Science@School Book 5C

Gases around us

Activity worksheets

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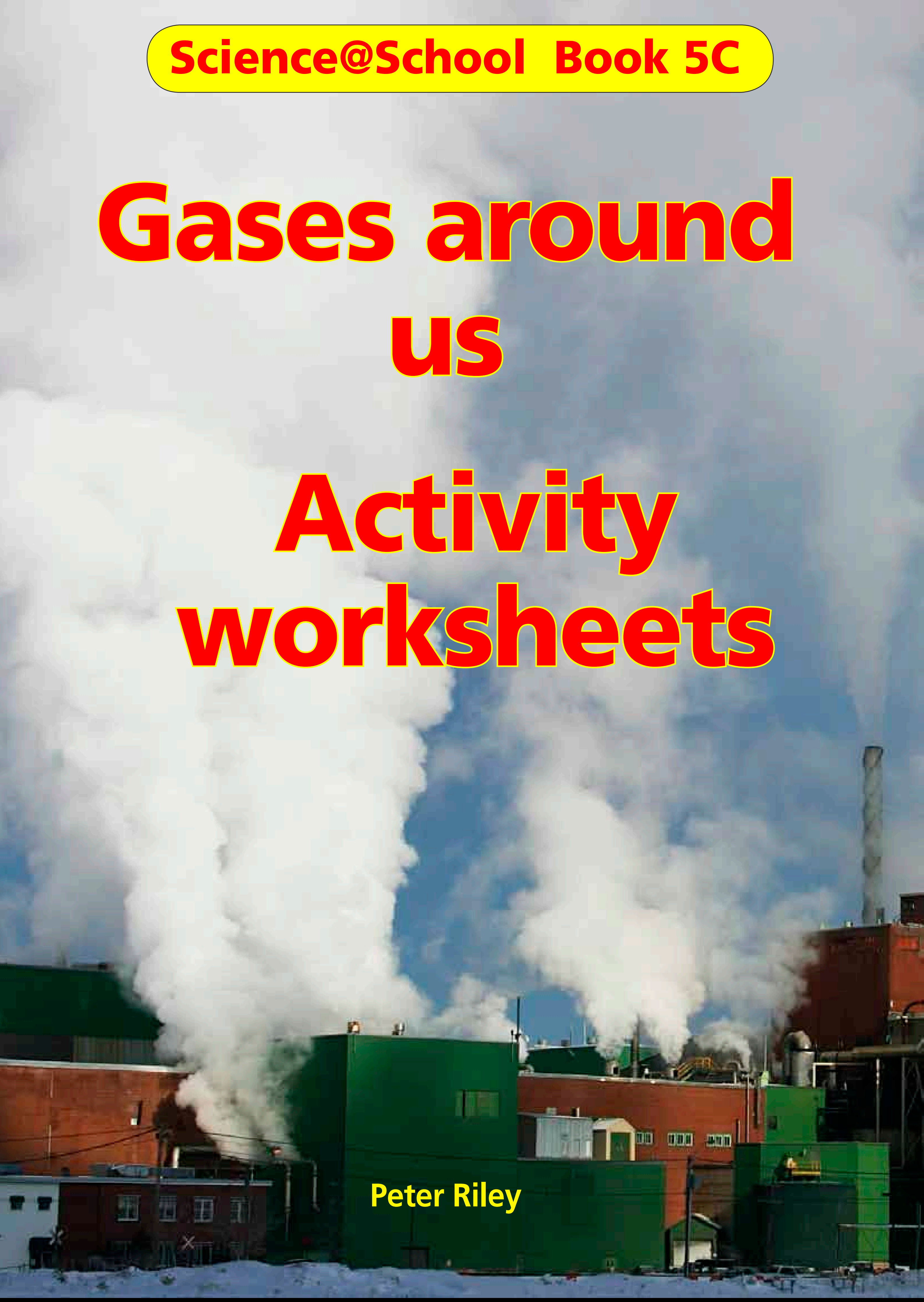

1 Teacher's sheet: comprehension

See **pages 4 and 5** of *Gases around us*

Answers

1. **At the speed of sound*.**

2. **Ice.**

3. **(i) solid; (ii) liquid, gas; (iii) gas.**

4. **A = liquid, B = solid.**

5. **Air rushes back into the bottle very quickly because air is a gas, and gases fill any space they can.**

Complementary work

(a) The particles from which solids, liquids and gases are made are so small that they can only be seen by very powerful microscopes. However, scientific models can be made by thinking of each child in the class as a particle of matter.

Divide the class into three groups. Ask the children in the first group to hold on to each other. They are the particles in a solid. Ask the children in the second group to stand close to each other and move past each other. They are the particles in a liquid. Ask the children in the third group to walk about the classroom, touch the walls as they reach them, then turn round and walk in a different direction. These children are particles of a gas.

Teaching notes

While children can easily distinguish between solids and liquids, they have difficulty with the concept of gases, and time must be taken to build up their ideas.

The unit begins with a familiar gas-filled object – a balloon. You may like to blow up some balloons with a pump and talk about how the balloons inflate because you are pushing more and more gas into them. The children may say that there was nothing in an empty balloon, but this is not true. There is a small amount of air in the balloon, but it is not pushing strongly on the walls of the balloon. When you pump in more air, it can push more strongly and make the balloon inflate.

The children may ask if there is air in the empty flask in Picture 2. This flask has had the air removed from it by a pump. It does not implode (explode inward) because the walls of the flask are thick and strong. A space without any matter, including gas, in it is called a vacuum. It is very difficult to remove every particle from a space so there are two kinds of vacuums. A perfect vacuum is completely empty, while a partial vacuum contains some gas particles. Almost all vacuums, like the one in the empty flask, are partial vacuums. Even in space, there are particles of gas (such as those that make up the stars), so most of space is a partial vacuum. There may be some places in space that are so far from any stars that perfect vacuums can exist. If you wish to introduce the concept of a vacuum, you may ask the children to find out about how a vacuum cleaner works, and how vacuum-packed food is made.

The brown gas in the flasks in Picture 2 is bromine. It is a harmful gas and is combined with other chemicals to make photographic film and dyes.

The microscopes which are used to examine the particles of matter are called electron microscopes. They do not use light like the microscopes used in schools.

***** The speed of sound changes depending on the type and temperature of the medium (gas, water, etc) it is travelling through. The speed of sound through dry air at 0°C is 331.29m per second (741.1 miles per hour), but this increases if the air temperature increases.

1 Teacher's sheet: activity

Based on **pages 4 and 5** of *Gases around us*

Introducing the activity

(a) You could begin by telling the children that the first person to show that air was a substance was a scientist called Hero. He lived in Greece in the first century AD. He showed that air was a substance by trying to put water in a special container that held air. In this activity the children will repeat a form of his experiment and see if they agree with him.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through task 1 (see note (i)).

(c) Read through tasks 2 to 7 with the children (see note (ii)).

(d) Make sure the children know what to do, then let them try tasks 2 to 7 (see note (iii)).

(e) Read through task 8 with the children then let them try it.

Completing the activity

(f) Let the children compare their observations in task 3, 5 and 6.

(g) Let the children compare their explanations to their observations.

(h) If the children have not successfully completed task 8 demonstrate it to them (see note (iv)).

(i) Ask the children if they agree with Hero that air is a substance.

Conclusion

When the neck of the bottle is open, the water will rise up inside the bottle as it is lowered into the water. When the neck of the bottle is closed, the water will not enter the bottle because it is filled with trapped air.

When a hole is made in the Plasticine, the air rushes out with a hiss, it feels cold on the skin, and the water rises up inside the bottle to the same level as the water outside the bottle.

Teaching notes

(i) You will need to cut the bottom off the bottles before the activity. If possible, let the children use a transparent bowl.

(ii) In task 4, remind the children that they are making a prediction. In task 5, remind the children that they are testing their prediction. In task 6, tell the children that they must be very quiet in order to listen for the air.

(iii) In the explanation, look for the water pushing the air out of the top easily when there was no Plasticine cap. When the cap was in place, the water pushed on the trapped air and it prevented the water from getting into the bottle. When a hole was made, some of the air rushed out, making a noise and blowing against the skin. The air moved because some of it was being pushed by the water.

(iv) Just tip the bottle slightly so bubbles escape into the water. The air is in the bubbles.

2 Teacher's sheet: comprehension

See **pages 6 and 7** of *Gases around us*

Answers

1. **The left-hand jar should have a small area of dark blue at the bottom of the jar, becoming paler to about a third up the jar. The middle jar should have a smaller area of dark blue at the bottom, and a paler region reaching up into the top half. The right-hand jar should have a very small, dark region at the bottom and should be filled with pale blue.**
2. **Because the two gases mixed.**
3. **Before or at 15 minutes.**
4. **Because the particles of the two gases kept bumping into each other.**
5. **They bounce about. The air moves down while the blue gas moves up.**
6. **The blue gas. It stayed at the bottom and slowly spread upwards. If it had been lighter, it would have stayed at the top and spread downwards.**

Complementary work

(a) Let the children make a survey of the school to find the windows that open for ventilation.

(b) Let the children use secondary sources to find out about air conditioning.

Teaching notes

The scientific principle that is illustrated in this unit is diffusion. You do not need to tell the children this word. Particles in a gas have enough energy to move freely. As they move, they bump into each other and change direction. When two different gases meet, their particles bump into each other and mix. It is important for the children to realise that this happens even though the two gases appear still, like the two gases in the experiment. One gas is not being blown into the other, and the lower gas is not rising because it is hotter than the other. Both gases are at the same temperature.

The children may find it difficult at first to imagine that the mixing is due to very tiny gas particles. The supporting practical activity may help them to visualise how the mixing occurs.

The brown gas in the experiment in the pupil book is bromine. It is harmful but is used with other chemicals to make photographic film and dyes.

The tall cylindrical container for the gases is called a gas jar. The top of the gas jar is closed by a circular piece of ground glass called a ground glass cover. The lower part of the cover is coated with petroleum jelly which makes a gas-proof seal that keeps both gases in the gas jar.

2 Teacher's sheet: activity

Based on **pages 6 and 7** of *Gases around us*

Introducing the activity

(a) Begin by reminding the children that solids, liquids and gases are made of very tiny particles that cannot be seen (see note (i)). Tell the children that scientists often make models to help them understand their observations. In this activity the children are going to make a model to help them understand how gases mix, as shown on pages 6 and 7 of the pupil book.

In the model, the particles will be represented by plain white peppercorns and white peppercorns dyed black (see note (ii)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 4.

(c) Let the children work through tasks 1 to 4 (see note (iii)).

(d) Go through tasks 5 to 7, then let the children work through them (see note (iv)).

(e) Let the children complete tasks 8 to 10.

Completing the activity

(f) Let the children compare their descriptions.

Conclusion

The peppercorns (particles of gas) move in a random way. They bounce off each other and off the walls of the container. The particles of one gas spread through the particles of another. Some particles may be grouped together, and others may be completely separated.

Teaching notes

(i) The children must understand clearly that these particles are very, very small. They must not confuse these particles with particles of sand or dust, which are very much larger than atoms. Some children may have heard of the words atom or molecule. You can confirm that these are the tiny particles from which solids, liquids and gases are made.
If the children ask how atoms and molecules are different, it is sufficient to say that a molecule is made from a group of atoms, but both behave as shown on pages 4 and 5 and in this activity.

(ii) **Only white peppercorns are used because they roll more easily than black peppercorns.** The black peppercorns for this activity are made by dipping white peppercorns in black food dye, then letting them dry.

(iii) It is very important that the inside of the square is flat and level so that the peppercorns can roll about in a random way and not collect in particular places due to humps and hollows in the surface.

(iv) The children should be very careful not to disturb the peppercorns after they have made their first drawing, so you can check their work if you wish.

Teacher's sheet: comprehension

See **pages 8 and 9** of *Gases around us*

Answers

1. **The dots should be all round the flower. The dots should become more widely spaced as you move away from the flower.**

2. **The dots should be on the right side of the flower. They should be close together near the flower, but more spread out as you move from left to right.**

3. **Gases.**

4. **Air freshener, perfume, flower petals, food, cooking.**

5. **There is room in the air for the particles to move about.**

6. **You can only smell scents when the particles are in a high concentration. They are in a high concentration close to a flower, but the concentration becomes lower as you move away from the flower.**

Complementary work

(a) A simple rosewater scent can be made by soaking rose petals in water. Several samples may be set up and left for different times. The time the petals soak for may be compared with the strength of the smell.

(b) The children can use secondary sources to find out how perfumes are made.

Teaching notes

It is important that the children realise that scents and smells are particles of gas. This will help them distinguish gases from solids and liquids. Some gases escape from liquids and damp solids by evaporation. You may like to extend the work by asking the children to make a smell list for a day. This could be developed into a survey of scents and fragrances used around the home, such as air freshners, joss sticks and aromatic oils. You could also let the children keep a smell diary on their way to and from school for a week. At the same time, note the wind directions for that week and, if possible, relate the smells to the direction of the wind. You could use this information with air pollution in Unit 9.

In still air, scent spreads out as the scent particles bump into other particles in the air. This process is called diffusion, but the children do not need to know the term at this stage. When cooking takes place, hot air rises and carries the smells upwards, speeding up the spread of the smell. Cooking smells also travel faster, because the particles have received energy from the heat used in the cooking, and move faster. The faster moving particles diffuse through the air faster than more slowly-moving particles.

Our ability to detect smells depends upon their concentration, but it also depends on the amount of time that we are exposed to them. After a time, the smell receptors in the nose no longer inform the brain of the presence of a smell, even though the smell may still be present. For example, you may be aware of the scent of a bunch of flowers in a room when you first enter the room but later, after spending time in the room, you would not smell them. Someone entering the room later may marvel at the smell, while you are no longer aware of it.

Teacher's sheet: activity

Based on **pages 8 and 9** of *Gases around us*

Introducing the activity

(a) Remind the children that all scents and smells are gases that have escaped from solids, like fruit, or liquids, like shampoo (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their name and form then go through task 1 (see note (ii)).

(c) Go through tasks 2 to 4 (see note (iii)).

(d) Let the children try tasks 2 to 4.

(e) Let the children try task 5 (see note (iv)).

(f) Let the children complete tasks 6 to 8.

Completing the activity

(g) The children can compare their answers in task 6 (see note (v)).

Conclusion

Solids, like foods, and liquids, like shampoo, all give off smells.

Some substances produce large quantities of a smell and others produce small amounts.

A simple grading system can be used to compare the strength of smells, but it has some limitations.

Teaching notes

(i) It may be worth defining scents as pleasant smells, and grouping smells as either pleasant or unpleasant. Unpleasant smells usually come from substances which are harmful to us. Human wastes are an example of substances which are harmful and have an unpleasant smell. Natural gas does not have a smell, so smelly substances are added to it so we can smell when unlit gas has been left on or when there is a gas leak.

(ii) Label the jars yourself, and let the children write in these letters in the table.

(iii) Many investigations on scents and smells, including this one, are subjective. The use of a star rating gives the children a means of quantifying their observations. Make sure that they are familiar with this form of grading.

(iv) You may read out the names of the substances or put a list on the board when everyone has finished task 4. Alternatively, you may ask the class what they think the answers are, and then give them out.

(v) The children may find that there is some variation in their groupings. This may be due to variations in the children's sensitivity to smells.

4 Teacher's sheet: comprehension

See **pages 10 and 11** of *Gases around us*

Answers

1. **The balloon should be fully inflated and upright. It should be rising off the ground.**
2. **Upwards. The hot air rises and carries the smoke particles with it.**
3. **It turns round. The hot air rising from the bulb passes between the windmill's blades and makes the windmill turn.**
4. **Thermals.**
5. **The Sun.**
6. **When warm air rises.**

Complementary work

(a) When the children have studied the hot air balloon and seen that hot air inflates the balloon, they may wonder what happens to a balloon if it is cooled down. You can test this idea in the following way. Inflate two balloons to the same size. Place one in a fridge for a few hours, and leave the other in the classroom. Later, when the two balloons are compared, it will be seen that the one from the fridge has shrunk in size. This change is due to the air inside the balloon contracting.

Teaching notes

The children may wonder how heat affects the particles from which the air is made. The particles of a gas can move freely. They move because they possess a certain amount of energy. Heat is a form of energy. When air is heated, its particles move faster. This makes them move further apart. A gas with its particles spread apart is less dense than a gas with its particles closer together. The air close to a fire has widespread particles and is less dense than the surrounding air. The less dense air floats above the denser air, just as a piece of cork floats up through water.

You may wish to link the section on clouds with studies on the water cycle.

4 Teacher's sheet: activity

Based on **pages 10 and 11** of *Gases around us*

Introducing the activity

(a) Look at the photograph on page 10 with the children. Tell the children that the arrangement of the fins in the windmill makes the windmill turn round when warm air passes through it. Show the children how to draw a spiral and cut it out. Ask them how they could test the spiral to see if it could be used to detect warm air, like the windmill (see note (i)).

You could demonstrate the spiral by hanging it over a light bulb or heater (see note (ii)).

Challenge the children to investigate spirals of different lengths and thicknesses.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through tasks 1 to 7, referring back to your demonstration in the introduction.

(c) Let the children perform tasks 1 to 7.

(d) Check the spirals made by the children, then let them perform task 8.

(e) Check the plans (see note (iii)) and if suitable let the children carry out their tests.

(f) Let the children perform task 10.

Completing the activity

(g) Let the children compare their results.

Conclusion

The long, thin spiral will turn fastest. The short, thick spiral will turn the slowest.

Teaching notes

(i) Some children may suggest hanging the spiral from a piece of string. This will not work. The spiral must be suspended on thread.

(ii) If a light bulb is used, make sure that it is a pearl bulb, as this produces less glare than a clear glass bulb. The children must look at the spiral and not the bulb.

(iii) In the plan, the children should show that they will compare the number of times the spiral will turn round. This could be the time taken for each spiral to turn round ten times, or the number of times each spiral turns in a minute. Each spiral should be hung in exactly the same place above the heat source. The length of the spirals will vary, but the distance between the heat source and the bottom of each spiral should be the same for each test.

5 Teacher's sheet: comprehension

See **pages 12 and 13** of *Gases around us*

Answers

1. **A hygrometer.**

2. **(i) A hair; (ii) It gets shorter; (iii) The arrow points towards the top of the scale.**

3. **Water vapour.**

4. **It gets smaller.**

5. **Warm, dry, moving.**

Complementary work

(a) The change in hair due to moisture in the air can also be demonstrated by simply hanging a pointer from a hair. Tape one end of a long hair (10+ centimetres) to the middle of a pencil, and tape a spent match stick or toothpick (this is the pointer) to the other end. Hang the hair inside a plastic jar. If the pointer does not take up a horizontal position, add a drop of glue to one end to make it balance. Put the jar in a place where the children can look at it over a few days. Leave the jar open so air can freely pass in and out. As the hair lengthens and shortens, the pointer changes position.

Teaching notes

The children in the class may have a range of ideas about what happens when water is lost by evaporation. They may just say that it has vanished, or use words like melted or dissolved. Look for these words in their responses and clarify what each of their wrong answers means.

If you have talked about air particles in some detail in Unit 1, you could build on it here to help focus the children on evaporation. Remind the children of how liquids, such as water, are made of particles which touch each other and slide over each other, whereas gas particles are free to move around. You could look at Picture 2 on page 6 and, if the children took part in the scientific modelling in the introduction to Unit 1, you could ask them how they could model evaporation. One way to do this would be to have three or more parallel lines of four children each. They could each hold onto the shoulders of the children around them. Let one of the outer lines be the liquid surface and ask these children to stop holding onto the children in the next line and to each other. Now ask the children in the next line to let go of the 'surface line' too, so that the children in the outer line can move away and become particles of gas. Now repeat this with the next line, and so on until all the children have 'evaporated'.

The answer to the question on Picture 4, page 13, is that the humidity in the air in the jar increases because the air is less likely to get stirred by any breeze, the further down the measuring cylinder it is.

You may wish to follow up the process of evaporation by considering humidity. You could do this by making the very simple hygrometer in the complementary activity, or by making the hygrometer shown on page 12 as a technology project.

5 Teacher's sheet: activity

Based on **pages 12 and 13** of *Gases around us*

Introducing the activity

(a) Look at Picture 3 on page 13 with the children. Ask them how they could measure the speed at which the water evaporated from the puddle between 9am and 10am (see note (i)). Ask the children how they could see if water evaporated inside a building (see note (ii)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form and go through tasks 1 to 4 and task 7(a) (see note (iii)).

(c) Let the children carry out tasks 1 to 4.

(d) Go through tasks 5 and 6 then let the children carry them out (see note (iv)).

Completing the activity

(e) Let the children try task 7(b) (see note (v)).

(f) Let the children try task 8 and share their results with the rest of the class (see note (vi)).

Conclusion

Evaporation is fastest in places where the air is warm, dry and moving. It is slowest where the air is cold, damp and still.

Teaching notes

(i) The position of the edge of the puddle can be marked on the ground at 9am. At 10am the position of the edge of the puddle can be marked again, and the distance between the two marks can be measured. If there is a puddle in the playground, and the weather is fine, you could test the idea. If there is no puddle, you could take out a bucket of water and make one.

(ii) The children may suggest using mini-puddles in dishes or saucers. You could then introduce the sheet as a way of checking their answers and ideas.

(iii) The children could select a range of places, from sunny windowsills to cold cupboards. Discuss ways in which they can make the test fair.

(iv) In task 6, look for differences in air temperature, humidity and air speed.

(v) If children have suggested a short period of time, they may have found no difference in the water levels. They could then revise the time interval to perhaps a day. (Note: At a damp time of year, this could take several days.)

(vi) If some children have selected places where evaporation is fast, they could measure the water levels every hour and plot a graph of their results. If different groups of children have been using containers of different sizes, an investigation could be made on the effect of the size of surface area on evaporation. If this is tried, the children will find that evaporation will be slower in containers which only allow a small surface area of liquid to be exposed to the air.

6

Teacher's sheet: comprehension

See **pages 14 and 15** of *Gases around us*

Answers

1. **A is a lump of chalk. B is vinegar.**
2. **Bubbles will form in the vinegar. They contain carbon dioxide. They rise to the surface of the vinegar.**
3. **Air trapped inside the sponge.**
4. **Carbon dioxide.**
5. **The gas in the bubble is lighter than the liquid, and so rises, or floats, to the surface.**
6. **The film of soap makes the bubble heavier than air.**

Complementary work

(a) Let the children examine a piece of sponge with a magnifying glass and describe what they see. They could weigh the sponge, then push it below the surface of the water in a bowl and slowly squeeze it. They should describe what they see as the sponge is squeezed, then remove it and weigh the sponge again. They should explain that the increase in weight is due to the water that has filled the spaces in the sponge that had been filled with air.

Teaching notes

The unit begins by considering the bubbles made when air is displaced by water. It then moves on to consider bubbles in fizzy drinks. These bubbles contain carbon dioxide. This gas is not being displaced like the air in a sponge. It is dissolved in water and is released when the top is taken off the drinks container. The reason for this is that carbon dioxide gas is pushed into the water with pressure to make more of it dissolve. A high pressure is used in the manufacture of fizzy drinks, so large amounts of carbon dioxide will dissolve. Inside the sealed drink container, the small amount of gas at the top of the liquid still exerts a high pressure on the gas, so it stays in the liquid. When the top of the container is removed, this gas escapes into the air and the pressure falls greatly. As the pressure on the liquid is now much smaller, the carbon dioxide makes its escape as bubbles. The bubbles escape more quickly from the warm fizzy drink because carbon dioxide is less soluble in the warm water than in the cold water.

The dissolving and releasing of carbon dioxide is an example of a reversible change because if the carbon dioxide was collected, instead of being released into the air, it could be pushed back into the liquid using special equipment.

This unit also considers the making of carbon dioxide by a chemical reaction. The vinegar reacts with the chalk to make carbon dioxide. This is an example of an irreversible change, as the carbon dioxide cannot be put back into the chalk.

6

Teacher's sheet: activity

Based on **pages 14 and 15** of *Gases around us*

Introducing the activity

(a) Look with the children at the 'Make your own bubbles' section on page 15 of the pupil book. Either perform this experiment as a demonstration or let groups of children try it. Now show them some bicarbonate of soda, a jar of water, vinegar and currants, and ask the children what might happen when these ingredients are mixed together (see note (i)).

Using the sheet

(b) Give the children the sheet, let them write their names and form on it then go through tasks 1 to 5 with them (see note (ii).

(c) Let the children carry out tasks 1 to 5 (see note (iii)).

(d) Let the children carry out task 6 (see note (iv).

Completing the activity

(e) Let the children compare their observations and explanations.

Conclusion

When bicarbonate of soda is dissolved in water, then mixed with vinegar, bubbles of gas are produced (see note (v)). Some of the bubbles collect on the surfaces of the currants (see note (vi)). When a large number of bubbles collect on a currant, they make it light enough to float to the surface. Some currants lose bubbles as soon as they reach the surface, and sink again. Other currants keep their bubbles and remain at the surface for some time. If a currant sinks and collects bubbles from the side of the jar, it may become light enough to float to the surface again.

Teaching notes

(i) The children may suggest that bubbles may be made by mixing the bicarbonate of soda, vinegar and water together. They may be puzzled about what will happen to the currants. Use this to drive the investigation forwards.

(ii) The jar should be tall and have a volume of about $250cm^3$. Some standard glass tumblers are ideal. It does not matter if some of the bicarbonate of soda remains undissolved at the bottom of the jar. Do not use warm water. This makes the chemical reaction take place more quickly and produces smaller bubbles.

(iii) In task 4 the children will see bubbles being produced. Some may stick to a currant and cause it to rise before the water has stopped swirling round. In task 5 the children should observe that bubbles collect on the currants and cause them to rise. They may see currants rise to the surface, stay there awhile, and then sink. Some currants may sink as soon as they have touched the surface. Other currants may touch the bubbles on the side of the glass as they sink, then rise again.

(iv) Compare their explanations with those in the conclusion.

(v) The gas in the bubbles is carbon dioxide.

(vi) The rough surface of the currants provides a good surface for the bubbles to stick to.

Teacher's sheet: comprehension

See **pages 16 and 17** of *Gases around us*

Answers

1. **Because balloon A contains air and balloon B does not. The weight of the air in A makes the balance tip.**

2. **It could be inflated, or blown up, to the same size as balloon A.**

3. **Nitrogen.**

4. **Oxygen.**

5. **Carbon dioxide.**

6. **(i) It is used in crisp packets to keep the food fresh; (ii) It is a light gas and is used to make balloons float.**

Complementary work

(a) The children can use secondary sources to find out about the thickness of the layer of air around the Earth, and how the proportions of the gases in the atmosphere change with altitude.

Teaching notes

Children can find air a confusing substance. They cannot see it and feel it in the same way that they can see and feel solids and liquids. This can lead to the children dismissing air as 'nothing'. On the other hand, children usually know that oxygen is in the air and is vital for their survival, and many know about carbon dioxide.

This unit takes this basic knowledge and extends it so the children can appreciate that air is not just a mixture of oxygen and carbon dioxide, but also contains a large volume of nitrogen – a gas which is unreactive. It may be worth letting the children appreciate the abundance of this gas by dividing the classroom into two parts – one part representing a fifth of the volume of the room (for oxygen) and other part four-fifths of the volume of the room (for nitrogen). You could say that if oxygen and nitrogen in the air could be separated, then these are the volumes they would fill. You could ask the children to reflect on their survival chances if they are in the four-fifths of the room that you have designated to be filled with nitrogen!

Some children may ask how the gases in the air are separated. This is done by cooling the air down to –200°C. At this temperature, the air turns into a liquid. The liquid air is then carefully warmed. The different gases will separate because they have different boiling points. For example, the boiling point of liquid nitrogen is –196°C, and that for oxygen is –183°C.

Teacher's sheet: activity

Based on **pages 16 and 17** of *Gases around us*

Introducing the activity

(a) Tell the children that scientists in the past were fascinated by the air and performed experiments to find out what it was made from. You are going to show them one of these experiments and you will be asking them to predict what happens at different stages in the experiment (see note (i))

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 and 2 (see note (ii)).

(c) Let the children perform tasks 1 and 2.

(d) Go through task 3 then let the children try it (see note (iii)).

(e) Go through task 4 then let the children try it (see note (iv)).

Completing the activity

(f) Let the children try task 5 as you perform the experiment.

Conclusion

When a jar is placed over the candle and lid, the level of the water will go down, because air trapped in the jar pushes down on the water surface. When a volume of air is trapped around a burning candle, the candle will continue to burn until all the oxygen in the air is used up. When this happens, the water level inside the jar rises because the volume of the air inside the jar has been reduced (see note (v)).

Teaching notes

(i) After making a risk assessment you may feel that some groups of children could perform the experiment under supervision.

(ii) The children may remember how air was trapped in the top half of the bottle in the activity in Unit 1. If they do, they may predict that the water level will go down.

(iii) Some children may think that the candle will burn a long time, while others may think that because you are putting something over the flame it will go out straight away. Children who know that oxygen is needed for things to burn may predict correctly.

(iv) The children may need prompting a little. If you did the activity in Unit 1, you could ask them what happened when there was less gas in the bottle. If they know that oxygen is used up in burning, they may make a correct prediction.

(v) It is often said that the water rises up to replace the oxygen that has been removed from the air during burning. While this is true, the rest of the air expands as it is heated, and carbon dioxide is also produced during burning, so the volume occupied by the water is not the same as the volume that was occupied by the oxygen. As the gases in the jar cool down the water level rises a little more.

This experiment was important in its day because it showed that air is not made up of a single substance, but includes one gas which is destroyed by burning (later identified as oxygen), and one gas that is not destroyed by burning (mostly nitrogen but later shown to be a number of gases).

Teacher's sheet: comprehension

See **pages 18 and 19** of *Gases around us*

Answers

1. **Carbon.**
2. **During the day.**
3. **It can catch fire.**
4. **They lose their shine.**
5. **Food.**
6. **When we breathe out we release carbon dioxide. Plants use this gas to make leaves, stems and flowers (all the parts of the plant).**

Complementary work

(a) The children can use secondary sources to find out about the uses of oxygen and carbon dioxide.

(b) The children can use secondary sources to find out how fire extinguishers work.

Teaching notes

Children sometimes confuse oxygen and air and think they are the same thing. Although they should realise the difference from studying the previous unit, the photograph on page 18 provides a useful starting point to consider what would happen if the air was pure oxygen. If possible, you could show the children a video which featured oxy-acetylene welding. The children would see just what happens when a gas burns in pure oxygen. Conditions become so hot that metals melt and become welded together.

Almost every living thing uses oxygen to unlock energy from food. This occurs in a process called respiration. (Some microbes do not use oxygen.) It is important to remember that plants need oxygen for this process, just like animals, and that animals also produce carbon dioxide. Plants differ from animals in that they need large quantities of carbon dioxide to make food in a process called photosynthesis. Plants produce large amounts of oxygen as a by-product, which is released into the air. A small amount is retained and used by the plant. Photosynthesis and respiration both take place in plants throughout the hours of daylight, but at night only respiration takes place.

8 Teacher's sheet: activity

Based on **pages 18 and 19** of *Gases around us*

Introducing the activity

(a) Ask the children how they could tell if oxygen was present in a mixture of gases. Look for the answer – it would make things burn. Now tell the children that they are going to investigate what happens when carbon dioxide removes oxygen from around a burning substance. Tell the children that carbon dioxide gas is heavier than air, and hold up an empty jug and a cup. Ask them how they could get carbon dioxide out of the jug and into the cup. Look for the answer – you could pour it out. The children can then be told they are going to make carbon dioxide and pour it over a flame (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 6 (see note (ii)).

(c) Let the children try tasks 1 and 2. Light the candle in a sand tray for them when they are performing task 2.

(d) Let the children try tasks 3 and 4 (see note (iii)).

(e) Let the children try task 5.

Completing the activity

(f) Let the children try task 6.

(g) You could ask the children what would happen if they made the carbon dioxide in the jug, then left it in the jug for a while before they poured it over the flame (see section (iv)).

Conclusion

A candle flame burns because there is oxygen in the air. Carbon dioxide gas is made when vinegar and bicarbonate of soda are mixed together. Carbon dioxide gas is heavier than air and can be collected in a jug. When it is poured on a flame, the flame goes out because the carbon dioxide pushes the air out of the way and takes its place, and things cannot burn in carbon dioxide.

Teaching notes

(i) As children have some difficulty understanding how gases behave, because they cannot see them, this introduction may help them visualise what is going to happen. Alternatively, you may wish to omit the part with the jug and cup and let the children try and realise for themselves that carbon dioxide is heavier than air.

(ii) Make sure that you have performed the experiment and checked that the jug is large enough to hold the contents when the two chemicals are added together. A large amount of froth rises up inside the jug and will spill over if the jug is not tall enough. Emphasise that the gas should be poured slowly. If this is done, there should be enough gas left in the jug to perform task 5 twice. **No liquid should be poured from the jug.**

(iii) The children should be amazed at how quickly the flame goes out and must stop pouring straight away so they have some gas left for task 5. The flame goes out quickly because the gas flows very quickly out of the jug.

(iv) If the children have done Unit 1, they may remember that a heavy gas will mix with a light gas over a period of time. They could set up an experiment to test their answer.

Teacher's sheet: comprehension

See **pages 20 and 21** of *Gases around us*

Answers

1. **In the engine.**

2. **(i) Air containing oxygen;**
   (ii) Nitrogen dioxide.

3. **(i) Coal, oil and gas; (ii) It combines with oxygen to make a gas called sulphur dioxide.**

4. **Water droplets containing sulphur dioxide.**

5. **The haze is made by nitrogen dioxide gas. This gas is made in vehicle engines when they burn petrol or diesel. The air is still in summer, so the gas just collects in it and is not blown away.**

Complementary work

(a) You can show how a gas can alter the behaviour of a living thing in the following way. Put an unripe banana in a bag on its own. Put another unripe banana in a bag with an apple. After a few days the banana with the apple will have ripened, while the other banana remains unripe. This difference is due to the apple, which releases a gas called ethylene. This gas speeds up the ripening process.

Teaching notes

It is important that the children realise that there are two kinds of air pollution. These are – pollution by solids, such as the soot particles in smoke, and pollution by gases. Smoke can be seen because of the large number of solid particles mixed with the gas. These particles must not be confused with atoms, the very tiny particles that all matter is made from. Even if a chimney is not releasing smoke, it could be releasing colourless gases. To emphasise the point that gases can be produced unseen, demonstrate the complementary activity to the children.

In the activity on the following page the children can collect and test rain for acidity. You may wish to prepare the children for this test by introducing them to the terms acid and acidity.

We usually think of an acid as a corrosive liquid that dissolves metals and rocks. While some strong acids have these capabilities, there are many acids which are weaker and less corrosive. The strength or acidity of an acid is measured with indicators. These are substances which change colour when they come into contact with an acid. Indicators also change colour when they come in contact with another group of liquids called alkalis, or bases. Alkalis dissolve fats.

The acidity of an acid, or the alkalinity of an alkali, is measured on a scale called a pH scale. If a liquid registers pH 7 on the scale, it is neutral. As the pH changes from 6 to 1, the acidity increases, and as the pH changes from 8 to 14 the alkalinity increases. Use universal indicator paper when testing water. The paper has a range from pH 1 to pH 11. Tap water normally has a pH of 7. Rain normally has a pH of between 5 and 6. Acid rain has a pH in the range of 3 to 4.

9 Teacher's sheet: activity

Based on **pages 20 and 21** of *Gases around us*

Introducing the activity

(a) Show the children some leaves covered in dust. Wipe some of the dust onto a white tissue to show that the leaves are dirty. Tell the children that examining leaves is one way of looking for air pollution. The dust and soot settle out of the air onto them. Tell the children that they are going to investigate air pollution using a white board, and later examine rain for signs of pollution.

Using the sheet

(b) Give out the sheet and let the children write their names and form then go through tasks 1 to 4.

(c) Ask the children why tasks 2 and 3 are important (see note (i)).

(d) Let the children try tasks 1 to 4 (see note (ii)).

(e) Go through tasks 5 to 9 (see note (iii)).

(f) Let the children try tasks 5 to 9.

Completing the activity

(g) When all the tasks are complete the children can compare their results (see note (iv)).

Conclusion

The air can carry solid particles which settle out on surfaces. The quantity of solid particles which settle on a surface may depend on the wind speed and direction.

Rain water can also carry solid particles which settle on surfaces. The acidity of the rain water may be different from tap water. The amount of particles in rain and the acidity of the rain may depend upon the wind speed and direction.

Teaching notes

(i) The children should answer that the wind may blow from the direction of a source of pollution, such as a factory or a power station. They should say that in fast moving air, particles may not settle.

The children will need a reference book containing the Beaufort wind scale to record the wind speed.

(ii) If the school has a binocular microscope, use it in addition to magnifying glasses.

(iii) You may wish to omit tasks 6 and 9. If you include them, you may like to spend some time introducing the concept of acidity (see the teacher's notes page 51).

(iv) The children may find that the wind speed and direction is different when they are sampling rain to when they were sampling air. This may encourage them to make more systematic samples over a period of a month. A wind rose (which is a diagram that plots the number of times wind is recorded against its direction) may be constructed as a poster and information about pollution in the air and rain can be attached to it.

10 Teacher's sheet: comprehension

See **pages 22 and 23** of *Gases around us*

Answers

1. **It will go out because all the oxygen has been used up.**
2. **It will be shorter because it will have burned down.**
3. **Light and heat.**
4. **It has a yellow flame, while a gas cooker flame is blue. It gives out a lot of light. A gas cooker flame gives out a lot of heat.**
5. **The candle flame does not mix well with oxygen, but the gas cooker flame does.**
6. **(i) Hydrogen; (ii) There is no oxygen in space to burn the fuel.**

Complementary work

(a) The children can use secondary sources to find out where coal, oil and gas are found in the world.

(b) The children can use secondary sources to find out how natural gas is transported and stored. If there is a gas holder in the neighbourhood, the children could check on it to see if it rises and falls. This will indicate that gas is being stored there before use.

Teaching notes

When a candle is lit, wax in the wick is melted, then changes into vapour and burns. The heat from the burning vapour melts more wax, which travels up the wick. At the point where the air is drawn up under the candle flame to meet the vapour, there is a blue region. In this region the vapour and air is thoroughly mixed and burning is complete. This region can be compared to the pale blue light on a gas stove where the gas and air are thoroughly mixed. Above the blue region on the candle flame is a small, clear region. Here, the vapour is unburned, due to a lack of mixing with air. Slightly higher up, air and vapour mix again, but not thoroughly. This results in incomplete burning which produces the yellow part of the flame. Light is produced in this part of the flame by particles of carbon which are so hot that they glow.

The presence of the carbon particles can be demonstrated in the following way. Pass a cold plate into the flame for a second, then remove it. A streak of black carbon particles will have collected on the plate.

Above the yellow part of the flame the vapour and air mix and burn. With mature children you can demonstrate the heat generated by this reaction in the following way. Hold a spent match two or three centimetres above the flame. In a few seconds it will burst into flame.

Teacher's sheet: activity

Based on **pages 22 and 23** of *Gases around us*

Introducing the activity

(a) You could begin by looking at Picture 2 on page 22 of the pupil book with the children. Ask them why one candle has gone out and the other is still alight. Look for the answer – the candle in the jar has used up all the oxygen (see note (i)). Tell the children that they are going to investigate how candles burn when they are enclosed in different jars.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 and 2.

(c) Let the children try tasks 1 and 2.

(d) Go through tasks 3 to 5 then let the children try them (see note (ii).

(e) Go through tasks 6 and 7 then let the children try them (see note (iii)).

(f) Let the children try tasks 8 and 9.

Completing the activity

(g) Let the children try task 10 and display their graphs to the class.

(h) Let the children look at the graphs from the different groups in the class, then complete task 11 (see note (iv)).

Conclusion

The larger the jar, the longer the burning time. This is due to there being more air (and oxygen) in larger jars than in smaller jars.

Teaching notes

(i) Make sure that the children do not believe that the candle has used up the air.

(ii) You may dry the jars for the children or, if they are mature enough, they can dry the jars themselves. Glass jars must be used, not plastic jars. Try the experiment yourself to make sure that the candle flame cannot touch any part of the inside of the jar.

(iii) The children should make one prediction at a time and test it. By doing this they might make a more accurate prediction in task 8.

(iv) When looking at the class display of graphs, some anomalous results may be seen. The group having such results could offer an explanation as to why they vary from the results of other groups. It is perfectly acceptable to record experimental error, such as slowness to cover the candle, as reasons for anomalies.