Martian Air - Teacher Notes

Safety First

This experiment uses a naked flame – a small candle – so appropriate care needs to be taken. The candle will be inside a bowl, so there is minimal risk of any child accidentally coming into contact with the flame. The candle will only be alight for a few seconds, after which it will go out, producing a very tiny amount of smoke. (The amount of smoke is so small that it will not set off even the most sensitive of smoke detectors.)
The experiment also uses an Alka Seltzer tablet. If you think there is any danger of one of the pupils putting this in their mouth, you can instead use vinegar and bicarbonate of soda. (This will be highlighted in the text below.)

About this Activity

This experiment involves making some carbon dioxide. The air on Mars is almost pure carbon dioxide, so the gas that we are making is just like that found in the Martian atmosphere. We will also show that carbon dioxide extinguishes a flame.

The activity introduces the children to:

- The idea that some planets (other than Earth) do have an atmosphere;
- This atmosphere may consist of different gases from the atmosphere on Earth;
- A flame needs oxygen to burn.

Before You Start

Equipment needed:

- A clear bowl – either plastic or pyrex – at least 10cm deep. (The flame will not be anywhere near the bowl, so there is no danger of a plastic bowl melting.)
- Tealight candle. There is one included in your Mission to Mars Science Pack. It can be re-used many times. (You can use a different candle if you wish – but it is important that the flame is well below the rim of the bowl.)
- Something to light the candle – a long-necked lighter (the type you use for lighting barbeques) or a long taper is ideal. (It is not advisable to use an ordinary cigarette lighter or match as there is a chance of burning your hand.)
- A couple of Alka Seltzer tablets. (Or alternatively, some vinegar and bicarbonate of soda.)

Worksheets:

There is a one page worksheet for this activity.

Other Notes:

Try to ensure that you do this experiment away from any draughts. For one thing, the moving air may stop the experiment from working successfully – and even if it does work, the children may think that it is the moving air that has blown the candle out!

Making Martian Air

Begin by telling the children that you are going to make some air which is just like the air on Mars.

- Pour a small amount of water into the bowl and place the tealight candle in the centre of the bowl. (The water should be just a few millimetres deep – and should come no more than halfway up the candle.)
- Light the candle. (The easiest way to do this without tipping the water or burning your hand is to use a long-necked lighter.)
- Wait a few seconds until the flame is established, then drop one Alka Selzter tablet into the water. You will hear the tablet fizzing as it reacts with the water.

(To do the experiment using vinegar and bicarb you need to pour vinegar into the bowl, rather than water, and then add a teaspoon full of bicarb once the flame is established.)

What happens?
The tablet starts to fizz – it is producing some gas.
After about 10-20 seconds the flame goes out.

(If the candle does not go out before the tablet stops fizzing, try adding another Alka Seltzer. If this still doesn't work, you need to use a deeper bowl – or check that there are no draughts.)

Why does the flame go out?
A candle flame needs **oxygen** in order to burn.
When the Alka Seltzer tablet **reacts** with water it produces **carbon dioxide** gas.
After about 30 seconds, the bottom of the bowl is full of **carbon dioxide**.
The flame goes out because there is no **oxygen** left.

Why is this relevant to Mars?
The atmosphere on Mars is almost pure (about 95%) carbon dioxide.

Can we breathe Martian air?
No, we need oxygen to breathe.

Also the air pressure on Mars is much less than that on Earth. (This means that there are far fewer air molecules per unit volume.) Mountaineers have problems breathing when they go to high altitude because the air pressure is much lower. On the summit of Mount Everest the air pressure is only a third of the air pressure at sea level. On Mars the air pressure is 100 times less than on Earth – so even if the atmosphere was pure oxygen, we would not be able to get enough oxygen molecules into our lungs to keep us alive.

However, it might be possible for other types of organism to live on Mars:

- Many types of microorganisms thrive on carbon dioxide – and produce oxygen as a by-product. (This could obviously be very useful if humans ever decide to live on Mars.)
- Although plants use carbon dioxide in photosynthesis, attempts to grow plants in an atmosphere of pure carbon dioxide have been unsuccessful.

Do you think Martian air is poisonous?
No! Ask how they know this. Here are several reasons:

- Obviously you would not be able to do this experiment in the classroom if it was poisonous.
- Our atmosphere contains carbon dioxide. (Although it is rather a small amount – only about 0.04%.)
- Carbon dioxide is used to make the bubbles in fizzy drinks.

Additional Discussion Questions

Can you see carbon dioxide?
No, it is invisible.

Can you smell carbon dioxide?
Many books and websites say that you cannot smell carbon dioxide, but this is not strictly true.
Wait a few seconds after the candle has gone out - so the candle is no longer hot - then bend over the bowl – put your nose right into the bowl - and have a good sniff. You will probably smell a sort of acid or slightly lemony smell. This is the smell of carbon dioxide.
You can also smell carbon dioxide when you pour out a glass of soda water. Do not fill the glass too full, so there is a space at the top for the carbon dioxide to accumulate. Now put your nose right into the glass and you should get that same acid/lemon smell.
(Of course, if you do the experiment with vinegar and bicarb you will not be able to smell the carbon dioxide. Although CO_2 is produced, all you will be able to smell is vinegar!)

Is carbon dioxide denser ('heavier') or less dense ('lighter') than air?
Carbon dioxide is denser than air.
We can deduce this from this experiment because if carbon dioxide was less dense than air, the carbon dioxide would simply rise up out of the bowl - so the candle would not go out.
Since carbon dioxide is slightly denser than air, it collects in the bottom of the bowl. This displaces the 'normal' air (which contains oxygen). As the bottom of the bowl fills up with carbon dioxide, the flame goes out.

Is carbon dioxide dangerous?
We have already discussed the fact that carbon dioxide is not poisonous, and in the quantities that we have produced it is not dangerous in any way.
But of course, we cannot breathe carbon dioxide, so if you entered a room filled with carbon dioxide you would die of asphyxiation.
Volcanoes produce large amounts of carbon dioxide. This can collect in caves or natural depressions (because it is denser than air). So animals – and some humans – have died near volcanoes because they have been overcome by a build up of carbon dioxide.

Further Ideas

An alternative way to do this experiment
Some children may not be convinced that it is the carbon dioxide that puts out the candle. After all, when the Alka Seltzer reacts with the water, some water spits up. Some children may think it is the water that puts out the candle. If so, you can try the experiment in a slightly different way:

- Put a small amount of water in the bottom of a 2 litre pop bottle and add an Alka Seltzer tablet. As it fizzes, the bottom of the bottle will fill up with carbon dioxide.
- Place the candle in the bowl, but this time without any water. Light the candle again.
- Put the neck of the bottle just inside the edge of the bowl and tilt the bottle slowly. The water should stay in the bottle – although it doesn't matter if a little water runs down the inside of the bowl. The important thing is that the invisible carbon dioxide gas will also be poured into the bowl (remember carbon dioxide is denser than air), and this should cause the candle to go out.

Varying the height of the candle

We have stated that the flame goes out because of a build up of carbon dioxide in the bottom of the bowl, so to test this idea further you can carry out the following:

- Repeat the experiment again, but this time we are going to measure how long it takes for the candle to go out. Start timing as you put the Alka Seltzer in the water.
- Now we are going to raise the candle by about a centimetre. You can do this, for example, by placing the candle on a lump of blu tack. Again, see how long it takes before the candle goes out. (You may need to add a second Alka Seltzer tablet – but don't do this until the first one has stopped fizzing.)

When you do the experiment for the second time it takes longer for the candle to go out – because the carbon dioxide has to fill up more of the bowl before the candle is starved of oxygen.