you fire at a curtain or blind. It is also highly entertaining if the air ball is aimed at the head of a person with long hair as the hair is blown about.

If you spray perfume into the gun and then fire it into an assembly of people only the target is aware of the smell initially. This demonstration shows that it is actually the air, which was present in the gun that has travelled to the target; it has not merely pushed other air molecules across the room.



Figures 3a & 3b - The Airzooka and its effect on hair from across the room

Sausages and balloons

There are some interesting demonstrations using air, where the scientific principles may be too difficult to explain to your pupils. However, if their interest is stimulated and they continue to study science at a higher level, they may have that "Eureka!" moment in the future.

Blow up that sausage - Make a long sausage out of a bin bag. Cut across the bottom and down one side. Fold in half (long sides together) and join along the edges with glue, stitching or stapling. Tie a knot in one end or close with an elastic band.

Ask if anyone thinks they can blow up the bag with one breath. Your volunteer will probably put his or her mouth close to the neck of the bag and blow. The pupil will not fill the bag in this way!

Figure 4 - Air collected when bag is close.

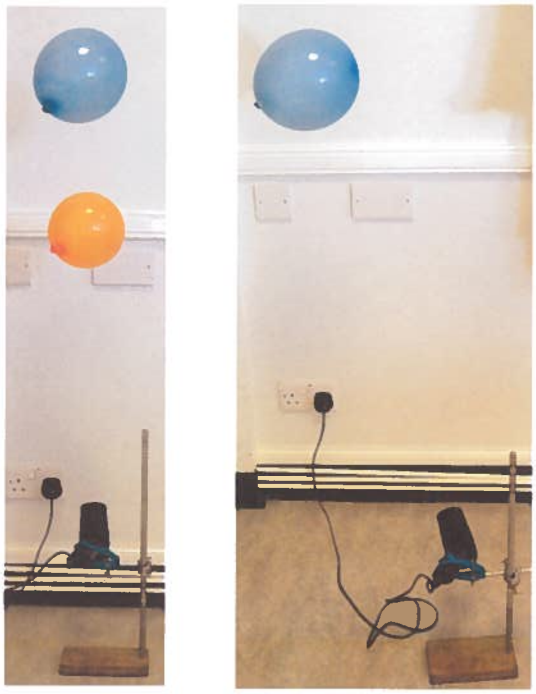
However, if you hold the bag open in front of you, at say 30 cm from your face, and blow, you will find that much more air enters the bag than was contained in your lungs. The scientific principle involved is called the Bernoulli Effect. A fast moving stream of air is surrounded by an area of low atmospheric pressure. In fact, the faster the stream of air moves, the more the air pressure of the moving air drops. Air always move from high pressure area to an area of low pressure. When you blow into the bag, higher pressure air in the atmosphere forces its way into the area of low pressure created by the stream of air from your lungs. In other words, air in the atmosphere is drawn into the long bag at the same time as you are blowing into the bag.

Figure 5 - Air collected when bag is further away.

For ready-made bags or for more scientific information see: http://www.stevespanglerscience.com/product/1479

This activity can explain how some weather systems work.

Balloon balance - Another fascinating way to demonstrate the Bernoulli Effect requires only a hairdryer and a balloon. When the hairdryer is directed upwards and switched on it creates a stream of moving air; a balloon can be "balanced" in the airstream (Figure 6a). Ask your pupils to predict whether a small balloon would float higher or lower than a larger one. It is possible to have two balloons of different sizes balanced in the airflow at the same time, which demonstrates neatly that the larger balloon floats higher.



Figures 6a & 6b - Two balloons in airstream and in airstream directed at an angle.

If the angle of the hairdryer is altered (Figure 6b), the balloon will move to stay in the centre of the airstream. The air in the centre of the air stream will be moving a little faster than the air towards the edge.

This is due to the fact that the air at the sides rubs on the stationary air in the room and is slowed a little. If the balloon begins to drift off centre, the faster air passing the balloon will be on the side towards the centre of the stream, with lower pressure, and the balloon will re-align itself.

Another balloon balance (cover pic) - How many children could stand on a board supported by four balloons?

Children will know that if they stand on a balloon it will burst. However, if a board is placed over four balloons, it will take the weight of four children without the balloons bursting. This is best done with the balloons taped to an upturned table to restrain them, and the table legs can provide support for the volunteers.

Figure 7 - Two 'children' in SSERC put the balloons under severe pressure!

Blow round the glass - You can demonstrate that air streams do not always travel in straight lines, but follow round the shape of obstacles. You may have seen wind flow patterns of smoke around prototype cars in wind tunnels. These show designers how good the streamlining is.

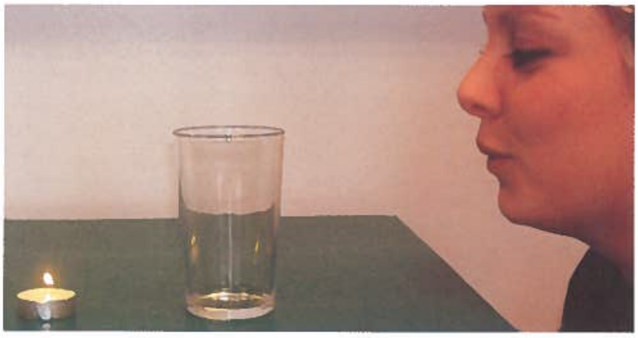


Figure 8 - Blowing round the glass.

Ask your pupils if it is possible to blow out a candle when there is an obstacle in the way? This is a quick and easy activity to show your breath must travel round the sides of the glass (or tin of soup etc). Just blow straight ahead and the candle will go out.

Bubble & fizz

Figure 9a - Remember Creamola foam?

Put some fizz in your life - Bubbles in fizzy drinks are carbon dioxide gas which is pumped into the liquid before the can or bottle is sealed. When you open the container the pressure is reduced and the gas bubbles out. You can make your own 'fizzy drinks' (remember Creamola Foam?). Citric acid is a severe eye irritant so be careful when handling the powder. Do not touch your eyes.

Figure 9b - Bubbles in drink

Put six teaspoons of citric acid crystals (available from a pharmacist) and three teaspoons of baking soda into a bowl. Using the back of a spoon, grind the two substances together to make a powder then add two tablespoons of icing sugar. When two teaspoons of this "Fizz Mix" are added to a glass of still water you will see that it makes it fizzy. For reasons of good hygiene, pupils should not drink the fizzy water.

Using almost the same recipe, add four tablespoons of icing sugar instead of two to make a powder with the effect of sherbet. When sherbet dissolves in your mouth, the citric acid and baking soda react with the water in the saliva to produce bubbles of carbon dioxide gas on your tongue. Pupils can taste a small amount on the end of a lollipop stick on the end of their tongue. Do not share sticks. Have some proper sherbet for the children to taste also.

Making gas - You can produce carbon dioxide gas in the classroom by mixing vinegar (or another acidic liquid such as lemon or grapefruit juice) and bicarbonate powder. Use a filter funnel or a paper cone to fill an uninflated balloon with bicarbonate. Pour vinegar into a one litre plastic bottle until it is about one quarter full. Stretch the neck of the balloon over the top of the bottle and then lift the balloon so that the bicarbonate falls into the bottle. You will see the vinegar start to fizz. The bubbles given off are carbon dioxide and will gradually begin to inflate the balloon.

Figure 10 - A carbon dioxide fire extinguisher.

Put out that fire - As mentioned earlier, burning can only take place if there is sufficient oxygen available. Some fire extinguishers (Figure 10) are designed to produce carbon dioxide (a gas which does not normally assist burning), which will smother the flames and deprive them of oxygen.

You can demonstrate this by using the vinegar/bicarbonate mixture. Place a tea-light candle in the bottom of a bowl and light it (Figure 11). Pour vinegar to a depth of about 2 cm in a small bottle then sprinkle a teaspoon of bicarbonate onto the vinegar. Bubbles of carbon dioxide will be generated and because this gas is more dense than air, it will collect in the bottom of the bottle. Once the bicarbonate has stopped fizzing, carefully tip the bottle over the candle flame (don't let the liquid drip out) so that the more dense carbon dioxide gas pours down into the bowl, displacing the air (Figure 12). Because the candle flame will no longer have the oxygen in the air available it will go out.

Vulcanicity - The same mixture can be used to make a model volcano "erupt". Place a small bottle half full of bicarbonate in the centre of a tray. Make a volcano round it either from paper maché, or by piling small stones, sand or gravel against it, taking care not to cover the opening to the bottle. Add a small amount of red food colouring to a container of vinegar and pour this into the hole in the top of the volcano. The bubbles of carbon dioxide which form will force out the red vinegar and provide an "eruption".

See Primary Bulletin 41 for more on Fizz-pop rockets, solar sausages, soap sculptures, balloon hovercrafts etc.

The 'Fair Test'

A P7 pupil was shown a picture of two almost identical plants, one in a black box, the other in a glass box (CASE lesson 4). She was asked if this was a fair test to show whether plants grew better in light or dark conditions. The dialogue went like this:

"Is this a fair test?"

"Aye!"

"Why do you think that?"

"Well, it's a plant. It's no' like it's got feelings or nothing. What does it care if it's in a black box? So it's fair enough."

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Figures 11 & 12 - Set-up with tealight in bowl (right) and 'pouring' the carbon dioxide gas over the flame (above)