Indoor Air Quality
WORKING PARTY

WellHome

Healthy Air

Did you know that air pollution is a problem that can affect your health? You might have heard of air pollution outside, such as smelly exhaust fumes next to busy roads, but air pollution can be a problem inside as well. Children in the UK spend most of their time inside, in fact on average children spend only 68 minutes per day outside, so having clean air inside is important to keeping fit and healthy.

How much time did you spend outside today?

Is this more or less than the average of 68 minutes?

Pick a different day, maybe a weekend or a day with different weather conditions. How much time did you spend outside?

T D G V S D M K L G G W K M Y L T D D S
W J K X N W M P B J N J X C K Q Z R I Z
R B Q N F Y R O G Q R O G O V R D V F D
B E B F L N K Q L N T Y F H T R G F F U
R R D G V Q S X C D G U U B P B G M I N
A C E N T H Y P E R A C T I V I T Y C H
L U V A E Z G C M B H B C T C W Y F U I
L S F D T S F B K T S V V B J G L H L N
E I H K Q H S W S W Y D N Q S Y Y S T A
R C S V M M I O F G X L G Y H Q P Z Y T
G C H E S T I N F E C T I O N S T Z S T
Y D K P C M G M G T I C F V T J C M L E
W R B S F B S T W P H Z W T N M C P E N
T N E T Z G F W B B R E T H G Q B B E T
W D C B S F P G G K P O E C E C V R P I
R G Z V Q T T H S Q T Z B Y P E W K I O
D X E Y P G D M F Y K S M L E C Z L N N
B K M R E S R S H N K Q F N E S J E G I
E K A N J S K I N P R O B L E M S Z M N
S J T Z J D R P Z F R F L R Z P S W L R

The wordsearch includes different problems school age and pre-school children might experience that are sometimes caused or made worse by dirty air.

Pre-school

- ☐ Allergy
- ☐ Chest infections
- ☐ Skin problems
- ☐ Hyperactivity
- ☐ Inattention

School age

- ☐ Difficulty sleeping
- ☐ Redness of the eyes

Both

- ☐ Breathing problems
- ☐ Wheeze
- ☐ Eczema

Do you ever feel any of these things? Where do you feel them?

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ANSWER SHEET

T D G V S D M K L G G W K M Y L T D D S
W J K X N W M P B J N J X C K Q Z R I Z
R B Q N F Y R O G Q R O G O V R D V F D
B E B F L N K Q L N T Y F H T R G F F U
R R D G V Q S X C D G U U B P B G M I N
A C E N T H Y P E R A C T I V I T Y C H
L U V A E Z G C M B H B C T C W Y F U I
L S F D T S F B K T S V V B J G L H L N
E I H K Q H S W S W Y D N Q S Y Y S T A
R C S V M M I O F G X L G Y H Q P Z Y T
G C H E S T I N F E C T I O N S T Z S T
Y D K P C M G M G T I C F V T J C M L E
W R B S F B S T W P H Z W T N M C P E N
T N E T Z G F W B B R E T H G Q B B E T
W D C B S F P G G K P O E C E C V R P I
R G Z V Q T T H S Q T Z B Y P E W K I O
D X E Y P G D M F Y K S M L E C Z L N N
B K M R E S R S H N K Q F N E S J E G I
E K A N J S K I N P R O B L E M S Z M N
S J T Z J D R P Z F R F L R Z P S W L R

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What is in Dirty Air?

It is difficult to measure how clean or dirty the air is. One reason is because there can be many different substances in the air. Air is a mixture of gases, including oxygen and carbon dioxide, and can also contain water vapour, tiny particles that are too small to see, and other chemicals in gas or vapour form. Some substances are good for us, like oxygen which we need to breathe to live. Others, on their own in small amounts are not a problem but when they build up in the air and/or mix with other substances, they can cause health problems. These are called air pollutants.

Draw a line to match the substance of pollution and the correct source!

AIR POLLUTANT

$PM_{2.5}$
Extremely small particles, invisible to the naked eye.

Volatile Organic Compounds (VOCs)
Wide variety of chemicals given out at room temperature. VOCs are very common and concentrations of these chemicals can be much higher indoors compared to outdoors.

Formaldehyde
Colourless strong-smelling gas released into the air at room temperature. This process is called off-gassing.

Carbon dioxide (CO_2)
A natural gas making up part of the air we breathe. We also breathe out CO_2 as a waste product. It has no taste, smell or colour and cannot be detected by humans.

Carbon Monoxide (CO)
Poisonous gas that has no taste, smell or colour and cannot be detected by humans. Carbon monoxide alarms should be fitted to detect dangerously high levels.

Nitrogen dioxide (NO^2)
A toxic gas that is mainly formed by burning fossil fuels at high temperatures. It is reddish-brown in colour and is a key part of outdoor air pollution.

SOURCES (where they come from)

Indoor sources include human activities such as burning wood, coal or gas. Outdoor sources include burning fossil fuels and industrial processes such as cement production.

Building materials, DIY paints, cleaning products, furniture, flooring and carpets.

Cooking, smoking, burning materials such as candles or incense, car exhausts.

Damaged or faulty gas appliances such as boilers or stoves.

Burning gas, oil, paraffin, wood or coal in stoves, ovens, heaters and fireplaces.

Building materials, wooden furniture, cleaning products, hairspray, nail varnish, air fresheners, fragranced products.

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What is in Dirty Air?

Draw a line to match the substance of pollution and the correct source!

AIR POLLUTANT

Pollen
A powder containing the tiny grains or spores which are released from plants during their reproductive cycle. Pollen grains can vary in size depending on the plant species.

Humidity
The amount of water vapour in the air. This is not a pollutant, but too much of it can cause water to collect on cool surfaces as condensation and lead to damp and mould.

House dust mites
Tiny bugs which live in humid and warm environments. They are one of the most common indoor allergens but can often only be seen under a microscope. House dust mites mostly eat the dead skin cells we shed.

Moulds/fungi
Caused by high humidity and poor ventilation in the home.

Pet hair and dander
Dander is small flakes of skin shed by animals. Along with fur and feathers, this can cause allergic reactions.

Radon
Radioactive gas found at various levels across the UK. Can build up in homes with poor ventilation.

SOURCES (where they come from)

Found in bedding, carpets, mattresses, clothing and soft furnishings such as sofas and soft toys.

Soil, rocks and water. Enters buildings through the ground.

Boiling water, cooking, showering.

Animals and places they have been.

Plants.

Damp areas in the home.

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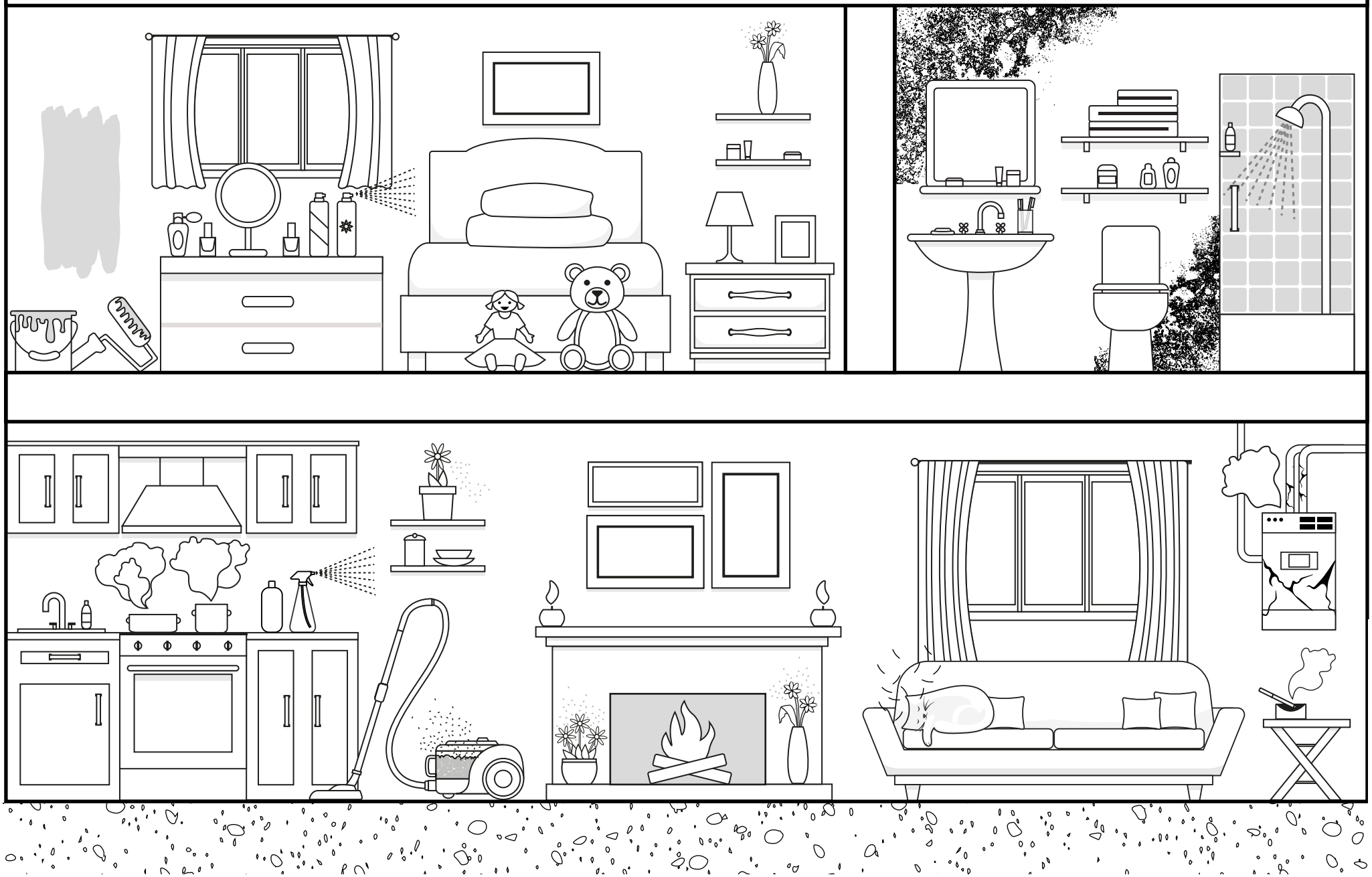
Pick a colour to use and colour the sources in.



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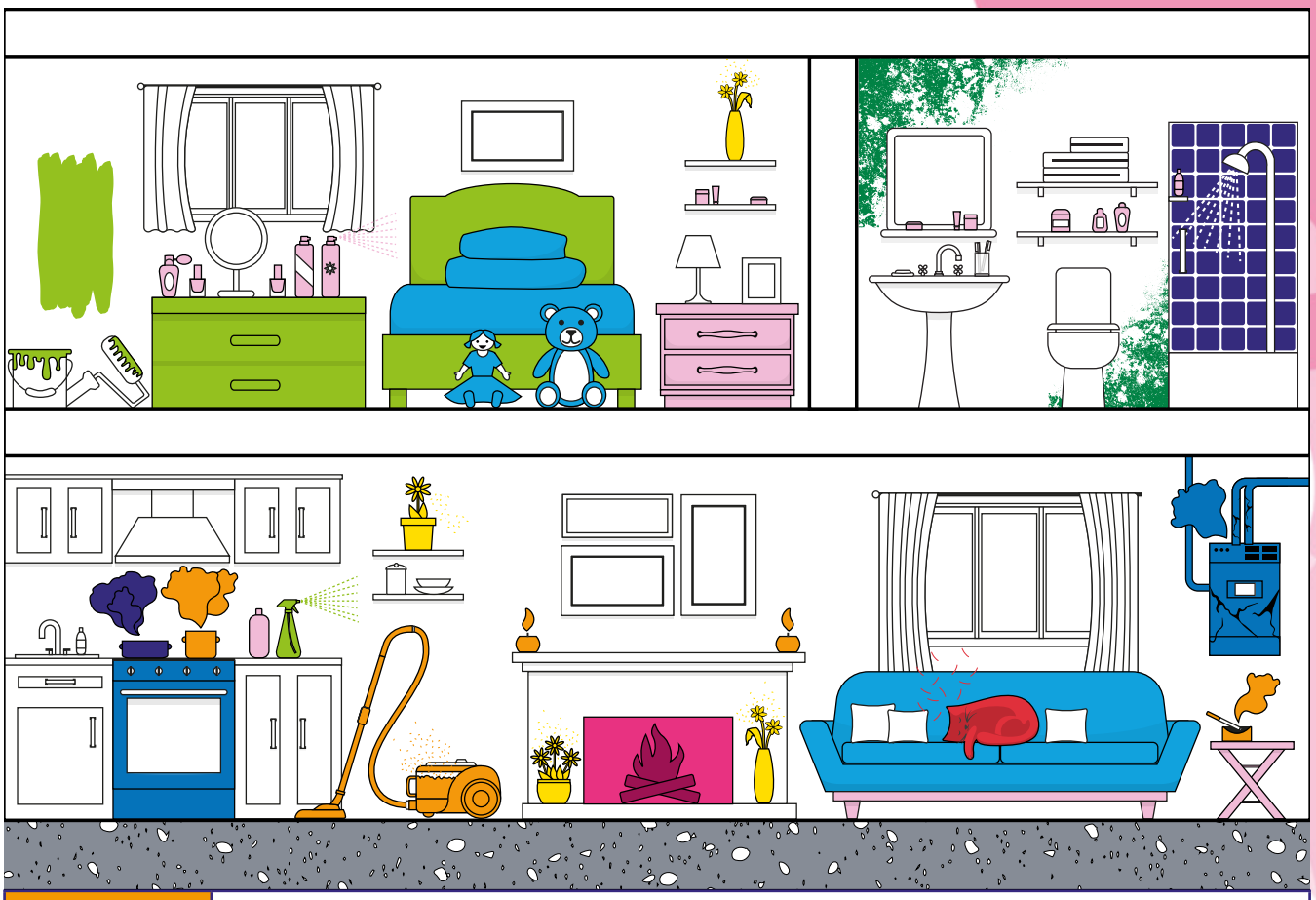
What is in Dirty Air?

ANSWER SHEET



$PM_{2.5}$	Indoor sources include cooking, smoking and burning anything such as candles or incense. Particles can also settle on surfaces and be released back into the air during activities such as vacuuming. Outdoor sources include car exhausts.
Volatile Organic Compounds (VOCs)	Common sources of VOCs include building materials, furniture (wood preservatives), household consumer products including cleaning products, cosmetics such as hairspray and nail varnish, air fresheners, fragranced products.
Formaldehyde	Key sources are building materials, DIY paints, cleaning products, furniture, flooring and carpets.
Carbon dioxide (CO_2)	Indoor sources include human activities and burning wood, coal or gas. Outdoor sources include burning fossil fuels and industrial processes such as cement production.
Carbon monoxide (CO)	Damaged or faulty gas appliances such as boilers or stoves.
Nitrogen dioxide (NO^2)	Indoor sources of nitrogen dioxide include burning gas, oil, paraffin, wood or coal in stoves, ovens, heaters and fireplaces, especially if these are poorly maintained.
Pollen	Outdoor or indoor plants.
Humidity	Boiling water, cooking, showering
House dust mites	House dust mites are found in bedding, carpets, mattresses, clothing, and soft furnishings such as sofas and soft toys.
Moulds/fungi	Mould is most commonly found in damp areas of the home such as bathrooms, but mould can grow anywhere in the home.
Pet hair and dander	Animals including pets and pests, and places the animals have been, such as on carpets, on furniture, in dust and in the air.
Radon	Outdoors radon appears naturally in some areas of the UK in soil, rocks and water. It enters a building through the ground.

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Building Bunting

Buildings are complicated environments, and different activities and objects in buildings can create substances that can be harmful if they reach high levels. Other substances are found outside. These substances can be gases, water vapour or tiny particles in the air.

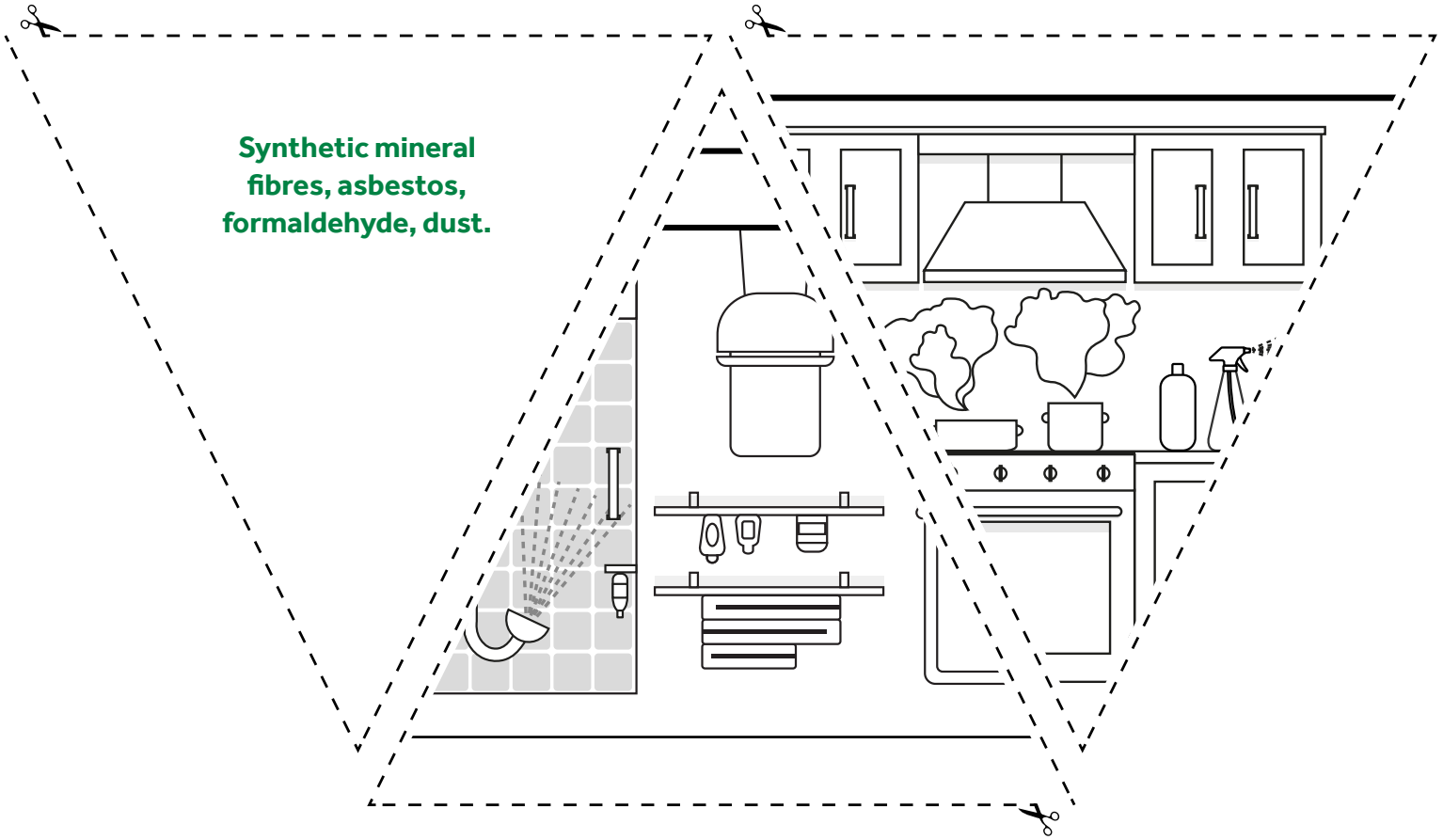
Each of the triangles contain:

- A drawing of a room that you might have in your home; or
- A description of some substances and objects or activities that can be sources of potentially harmful indoor air pollution.

1. Cut out all the triangles and write the names of the rooms on the pictures. The rooms included are: **bedroom, bathroom, kitchen, attic, living room and garage.**

2. Next, match up the descriptions to the drawings. If you want, you can stick the description to the back of each drawing, colour the pictures in and join them together to make a set of bunting.

Synthetic mineral fibres, asbestos, formaldehyde, dust.



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Building Bunting

Dust and dust mites, bacteria and viruses, pet hair, and chemicals from personal care products.

Gases and particles from gas cooker, chemicals from cleaning products.

Mould and damp, chemicals from cleaning and personal care products.

Gases from car exhaust, damp and mould, chemicals from stored paints and pesticides.

Radon gas from the ground in affected areas, pollen from indoor plants, gases from fires and wood-burning stoves, chemicals and formaldehyde from carpets, paints, glues, furniture and air fresheners, cigarette smoke, pet hair.

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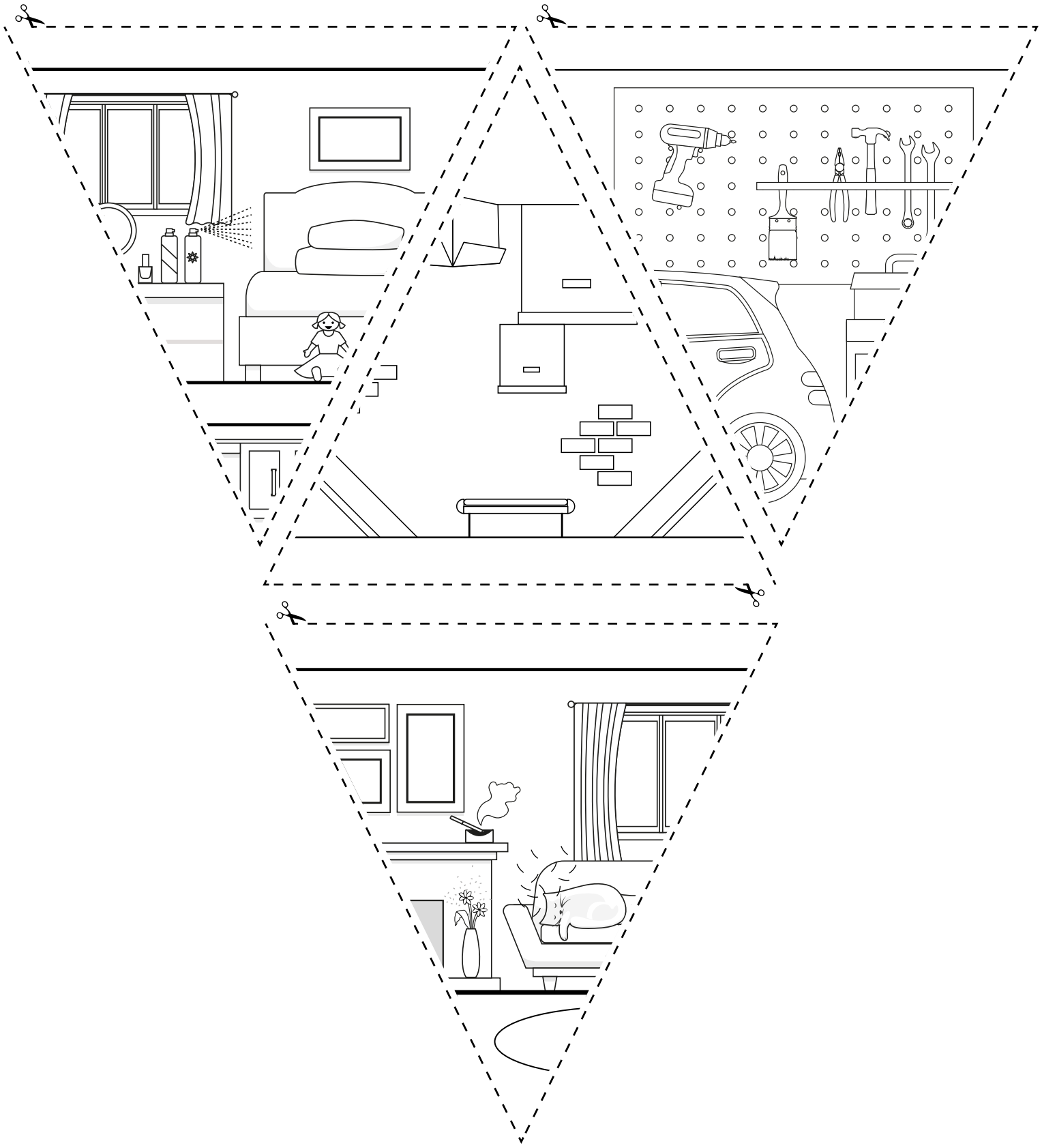
Building Bunting



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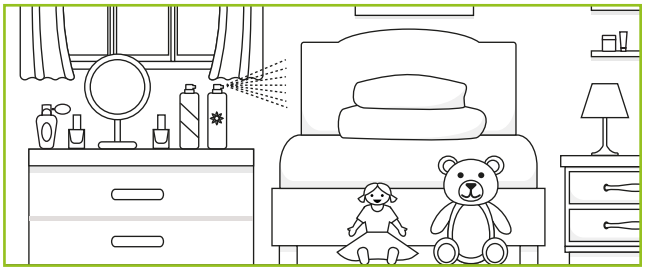
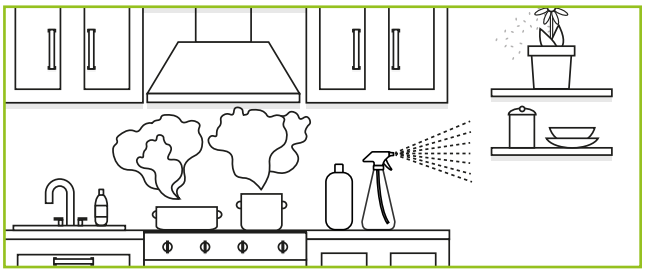
Building Bunting

ANSWER SHEET

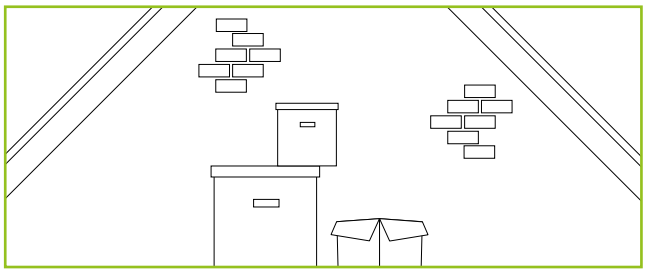


Bedroom
Dust and dust mites, bacteria and viruses, pet hair, and chemicals from personal care products.

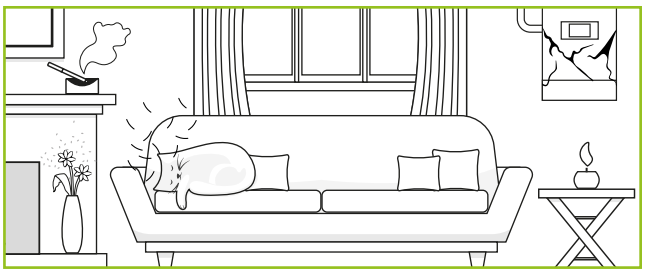
Bathroom
Mould and damp, chemicals from cleaning and personal care products.



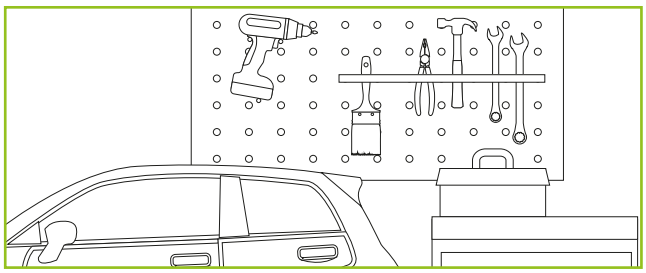
Kitchen
Gases and particles from gas cooker, chemicals from cleaning products.



Attic
Synthetic mineral fibres, asbestos, formaldehyde, dust.



Living areas
Radon gas from the ground in affected areas, pollen from indoor plants, gases from fires and wood-burning stoves, chemicals and formaldehyde from carpets, paints, glues, furniture and air fresheners, cigarette smoke, pet hair.



Garage
Gases from car exhaust, damp and mould, chemicals from stored paints and pesticides.

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Spot the Signs

Common activities and objects found inside buildings can create or emit substances into the air that may be harmful to health at high levels. Indoor air scientists call these pollutant sources.

The picture shows 10 sources and signs of dirty indoor air, can you spot them all?

Write down why you think they might be a problem.

1		6	
2		7	
3		8	
4		9	
5		10	

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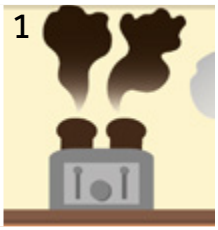
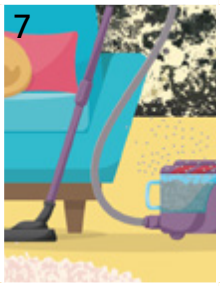
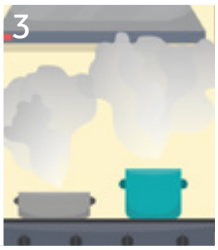
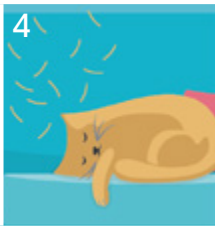
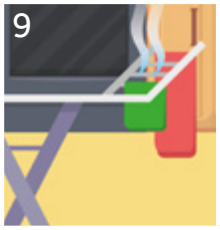
Spot the Signs

ANSWER SHEET

1 	Burning food can be a source of particles and so you should avoid burning food if possible.	6 	Personal care products can also release chemicals (VOCs) and particles into the air. If possible, use non-spray options, or use ventilation at the same time.
2 	Soft furnishings such as rugs and carpets can collect dust, this can be released back into the air and can trigger allergies in some people.	7 	Vacuuming is one of the easiest ways to clear dust, which is especially important for people with asthma. However, if it isn't emptied regularly and kept in good condition, a vacuum cleaner can release dust and particles back into the air.
3 	If you have one it is best to use the cooker hood during cooking to extract any pollutants to outside. Putting lids on pans also reduces the amount of steam, which would help keep the humidity down.	8 	Mould is more likely to form in cold damp environments. Cleaning off visible mould can help, if you have persistent mould in rented housing you can contact your landlord or environmental health department.
4 	Pet hair and dander can trigger allergies for some people.	9 	Drying clothes inside releases water vapour into the air, which can cause damp.
5 	Cleaning products are a source of VOCs (chemicals). It can help to use one multi-purpose cleaner for everything to reduce the number of different chemicals in the air.	10 	Opening windows is a simple way to improve indoor air by letting outside air in, if the outside air isn't polluted.

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What can you Measure?

Sometimes indoor air pollutants can build up to levels that cause health problems because of the environmental conditions. The humidity of the air can have an important impact on allergies. Temperature and humidity can be used to help understand indoor environmental conditions that can affect the level of air pollutants indoors.

The WellHome researchers will make observations and take measurements just like these. Hold onto your data from this activity, you can show it to the WellHome recherches when they come back to pick up the air pollution sensors.

In your pack you have a little sensor that can tell you the temperature (in °C) and percentage relative humidity (%).

Follow the steps below to use this to investigate the temperature and humidity around your home:

1. Pick one day you want to investigate.
2. Use the boxes on this page and the next to record data at different times of the day or during different activities (there's also an empty box for you to choose your own activity!).
3. Use your sensor to tell you the temperature and humidity.
4. Colour in the circles next to them using the colour scales on this page. (These are a rough guide of the normal temperatures found in buildings).

Waking up or going to sleep

Location/room		
Temperature	°C	○
Humidity	%	○
How many people are in the room?		
What else is happening?		

Temperature:

- **Cold** Less than 17°C
- **Cool** 17°C – 19°C
- **Fine** 20 – 22°C
- **Warm** 23 – 24°C
- **Hot** More than 24°C

Humidity:

- **Dry** Less than 30%
- **Fine** 30% – 65%
- **Wet** 65% – 85%
- **Very Wet** More than 85%

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What can you Measure?

Eating food

Location/room

Temperature °C ○

Humidity % ○

How many people are in the room?

What else is happening?

Playing

Location/room

Temperature °C ○

Humidity % ○

How many people are in the room?

What else is happening?

Brushing teeth or after having a shower or bath

Location/room

Temperature °C ○

Humidity % ○

How many people are in the room?

What else is happening?

You pick: _____

Location/room

Temperature °C ○

Humidity % ○

How many people are in the room?

What else is happening?

Temperature:

- **Cold** Less than 17°C
- **Cool** 17°C – 19°C
- **Fine** 20 – 22°C
- **Warm** 23 – 24°C
- **Hot** More than 24°C

Humidity:

- **Dry** Less than 30%
- **Fine** 30% – 65%
- **Wet** 65% – 85%
- **Very Wet** More than 85%

What did you find? You could think about which room was the warmest and coldest, were there any activities that seemed to change the humidity?

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Control the Source

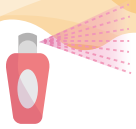
Scientists and engineers have known for a long time that the best way to improve the air in a building is to remove any objects or activities that could be a source of indoor air pollution. Max von Pettenkofer knew this in 1858:

"If there is a pile of dog poo in a room, don't try to get rid of the smell by opening a window. Take the dog poo outside"

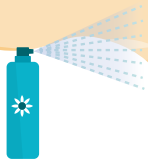
Sometimes the activities are important, and we can't stop doing them, so instead we use ventilation to reduce the levels of pollutants inside. Ventilation is when clean air, usually from outside, is used to replace stale indoor air. This can be through natural ventilation, such as opening a window, or mechanical ventilation, where a fan is used to pump air in or out of a space.

Here are some common indoor sources of pollutants. For each of these activities would you remove the source and/or use ventilation to reduce the pollutant levels? (Tick the boxes that you think are correct and then check your answers on the next page).

Cooking:
Remove ☐ Ventilate ☐



Spraying perfume and deodorant:
Remove ☐ Ventilate ☐



Spray air freshener:
Remove ☐ Ventilate ☐

Someone else smoking:
Remove ☐ Ventilate ☐

Burning food:
Remove ☐ Ventilate ☐

Burning candles or incense:
Remove ☐ Ventilate ☐

Drying clothes inside:
Remove ☐ Ventilate ☐

Showering or bathing:
Remove ☐ Ventilate ☐

New furniture:
Remove ☐ Ventilate ☐

Repainting walls:
Remove ☐ Ventilate ☐

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Control the Source

ANSWER SHEET

Activity	Remove	Ventilate	Explanation
Cooking		✓	Cooking is an important activity that happens in most homes on most days, so the best way to reduce risk is to use ventilation during cooking and for 10 minutes afterwards.
Spraying perfume or deodorant	✓	✓	If possible, you should use non-spray alternatives. If that is not possible, then use ventilation during and afterwards
Spray air freshener	✓		Despite the name, air freshener does not clean the air, it adds different chemicals into the air. These chemicals might smell nice but that doesn't mean they are good for your lungs.
Someone else smoking	✓		Smoking inside causes secondary exposure, this is when someone other than the person smoking breathes in the smoke.
Burning food	✓		Burning food can be a source of particles so it is best to avoid burning food where possible. It might also set off your smoke alarm.
Burning candles or incense	✓	✓	Burning candles and incense, especially if they are scented, can increase the levels of VOCs indoors, so is best avoided if possible. Where it is not possible you should use extra ventilation.
Drying clothes inside	✓	✓	If you have the option to dry laundry outside, it is better to do so. If you don't have the choice, then using extra ventilation such as drying clothes next to an open window can help to keep the humidity down inside.
Showering or bathing		✓	Showering or having a bath is important for keeping clean. People can't stop this activity, so instead ventilation is important to get rid of excess moisture, this is why many bathrooms have an extractor fan fitted.
New furniture	✓	✓	New furniture can release formaldehyde and VOCs into the air. If you need to buy furniture new, it is important to increase the ventilation rate to reduce the build-up of chemicals indoors.
Repainting walls	✓	✓	Have you ever been in a freshly painted room? If you have you might recognise the new paint smell. Household paints are a source of VOCs but you can buy paints labelled as low VOC and it is best to use these if possible.

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How does Ventilation work?

Air and lots of air pollutants are invisible and don't smell, so it is difficult for humans to detect how ventilation works. In this activity you are going to use water and squash to demonstrate how clean air can be used to dilute the concentration of pollutants in dirty air. If you don't have squash, you could use juice, food colouring or even paint, **just please don't drink the water if you are using paint!**

You will need:

1. 3 cups, preferably transparent and about the same size
2. Squash, dark colours like blackcurrant flavour work best. If you don't have any squash, you could use juice, food colouring or paint.
3. Water
4. A sink to pour the liquid away if you don't want to drink it
5. One elastic (rubber) band
6. Optional: A piece of white paper

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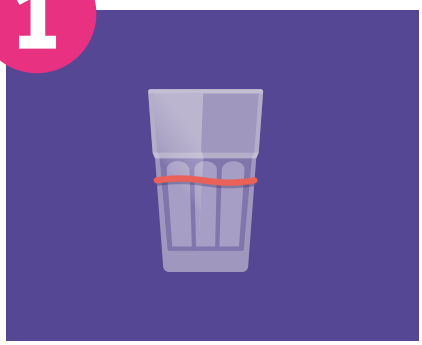
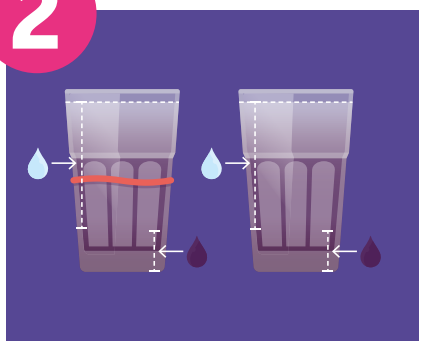
How does Ventilation work?

1



Step 1: Take one cup and put the elastic band around it about half way up. You will use this to measure the amount of liquid in the cup.

2

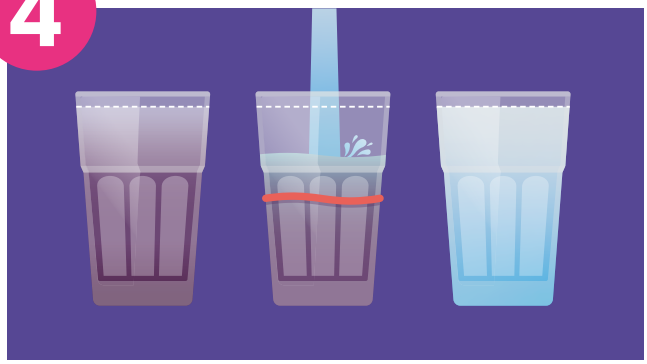


Step 2: Take this cup and one other and make up the squash in each using the instructions on the bottle. You should try to use exactly the same amount of squash and water in each so both cups of are identical.

3

Step 3: Fill the other empty cup with water. The two cups that don't have the elastic band around them are your controls, you can use these to compare to the middle cup with the elastic band after each step.

4



It might help to hold a piece of white paper behind the cups to see the colour better.

Step 4: Empty out or drink half of the squash in the cup with the elastic band, so that the contents comes up to the elastic band. Fill it back up to the top with clean water.

What has happened to the colour of the squash?

What does it taste like?

Compare it to the cup of squash and the one of water. What do you notice?

5

Step 5: Repeat step 4, emptying out half of the mixture and refilling it with water. After each time you do this, write down what has happened to the colour and the taste. Keep repeating it over and over until you have cleared the pollutant, keeping a tally of how many times you refilled with clean water:

How many times did you have to replace the liquid to clear the 'pollutant'?

In this test a cup is used to model a room. The water is clean air and the squash (or food colouring) is a substance or pollutant that has been released into the air. Emptying out some of the liquid and replacing it with water is like what happens when you open a window or turn on a fan to provide ventilation. Using ventilation for longer is like half emptying the cup and refilling it more times.

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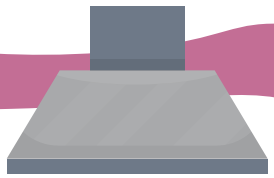
Home Air Scavenger Hunt

Indoor environments are complicated and contain a lot of things that can **improve** the indoor air or **make it worse**. Most people don't notice all of these things, and maybe don't know how to use them effectively, so we have created a scavenger hunt of things for you to find around your home. Remember, every home is different so you won't find all of these things in your home!

Tick the items you find and use the notes page to record any answers you have to the investigative questions, or to record what you observe when you conduct the experiment.



☐ Cooker hood

Each cooker hood will have their own care instructions. It is important the filters are cleaned, or replaced, as per manufacturer's instructions to ensure the ventilation works effectively so that pollutants are sucked up and vented outside the home.

Investigative questions

- How high is the cooker hood above the stove?

- How does it turn on?
- Is it very loud?
- Touch the grease filter (the bit with holes in it on the bottom), does it feel clean?
  (you must wash your hands straight after touching the filter , even if it does feel clean!)
- Can you find any information from the company about how this should be cleaned?

☐ Extactor fan (look in the kitchen or bathroom)

Extractor fans are important for ventilating the kitchen/bathroom, helping to remove damp or polluted air arising from domestic activities such as cooking and bathing.

Investigative questions

- Can you turn it on?
- When it's on, with an adult's help if you can't reach, put your hand in front of it, what do you feel?
- Where's the switch? Does it switch on with the light or is it a separate switch?

Experiments

Take 1 square of toilet paper and put it flat over the fan with the fan on, what happens? What if you turn the fan off?

In the UK Cooker hoods should be 65–75 cm above the stove, unless the manufacturer states otherwise. If the cooker hood is higher, more pollutants from cooking will mix with room air instead of being sucked outside through the cooker hood.

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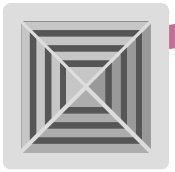
Home Air Scavenger Hunt



Mechanical air vents

Some buildings use fans and ducts to move air around a building.

Air vents

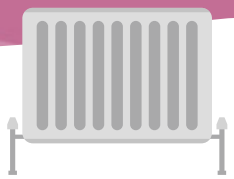
You might find a vent like this in your kitchen, especially in older buildings.

Investigative questions

- Can you see the sky through it like in the illustration?
- What do you think that means?

Smoke alarm

Smoke alarms do not protect against dirty indoor air, but some sources **of indoor air pollution** that cause smoke might set them off.



Radiators or other heaters

Keeping the building warm in winter helps to prevent damp and mould.

Investigative questions

- Ask an adult, how is your home heated?

Trickle vent

These are normally at the top of the window frame and let a small amount of air in and out without opening the window. Trickle vents are mainly found in new buildings.

Investigative questions

- How does is open or close?

Experiments

With it open, put your hand in front, what do you feel?

Air vents in the wall help to provide background ventilation and outside air when any windows are closed and extractor fans are switched off. Sometimes you can see the sky or light from outside through the vent, this means the vent is open and air can get through.

If you can't see the outside, it might mean:

- the vent is blocked
- the vent is closed (look to see if there is an option to slide it open)
- there is a cover on the outside (try to find it on the outside of the building to see if this is the reason)

Sometimes these vents can be spotted outside the building, especially older buildings, at the level beneath a floor. The ventilation they provide reduces build up of condensation in the colder months.

Many people don't like the drafts and wish to save energy. One way to do this is to leave the vents in place and seal any gaps in the floor joists, so the draft remains under the floor.

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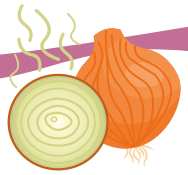
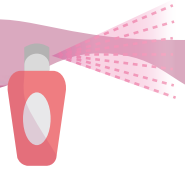


☐ Something with a strong smell

Be careful not to smell any household products. Always ask your guardian if unsure.



☐ Spray bottle such as hairspray or deodorant

Investigative questions

- Make a tally chart of how many you find.

- **Choose one** and check the label on the back. Does it say use in well ventilated spaces?

YES / NO

☐ Candles, incense or a fireplace

Investigative questions

- Make a tally chart of how many you find.

☐ Candles ☐ Incense ☐ Fireplace

☐ Cooking smells

Experiment

When someone is cooking walk around your home and see how far the smell spreads. Are there any smells that spread further than others?

☐ Condensation on a mirror or window in the bathroom

Experiment

Try timing how long it takes to clear after someone has a bath or shower? Is there anything you think would help it to clear faster?

Condensation on a mirror will disappear quicker if the room is well ventilated. Try opening a window or turning on a dehumidifier if you have one.

☐ Nail varnish or remover

Investigative questions

- Check the label on the back. Does it say use in well ventilated spaces?

YES / NO

- Are there any ingredients listed on the label? Can you find any of these pollutants in the ingredients list?

☐ Toluene ☐ Styrene ☐ Formaldehyde

You might want to look back at worksheet *What is in dirty air?* which lists other sources of pollutants in homes.

☐ Gaps under doors

Experiments

Using a ruler, measure how big the gap is.

The gap should be 1 cm to let air move between rooms. Sometimes carpets or flooring make this gap smaller.

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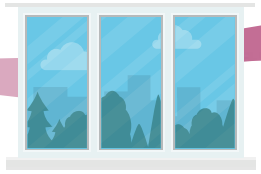

Windows

Not all buildings use windows that open, some use mechanical ventilation instead.

Investigative questions

- How many windows do you have that can open?

Dust in the air in a sun beam

Indoor air pollutants can build up in indoor dust. When you move about or do things at home, such as cleaning, that dust can be disturbed. Once disturbed it can become suspended in the air. Sometimes you can see the suspended dust when a beam of light shines through and the rest of the room is in comparative darkness.

Household dust has been found to contain all sorts of pollutants from:

- shampoos and plastics
- paints and cleaning products
- some building materials, furniture, fabrics, carpets and electronics, especially those with flame retardants
- fragrances
- some fabrics and non-stick coatings
- house dust mites and other pests, pet allergens, mould and fungi
- pesticides

For more information on sources of household pollutants, take a look at Annex 8 p68 of RCPCH RCP (2020) The inside story: Health effects of indoor air quality on children and young people.

Use this box to make notes and record any data from your experiments.

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