



MODULE 1

The burning candle



TIMING

1-2 hours

MATERIALS PER GROUP

1 Tea candle
1 Jar
1 Stop-watch
1 Straw
Matches
Photocopies of sheets
E1, E2, E3

SKILLS

Observation
Measurement
Argumentation
Working systematically
Planning
Group work

KEYWORDS

Oxygen
Carbon dioxide
Nitrogen
Inhaled air
Exhaled air

Overview

The following module uses the process of scientific enquiry, i.e. predicting – observing – explaining. Here children predict the outcome of an experiment and discuss it in small groups. It is a step in determining the composition of the air.

Aims

To understand that air is composed of different gases.
To understand that there is less oxygen in the air they exhale than in fresh air.

Teaching sequence

1. Children are going to investigate the oxygen content of air, by making a comparison between fresh air (i.e. the air they inhale) and exhaled air. The length of time a candle burns can indicate changes in oxygen content between fresh air and exhaled air. Distribute activity sheet E1. Each child predicts and writes down what will happen to a burning candle placed under a jar.
2. Divide the children into groups. They compare their ideas and agree on a prediction, which they write down with their reasoning.
3. Each group feeds back its ideas. Discuss their predictions and explanations as a class.
4. Distribute the materials needed for the experiment and demonstrate how to work the stopwatch.
5. Groups carry out the experiment and time how long the candle burns.
6. Write each group's candle burning time on the whiteboard and discuss the findings with the children. (See Teachers' notes).
7. Display Figure 2 (below), composition of fresh air, on the board and ask the children to predict whether there are differences in the oxygen content of fresh air and the air we exhale. Ask the children to suggest a research question and write the most appropriate on the board (e.g. does the air we inhale have the same oxygen content as the air we exhale?).
8. In their groups children should discuss how they can plan an experiment to test this question (see illustration in teachers' notes).
9. Children plan out/sketch their experiment and carry it out.
10. Distribute activity sheet E2. Children answer the questions on this sheet. Each group feeds back its observations, answers and explanations. Write the class results for candle burning times on the board and compare these times with those from experiment 1.
11. Plenary. Discuss how the children worked like scientists. They started with a research question, planned an experiment and carried it out. Groups probably used different ways of testing this question but all children should have observed that the candle in the jar with the exhaled air burned for a shorter time than the candle in the jar with fresh air.



From this experiment it could be concluded that exhaled air contains less oxygen than fresh air. Emphasise that this is the process of scientific enquiry that scientists use. Starting with a problem or a research question, they consider approaches to answer it and find evidence for the answer.

12. Display Figure 3 (below), the composition of exhaled air. In the exhaled air there is 16% oxygen, which is 5% less than in fresh air. Ask what the children think there could be in the exhaled air instead of oxygen. If they don't yet know, they should write a question mark in the second cloud. (See module 2).
13. Finally, children write down two things which they found out today.

Teachers' notes

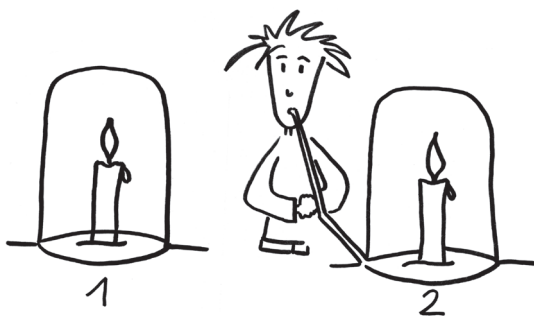
Air components

Fresh air consists of 78% nitrogen, 21% oxygen and 1% of other gases (including CO₂ and others). Oxygen is necessary for every burning process, whether burning a candle, or burning food at a cellular level*. When all the oxygen in the jar is used, the candle flame can no longer burn and so expires.

The metabolism of food in cells is analogous to a candle burning. Just as a candle requires oxygen to burn, cells need oxygen to 'burn' or release the energy (metabolise) from food.

Setting up the second experiment

Using a straw, children exhale into a glass jar inverted over a candle. Children consider how best to do this. They time how long the candle burns.



Experiment to test the difference in oxygen content between the air we inhale and air we exhale.

During photosynthesis, plants produce sugar, which they store in the form of starch. This is used by the plant to grow and reproduce. Animals and humans use plants as food, which provides fuel for them to grow. The energy stored in food must be released (or metabolised) in order for it to be used. Just like other simple chemical reactions in which fuels are burned, this requires O₂ and CO₂ is released. Whilst the food in our cells does not actually 'burn', we can use the analogy of a candle burning, with food being 'burned' in our cells.

The air we exhale has a higher carbon dioxide content and a lower oxygen content than the air we inhale (fresh air). (By volume, fresh air is 21% oxygen and 0.03% carbon dioxide; exhaled air is 16% oxygen and 5% carbon dioxide). Therefore, the jar containing exhaled air will contain less oxygen and hence the candle burns for a shorter period of time (in addition, carbon dioxide is heavier than oxygen and so will displace oxygen from the bottom of the jar).

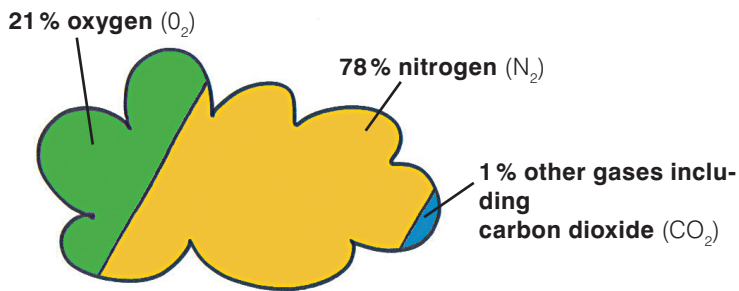


Figure 2: Air we inhale

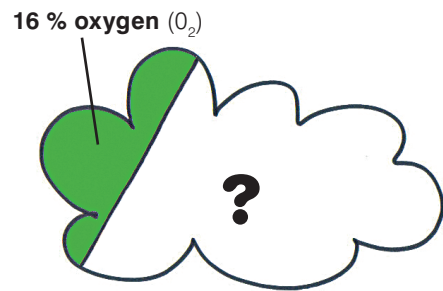


Figure 3: Air we exhale

Characteristics of an experiment

Research has shown that practical science experiments do not necessarily change children's ideas about science.

Therefore it is important to discuss with the children not only the outcomes of an experiment but also the process of inquiry itself. What makes a good scientific experiment?

Amongst others, two key factors make a good scientific experiment:

1. Generally only one factor for each experiment is changed:

In the experiment with the candle and the jar the only factor changed was the air. First fresh air was used and then exhaled air. Everything else was the same: same jar, same candle. Therefore the results (i.e. candle burns for a shorter time in exhaled air) must be linked to the different type of air.

2. The results of the experiment should be reproducible:

Different groups did the experiment and could repeat the experiment several times with the same candle if there is enough time. The results may vary (due to different amount of exhaled air or different management by the individuals), but in all the experiments the candle burning in exhaled air is expected to burn for a shorter period.

Health and Safety

Burning candles need careful handling

Review the issues that working with a burning candle raises.

FLAMMABLE

The burning candle



What do you think will happen if the candle is covered? Circle one letter.

- A: The candle burns brighter
- B: The candle burns out
- C: The candle burns for a while and then burns out
- D: The candle goes on burning as before

Why do you think that happens?

I think is correct because

The experimenters in my group are

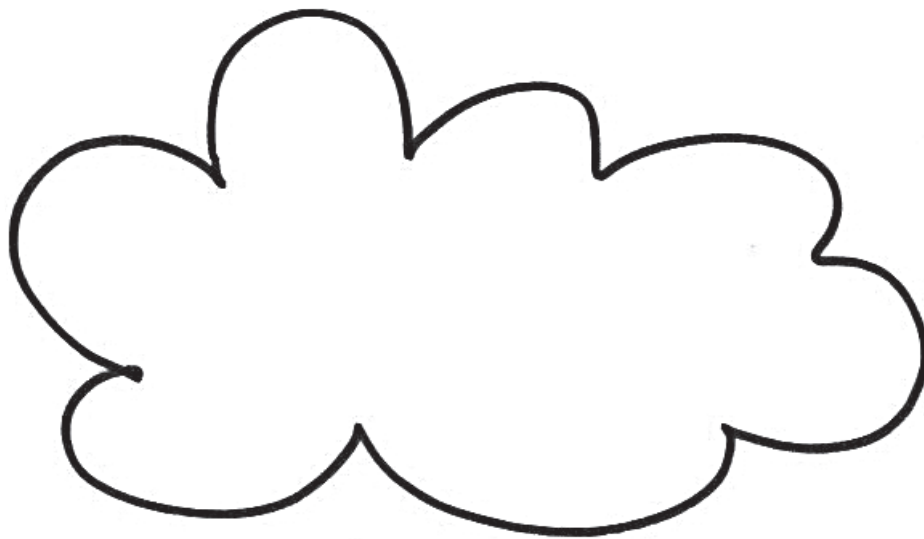
.....

We have decided that is correct because

Carry out the experiment and time how long the candle burns using the stopwatch!
The candle burned for seconds.

The burning candle

Draw the different components (i.e. gases) of fresh air in this cloud:



Does the air we exhale contain more or less oxygen than the air we inhale?

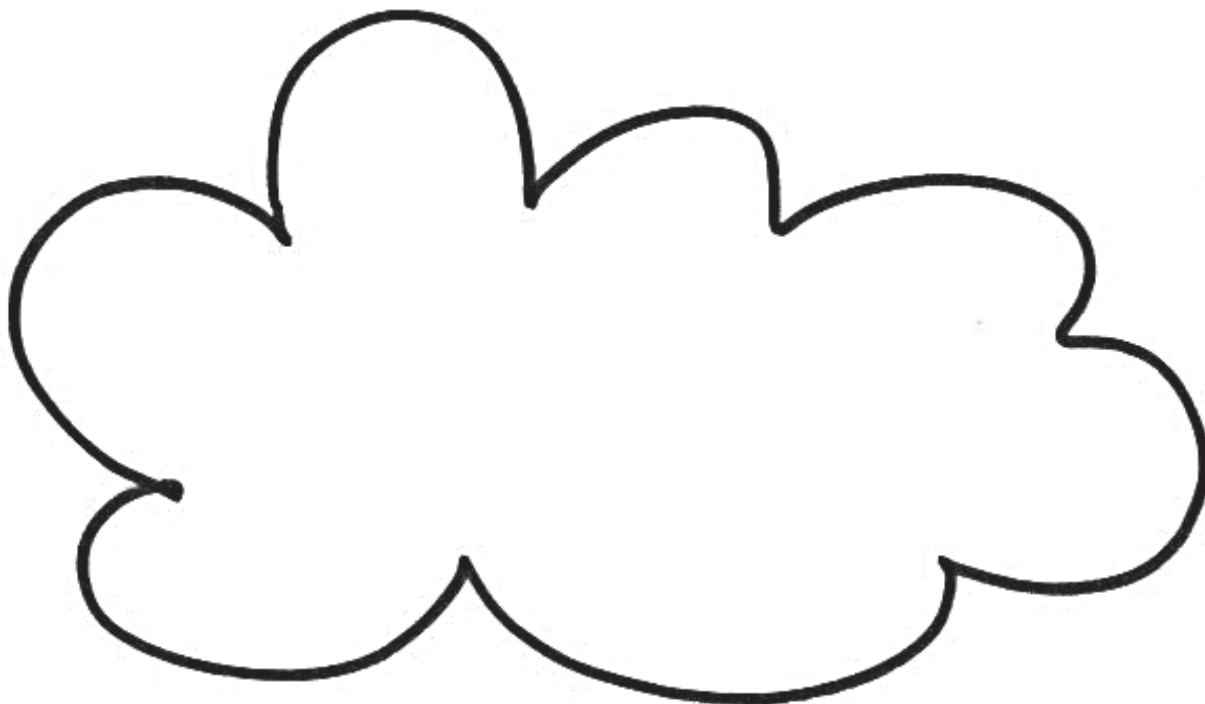
- A: less oxygen
- B: same amount of oxygen
- C: more oxygen

How can we find out? Plan an experiment, draw how you would set the experiment up and record your results.

In fresh air the candle burns seconds	In exhaled air the candle burns seconds
--	--

I think answer is correct because

Draw the different components of air that has been **exhaled** in this cloud



Today I learned