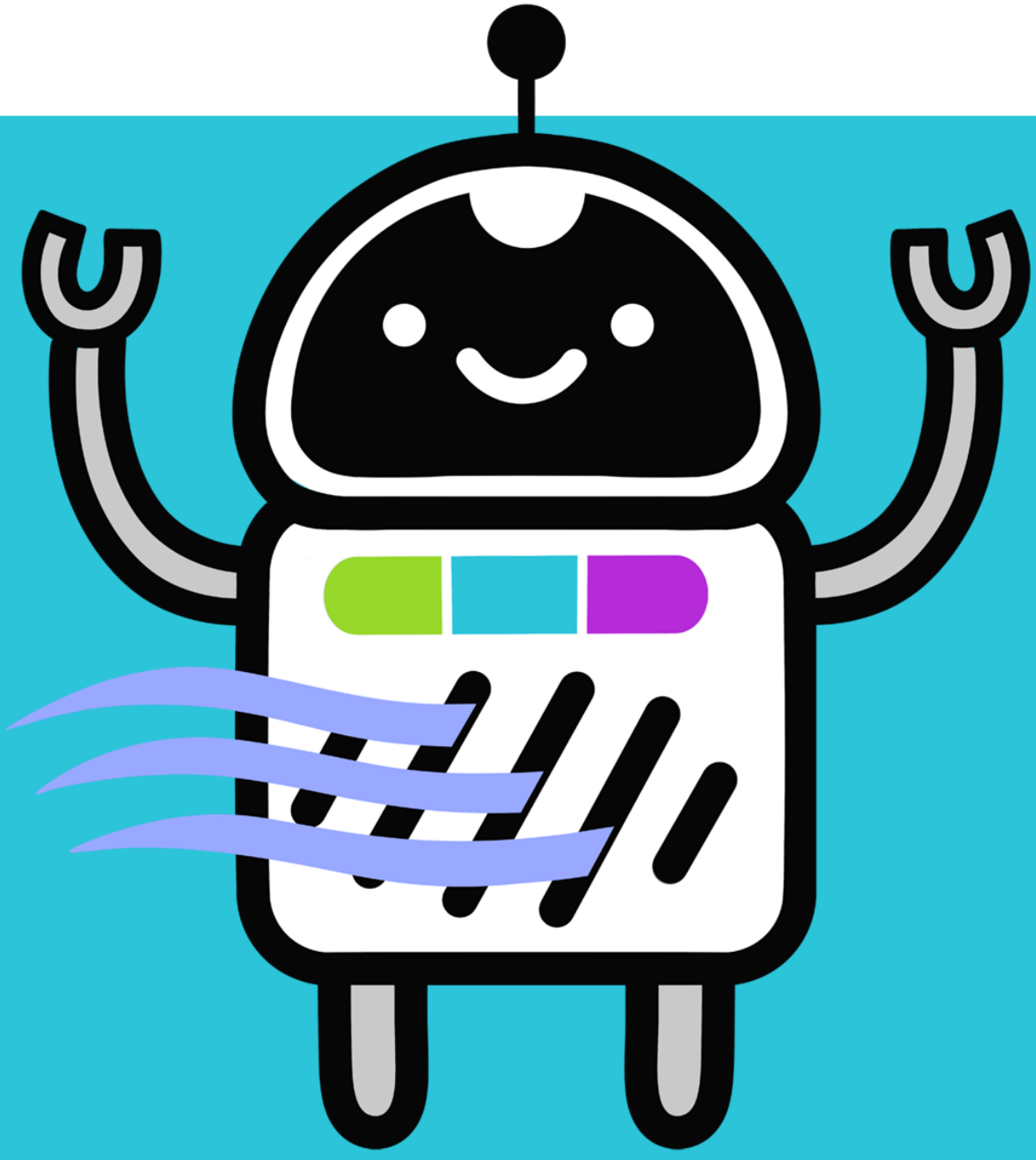
SAMHE

Schools Air quality Monitoring for Health and Education

Teacher activity guide



SAMHE teacher activity guide version: 1.0

Contents

Introduction

SAMHE (pronounced 'Sammy'!) stands for Schools' Air quality Monitoring for Health and Education. It brings together scientists, pupils and teachers to better understand school air quality.

About SAMHE

SAMHE has established a network of air quality monitors in schools across the UK. This is generating an unparalleled dataset which is helping researchers better understand schools' indoor air quality. Our overall aim is to understand and improve air quality for all schools long-term.

Through the initial SAMHE project (2022-24), over 1,300 schools received a free high spec air quality monitor that measures carbon dioxide (CO_2), volatile organic compounds (VOCs) , particulate matter (PM), temperature, and relative humidity. Teachers and pupils in those schools can access their data through a co-designed, interactive Web App, which enables them to see how air quality changes over the course of hours, days, weeks and months. The Web App also offers a range of related activities, creating opportunities for pupils to be scientists and do hands-on experiments with their monitor.

SAMHE is no longer offering air quality monitors to schools. Instead, this activity guide contains parallel versions of our Web App activities for schools which do not have a SAMHE monitor. The activities in this guide include quizzes, data analysis exercises, video and creative activities. Teacher guidance is embedded throughout. The full Teacher Resource Pack also includes a 'Data Pack' (containing example data and graphs) and pupil worksheets for most activities. These can also be downloaded separately from samhe.org.uk/get-involved.

How to use this guide

This guide contains 20 activities that can be used to teach pupils from age 5 - 18 about air quality. This guide is designed to be used flexibly and contains activities which can be used to complement curriculum teaching, to support outreach activity, or for extracurricular activities.

This guide begins with a summary of activities on pages 6 and 7. On these pages, a teacher icon is used to highlight activities that may require significant teacher facilitation, particularly for younger pupils.

Thereafter, activities have been grouped in sections depending on their format. The label in the turquoise banner in the top left corners of activity pages can be used along with the icons in the bottom left corners to help differentiate between sections.

At the start of each section, you will find a list of the activities within that section, with icons that denote the equipment needed, the time it will take, and how many people are needed to complete the activity. See overleaf for a full guide to the icons included in this guide.

Some activities, for instance 'Research Projects' (page 101), will require the use of the Data Pack. This is included in the full Teacher Resource Pack or can be downloaded separately from samhe.org.uk/get-involved. Other activities, such as 'CO_2 levels of an empty classroom' on page 57 will require the use of a CO_2 monitor (any type).

There are also activities in this guide, such as the 'SAMHE careers activity' on page 33, that require additional resources that can be found online. The relevant links for these resources are always given in the activity notes. For most activities, you will find an accompanying pupil worksheet in the full Teacher Resource Pack.

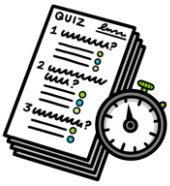
Although this guide can be used however best suits your teaching, our recommendation is that the 'introductory assembly' and understanding air quality measures quizzes (x3) are completed first to introduce pupils to key concepts. There are also some activities that are best completed before or after other activities. This is noted in the activity description where applicable.

How to use this guide: icons

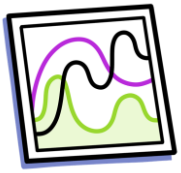
Activity type icons

These icons denote what the activity type is and can be found in the corner of activity pages.

Assembly



Quiz



Data analysis

Creative

Video

Research project

Activity description icons

These icons denote important activity information and can be found on the section contents pages.

Time

1+ person needed

3+ people needed

Equipment is needed

Equipment icons

These icons denote if a monitor or example SAMHE data is needed and can be found on the curriculum links pages.

CO_2 monitor needed

SAMHE Data Pack needed

Level of support icon

The icon denotes when an activity may require significant teacher facilitation, particularly for younger learners, and can be found on the summary of activities pages.

Teacher facilitation may be needed

Summary of activities

Type	Activity	Time (min)	Equipment needed	Page no
Assembly	Assembly - Introduction to Air Quality	15	Introductory Assembly Presentation	12
Quiz	Understanding Air Quality measurements: CO_2 	15		20
	Understanding air quality measurements: temperature and humidity 	15		24
	Understanding air quality measurements: particulate matter and VOCs 	15		28
	SAMHE careers activity	30	Careers booklet	33
	Learning about Clean Air Zones 	20		39
	End of term SAMHE quiz	10		45
	Sources of air pollution indoors	15	Sources of indoor air pollution image	49
Data Analysis	CO_2 before and after exercise 	15	CO_2 monitor, stopwatch	54
	CO_2 levels of an empty classroom 	25	CO_2 monitor, stopwatch	57

Summary of activities cont

Type	Activity	Time (min)	Equipment needed	Page no
Data Analysis	Temperature changes throughout the day 	20	Data Pack	60
	Investigating a particulate matter event 	25		63
	Understanding SAMHE graphs 	10	Optional: Graphs from Data Pack	69
	Collecting data about classrooms 	45	Metre ruler, calculator	73
Creative	Write to your MP	30		80
	Design an air quality poster	30	Computer and/or arts and crafts materials	83
	Clean Air Zones debate 	45	Greford City information sheet (in Pupil Worksheet folder)	86
Video	The Science of ventilation 	15	Science of ventilation video	94
	Learning about SAMHE methods 	15	SAMHE methods video	97
Research	Research projects 	-	Data pack	101

Curriculum links: England

In the table below we have listed some of the curriculum areas or skills that the SAMHE activities in this pack could be used to support. Curriculum links documented for schools in England relate to the National Curriculum in England, Framework Document (December 2014) and DfE's Mathematics AS and A level Content Guide (2016).

Activities where you need a CO_2 monitor (any type) or example SAMHE data (from the Data Pack) are shown by the symbols as described on page 5. If pupils are working towards an EPQ, you can find information on using SAMHE for a research assignment on page 101. For more details visit samhe.org.uk/resources/curriculum-links

Level	Subject	Topic
Key Stage 2	Science	Data logging 
	Mathematics	Area and volume
Key Stage 3 and 4	Science/ Geography	Earth and Atmosphere 
	Citizenship	Influencing Change
Key Stage 4	Biology	Health, disease and the development of medicines: Communicable diseases 
Key Stage 5 (A Level)	Mathematics/ Statistics	Working with large datasets 

Curriculum links: Scotland

In the table below we have listed some of the curriculum areas or skills that the SAMHE activities in this pack could be used to support. Curriculum links documented for schools in Scotland relate to Curriculum for Excellence: Experiences and Outcomes.

Activities where you need a CO_2 monitor (any type) or example SAMHE data (from the Data Pack) are shown by the symbols as described on page 5. If pupils are working towards an EPQ, you can find information on using SAMHE for a research assignment on page 101. For more details visit samhe.org.uk/resources/curriculum-links

Level	Subject	Topic
Second Level	Mathematics	Measurement, 3D Calculations
Third Level	Sciences	Processes of the Planet 
Third and Fourth Level	Social Studies	People, Place and Environment 
Fourth Level	Social Studies	People, Past Events, and Societies
Second, Third, and Fourth Levels	Sciences	Scientific Investigations, Inquiry and Analytical Thinking 

Curriculum links: Wales

In the table below we have listed some of the curriculum areas or skills that the SAMHE activities in this pack could be used to support. Curriculum links documented for schools in Wales relate to Curriculum for Wales: Programme of Study for Mathematics, Key Stages 2-4 (2016), Key Stages 2-4: Science in the National Curriculum for Wales (2008) and Key Stages 2-3: Geography in the National Curriculum for Wales (2008).

Activities where you need a CO_2 monitor (any type) or example SAMHE data (from the Data Pack) are shown by the symbols as described on page 5. If pupils are working towards an EPQ, you can find information on using SAMHE for a research assignment on page 101. For more details visit samhe.org.uk/resources/curriculum-links

Level	Subject	Topic
Key Stage 2	Mathematics	Using Data Skills
Key Stage 3	Science	Communication and Enquiry
Key Stage 2 and 3	Science	Interdependence of Organisms
Key Stage 4	Science	Overall Knowledge and Understanding
Key Stage 2 and 3	Geography	Understanding Places, Environments, and Processes

Curriculum links: Northern Ireland

In the table below we have listed some of the curriculum areas or skills that the SAMHE activities in this pack could be used to support. Curriculum links documented for Northern Ireland relate to the following documents / CCEA pages: Communication Levels 3,4 and 5: Writing to persuade, The World Around Us, CCEA GCE Specification in Mathematics, Local and Global Citizenship and Environment and Society.

Activities where you need a CO_2 monitor (any type) or example SAMHE data (from the Data Pack) are shown by the symbols as described on page 5. If pupils are working towards an EPQ, you can find information on using SAMHE for a research assignment on page 101. For more details visit samhe.org.uk/resources/curriculum-links

Level	Subject	Topic
Key Stage 1 and 2	Geography/ History/ Science and Technology	The World Around Us: Interdependence
Key Stage 3	Communication	Writing to Persuade
	Learning for Life and Work	Local and Global Citizenship
	Geography	Environment and Society
AS 2: Applied Mathematics	Mathematics	Working with Large Datasets

Introduction to Air Quality

This assembly introduces pupils to the SAMHE project, and indoor air quality measures we use. These are CO_2, temperature, relative humidity, particulate matter (PM), and volatile organic compounds (VOCs). It also explores what can affect indoor air quality, and what we can do to improve it.

Level
All

Estimated time
15 mins

People needed
1+

Equipment needed
SAMHE assembly presentation

We anticipate that all learners will be able to engage with this assembly.

You can find the assembly presentation in the Teacher Resource Pack (file name: SAMHE Introductory assembly presentation.ppt) or download it separately from: samhe.org.uk/get-involved. The script for the presentation is in the PowerPoint notes section and is also included in the following pages of this guide.

Learning outcomes
By listening and participating in this assembly, pupils will understand what indoor air quality measures such as CO_2, temperature, relative humidity, particulate matter (PM), and volatile organic compounds (VOCs) are, and what may affect them.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Assembly plan

Slide number	Directions
1	**Overview** In this assembly/presentation we will learn more about the SAMHE project, indoor air quality, and what might affect it.
2	**Introduce SAMHE** • SAMHE (Pronounced 'Sammy') stands for Schools' Air quality Monitoring for Health and Education. • SAMHE is a research project which involves 6 research partners - Imperial College London, the University of Cambridge, the Stockholm Environment Institute at the University of York, the University of Leeds, the University of Surrey, and the United Kingdom Health Security Agency. • Researchers from each of these institutions have come together to create activities and example data for us to look at to explore indoor air quality further.
3	**What is air quality and why does it matter?** • Air quality describes how clean or polluted the air we breathe is. The less pollution there is in the air, the better the air quality is. • When people think about air pollution, they often think about the quality of the air outdoors - for example, you might think of emissions from cars, factories or flying as things that affect air quality. • However, indoor air quality is also very important as most of us spend more than 80% of our time indoors.

Assembly plan cont.

Slide number	Directions
4-5	**How much air do you think you breathe at school?** *Instructions for speaker: invite pupils to guess how much air they breathe at school. This figure is an estimate for the total number of litres of air that pupils breathe during their time at school based on a typical school career (4-18). You could invite pupils to vote using a show of hands.* *When you're ready for the answer click through to slide 5.* The answer is approximately 7.2million litres of air. How many people got that right? To put that into context the SAMHE team estimate that's about 90,000 bathfuls of air.
6-7	**How does poor air quality affect us?** (Slide 6) Poor air quality affects our health and wellbeing, including affecting our lungs and heart. It can cause asthma or make it worse. *Instructions for speaker: if you have time you might like to get pupils to think about how poor air quality affects them and then perhaps share their thoughts in pairs. When you're ready click through to slide 7 to reveal some bullet points on how air quality affects us and talk through the following points.* • Even though you can't see what causes it, you will probably be aware of poor air quality. • Have you ever had a long lesson where the room felt stuffy and you found it difficult to concentrate? If you didn't have the windows open, there may have been high levels of re-breathed air, likely meaning high levels of carbon dioxide, which could have been one of the reasons you were struggling to concentrate! • Poor indoor air quality has also been linked to increased drowsiness, and headaches making it harder to learn.

Assembly plan cont.

Slide number	Directions
8	**How can we measure air quality?** • Now that we've seen how important air quality is, how do we measure how good the quality of our air is? Your school may have an indoor air quality monitor, or you may have seen one in your local area. • There are lots of different ways to measure air quality. Air quality monitors may measure: - Carbon dioxide - Particulate matter - Total volatile organic compounds - Temperature - Relative humidity
9	**Carbon Dioxide (CO_2)** • The most common source of CO_2 in classrooms is people. This is because we all breathe out CO_2. This makes carbon dioxide a good way to indicate indoor air quality because higher levels of CO_2 imply that a room contains lots of re-breathed air (that is air that's already been breathed out by someone else). • Equally when a room is well ventilated, we can expect that the CO_2 level will be lower because more fresh air is coming in from outside, replacing the re-breathed air.
10	**Total Volatile Organic Compounds** • Thinking about VOCs as things you can smell can help you to identify things that produce VOCs. For example, cleaning products, air fresheners, deodorant, and paint all produce VOCs. • Because there are so many different types of VOCs many air quality monitors, such as those used by SAMHE, detect the total volatile organic compounds, or TVOCs. • TVOCs readings are a measure of almost all the different VOCs that are likely to be in the air.

Assembly plan cont.

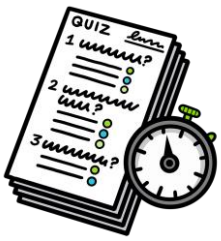
Slide number	Directions
11	**Particulate Matter** • The particles of most interest to air quality scientists and health researchers are those that are small enough to be breathed in. • Particulate matter is classified by size. There are two main size bands which are PM_{10} which includes any particles less than 10 microns in diameter and $PM_{2.5}$ which includes any particles less than 2.5 microns in diameter and bigger than 400 nanometres. • Particulate matter can come from naturally occurring sources such as pollen and desert dust, as well as from human activities including cooking and driving. From these examples you can see that particulate matter comes from sources both outdoors and indoors. • Particulate matter from outdoors can also travel indoors, so it is not a simple thing to analyse.
12	**Temperature** • The temperature can help us to understand how comfortable the room feels to students and staff. • Looking at the temperature can help you to make decisions about when to ventilate your classroom (for example by opening windows or doors) and how to balance ventilation requirements with making sure your classroom is comfortably warm to work in.
13	**Relative Humidity** • Relative humidity is shown as a percentage using the % symbol. This is because relative humidity is a measure of how much water vapour there is in the air compared to how much there could be at that temperature and pressure. If relative humidity was at 100% the air would be holding as much water vapour as it possibly could; if it was holding any more than that water droplets would form, and it might start raining indoors!

Assembly plan cont.

Slide number	Directions
14	**So, what affects indoor air quality in classrooms?** • There are lots of things that can affect air quality in classrooms. • For example, the types of activity going on in a classroom can impact indoor air quality. If we were all moving around a lot we'd be exhaling more, and therefore increasing CO_2 levels. On the other hand, if we were in an art lesson using things like paints or glues, we might be increasing levels of total volatile organic compounds. • Since the main source of CO_2 indoors is people breathing it out, the number of people in a room can affect the air quality too. The more people there are the higher you might expect the CO_2 levels to be. • However, these factors will be balanced out by the amount of ventilation, including how many windows and doors are open, and whether there are any air cleaning devices in the room. That said, bringing in air from outdoors can actually bring in pollutants, if windows are opened when there is a lot of traffic outside, for example.
15	**Take a look at this slide, which of these things do you think influence indoor air quality?** *Instructions for speaker: pause to allow pupils to think about which of these things influence indoor air quality. You could ask pupils to raise their hands for each of the things they think can affect indoor air quality. If you have time, you could even ask pupils to consider how they think each of these things might affect air quality.* • The answer is all these things can affect indoor air quality!

Assembly plan cont.

Slide number	Directions
16	**What can we do to improve indoor air quality?** • Improving indoor air quality can be really simple - and there are lots of easy things we can start doing straight away! • Ventilation is the name for the process of refreshing indoor air by allowing air to flow into a building or room while letting, potentially stale, air out. • Increasing the level of classroom ventilation, by opening windows and doors helps us maintain good air quality in indoor spaces, by diluting and removing pollutants from the air indoors. • That's not to say we need windows and doors open all the time though - thinking about how comfortable we are in a room is also important, and we also need to make sure we aren't wasting energy heating the room if all that heat is escaping out of the door! • Monitoring levels of CO_2 and temperature at the same time can help us balance these factors. • Equally, like we mentioned earlier, we should be conscious of the possibility of bringing in outdoor air pollutants. For example, we might want to keep windows closed during the rush hour to stop pollutants from cars coming in, or closed when there is a lot of pollen in the air. • Air cleaning devices like filters and purifiers can also be helpful.



Quiz activities

These activities are designed to test pupils' knowledge of different aspects of air quality.

Understanding Air Quality measurements: CO_2

This quiz introduces pupils to carbon dioxide (CO_2) a common metric for indoor air quality measurements. The quiz tests general understanding of CO_2, knowledge of the typical levels of CO_2 in a classrooms, and what affects the level of CO_2 in a classroom.

Level
Facilitation needed for younger pupils

Estimated time
15 mins

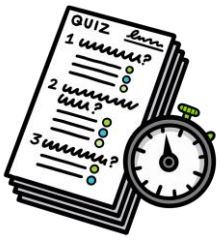
People needed
1+

We anticipate that younger pupils who have not yet been introduced to carbon dioxide will need teacher input to consider and understand the concepts in this activity . Older or more advanced pupils should be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have been introduced to the concept of carbon dioxide as a chemical compound, what the average levels of CO_2 in classrooms in the UK are, and how pupils can affect their environment.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity.
You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.



Questions and answers

1) What does CO_2 mean?

a) Carbon monoxide
b) Carbon trioxide
c) Carbon dioxide

The correct answer is c). The chemical formula for carbon dioxide is CO_2, whereas the formula for carbon monoxide is CO, and for carbon trioxide is CO_3.

2) Which of these answers is the closest description of CO_2?

a) Carbon dioxide is a chemical compound. Its molecules consist of one carbon atom joined to two oxygen atoms
b) Carbon dioxide is a chemical compound. Its molecules consist of one carbon atom joined to one oxygen atom.
c) Carbon dioxide is a chemical compound. Its molecules consist of two carbon atoms joined to one oxygen atom.

The correct answer is a). Carbon dioxide is a gas found in the air around us. It is a chemical compound made up of one atom of carbon with two atoms of oxygen.

3) What units are typically used to describe the amount of CO_2 in the air?

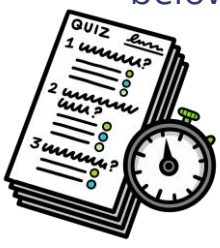
a) Parts per million, ppm
b) Grams, g
c) Grams per cubic metre of air, g/m^3

The correct answer is a). A value of 500 ppm would mean a concentration of a ratio of 500 CO_2 particles per 1 million air particles present in the air, or 0.05% as a percentage.

4) What is the average CO_2 level of an occupied room in the UK?

a) 250 - 400 ppm
b) 400 - 1500 ppm
c) 1500 - 3000 ppm

The correct answer is b). The lowest carbon dioxide readings we would expect to see would be just above 400 ppm, (because this is the level of CO_2 outdoors) and we would hope that the average levels indoors lie below 1500 ppm.



5) What can lead to increased levels of CO_2 in a room?

a) Increasing the number of people in a classroom
b) The colour of a classroom being red
c) The shape of a classroom being round

The correct answer is a). The most common source of CO_2 in classrooms is people. This is because we all breathe out CO_2. This makes carbon dioxide a good way to indicate indoor air quality because higher levels of CO_2 imply that a room contains lots of re-breathed air. Equally when a room is well ventilated, we can expect that the CO_2 level will be lower because more fresh air is coming in from outside, replacing the re-breathed air.

6) What can lead to decreased levels of CO_2 in a classroom?

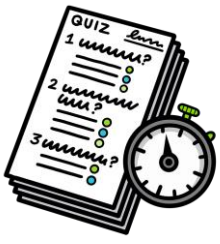
a) Getting occupants to jump up and down within the room
b) Increasing the ventilation of a classroom (e.g., by opening more windows)
c) The shape of a classroom being square

The correct answer is b). The simplest way to dilute the CO_2 we produce is by refreshing the air within the classroom with outdoor air. We call this ventilation.

7) What would it mean if the CO_2 level in your classroom was 500 ppm?

a) I would be unsafe
b) I would be safe

The correct answer is b). Typical outdoor CO_2 levels in the UK are usually a bit above 400 ppm, so a CO_2 reading of 500 ppm would be quite low - that's not harmful, in fact, the lower the CO_2 reading the better.



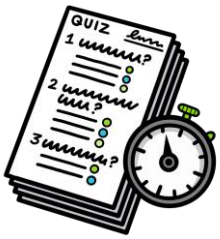
8) If the CO_2 level in your room was 2,000 ppm, would you be in immediate danger?

a) Yes, definitely
b) Not necessarily

The correct answer is b). Breathing in air with CO_2 concentrations of 2,000 ppm does not, in itself, put you in any immediate danger.

However, the CO_2 levels in your room indicate how much of the air has already been breathed by other people. 2,000 ppm is a relatively high value of CO_2 which indicates that more ventilation is required, for example, by opening windows. This is particularly important when there are lots of viruses around in the air, or when there are people with underlying health conditions.

A high level of CO_2 may also make you feel uncomfortable or tired and you may find it difficult to concentrate. CO_2 levels in classrooms in the UK should usually be below 1,500 ppm and ideally quite a bit lower. You can find out more about how to keep your classroom well ventilated on our website at samhe.org.uk/resources/ventilation



Understanding Air Quality measurements: temperature and humidity

This quiz introduces pupils to temperature and relative humidity, which are common measures of indoor air that can indicate thermal comfort. The quiz tests general understanding of temperature and humidity, and what affects these in a classroom.

Level
Facilitation needed for younger pupils

Estimated time
15 mins

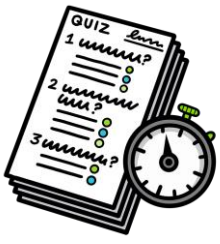
People needed
1+

We anticipate that younger pupils who have not yet been introduced to temperature and humidity will need teacher input to consider and understand the concepts in this activity . Older or more advanced pupils should be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have been introduced to the concepts of temperature and humidity, what the expected levels of these measures are in classrooms in the UK, and how they can affect the classroom environment.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity.
You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.



Questions and answers

1) Which of these answers is the closest description of temperature?

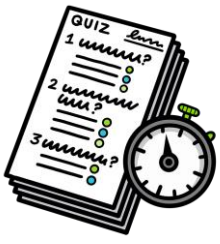
a) Temperature is a measure of how hot something is
b) Temperature is a measure of how wet something is
c) Temperature is a measure of how light something is

The correct answer is a), or more specifically, the average energy associated with the motion of the atom or molecules within a substance. Temperature is measured with a thermometer. In the UK, the most commonly used measurement for temperature is the Celsius scale which uses the unit degrees (°C). Air temperature is one important factor of temperature that you sense. Scientists call the temperature that you sense operative temperature which is a combination of the air temperature and the radiative temperature of the surfaces (wall, floors, ceilings, windows, desks, etc.) around you. A good measure of thermal comfort will always be how comfortable you feel, which is very personal - we are all different and therefore sense and feel things differently.

2) Which of these answers is the closest description of relative humidity?

a) Relative humidity is a measure of how much water vapour is present in the air relative to the maximum that the air could hold
b) Relative humidity is a measure of how many volatile organic compounds are present in the air
c) Relative humidity is a measure of how much particulate matter is present in the air.

The correct answer is a). Relative humidity is a measure of how much water vapour is present in the air relative to the maximum water vapour that the air could hold at that temperature and pressure. Since relative humidity is referring back to the total amount of possible water vapour, it is shown as a percentage using the % sign.



3) What is the average room temperature in the UK?

a) Between 10-12 °C
b) Between 25-27 °C
c) Between 18-24 °C

The correct answer is c). This temperature would indicate that you wouldn't feel too warm or too cold, and should be comfortable in indoor clothing, although your thermal comfort will always be personal to how you feel.

4) What is the average relative humidity of a room in the UK?

a) 0-30 %
b) 30-60 %
c) 70-90 %

The correct answer is b), the average relative humidity of a room in the UK is between 30 % and 60 %.

5) What does *not* directly affect how quickly a substance changes temperature?

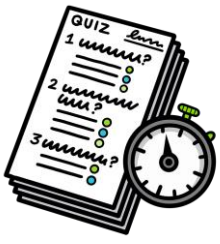
a) How hot the substance was yesterday
b) The mass of a substance
c) What a substance is made of

The correct answer is a). How quickly a substance changes temperature is directly affected by its mass, the greater the mass the more energy required to change the temperature by the same amount. What a substance is made of is important too, different substances require different amounts of energy to change their temperature by the same amount, scientists call this the 'specific heat capacity' of a substance.

6) What can directly affect relative humidity in a room?

a) The amount of ventilation in a room
b) The amount of noise in a room
c) The colour of a room

The correct answer is a), how the air moves in and around a room can affect humidity. Ventilation usually reduces humidity by removing moist air from the room. You can ventilate a room by opening doors and windows, or by using a device such as a dehumidifier.



7) What would it mean if the temperature in your classroom was 10 °C?

a) I would be unsafe
b) I would be safe

The correct answer is b). Although classrooms in the UK would usually be above about 18 °C, temperatures of 10°C are not harmful, but you may be uncomfortable.

8) What would it mean if the relative humidity of your classroom was 20 %?

a) I would be safe
b) I would be unsafe

The correct answer is a), although humidity in classrooms in the UK would usually be above 30 %, a humidity of 20 % would not be harmful, though you may feel uncomfortable, and your skin and throat could feel dry.

9) What would it mean if the temperature on your classroom monitor was 30 °C?

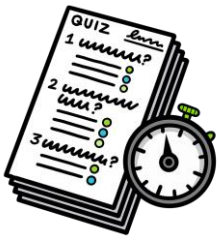
a) I would be unsafe
b) I would be safe

The correct answer is b). Although classrooms in the UK would usually be below about 24 °C, a temperature of 30 °C would not be harmful, though you may feel tired and uncomfortable.

10) What would it mean if the relative humidity reading on your classroom monitor was 80 %?

a) I would be safe
b) I would be unsafe

The correct answer is a), although humidity in classrooms in the UK would usually be below 60 %, a humidity of 80 % would not be harmful, though you may feel uncomfortable, and you could feel a bit clammy.



Understanding Air Quality measurements: Particulate matter and VOCs

This quiz introduces pupils to particulate matter and volatile organic compounds, which are two measures of air quality. The quiz tests general understanding of these measures, and what can influence the readings you would see in the classroom.

Level
Facilitation needed for all pupils

Estimated time
15 mins

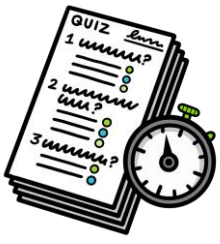
People needed
1+

Unless pupils have encountered the terms particulate matter and volatile organic compounds before, we anticipate that throughout this activity they will need teacher input to consider and understand these concepts. Younger or less advanced pupils may need more input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have been introduced to particulate matter ($PM_{2.5}$) and volatile organic compounds (VOCs), and how they can affect the classroom environment.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity.
You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.



Questions and answers

1) What does $PM_{2.5}$ mean?

a) Particulate matter in the air that is 2.5 microns or less in width

b) Particulate matter in the air that is more than 2.5 microns in width

c) Only particulate matter in the air that is exactly 2.5 microns in width

The correct answer is a). Particulate matter includes everything in the air that is not a gas, which includes things which cannot be seen by the human eye. The particles of most interest to air quality scientists and health researchers are those that are small enough to be breathed in.

2) Which of these answers is the closest description of particulate matter?

a) Particulate matter is the term for a mixture of solid particles and liquid droplets in the air

b) Particulate matter is the term for solid particles in the air

c) Particulate matter is the term for liquid droplets in the air

The correct answer is a), the correct term for the mixture of any solid particles and liquid droplets suspended in the air is 'particulate matter'.

3) What is the average level of $PM_{2.5}$ of a classroom in the UK?

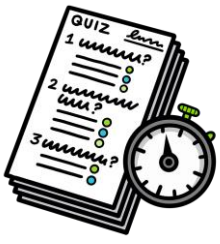
(measurements are given in micrograms (1/1000000 g) per cubic metre of air, which is written as $\mu g/m^3$)

a) Between 10 -20 $\mu g/m^3$

b) Below 10 $\mu g/m^3$

c) Over 20 $\mu g/m^3$

The correct answer is b). We would hope that average $PM_{2.5}$ levels are below 10 $\mu g/m^3$ in UK classrooms, but there is not enough data to know for sure. The UK Government reports an average $PM_{2.5}$ concentration of 7.9 $\mu g/m^3$ in 2021 at urban background sites (down from 12.4 $\mu g/m^3$ in 2009) - we hope that levels in classrooms might be lower than this on average, but these levels might be challenging to reach in classrooms near busy roads.



4) What two things might directly affect $PM_{2.5}$ levels within a classroom the most?

- **a) Being close to a main road and burning (including candles, gas cookers, and Bunsen burners)**
- b) Turning on a radiator and running a tap
- c) Using an electronic whiteboard and walking around the classroom

The correct answer is a), the brake and tyre wear from vehicles, and their combustion engines are major sources of $PM_{2.5}$ and the closer to a main road you are the more significant the contribution might be. Burning, even relatively clean fuels like gas, can also produce high levels of $PM_{2.5}$.

5) What would it mean if the $PM_{2.5}$ level in your classroom was 5 µg/m³?

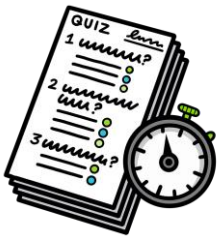
- a) I would be unsafe
- **b) I would be safe**

The correct answer is b), there is no harm in having low levels of $PM_{2.5}$, the particulate matter is so small that your comfort would not be affected.

6) What would it mean the $PM_{2.5}$ level in your classroom was 25 µg/m³?

- **a) I would be safe**
- b) I would be unsafe

The correct answer is a), based on short-term measurements of $PM_{2.5}$ there is no direct link evidenced between short exposures of particulate matter at these sorts of levels and an individual's safety; however, high levels of PM can act as a trigger for mild symptoms in some vulnerable people, including some asthmatics.



7) What does TVOC mean?

a) Total Variable Organic Chemicals
b) Total Volatile Organic Chemicals
c) Total Volatile Organic Compounds

The correct answer is c). The 'V' is for 'volatile' which means chemical substances that easily evaporate into the air at room temperatures; the 'O' is for 'organic' and means that the chemical substance contains some amount of carbon (a lot of common chemicals contain carbon); the 'C' is for 'compound' and means that the chemical substance is a mixture of different chemicals - together, they are referred to as 'VOCs'. The 'T' is for 'total' and refers to the fact that sensors can detect the presence of a wide range of VOCs. SAMHE uses a special index called Ind30 to report TVOC measurements, but measurements like parts per million (ppm)/parts per billion (ppb) are also common.

8) Which of these answers is the closest description of Volatile Organic Compounds (VOCs)?

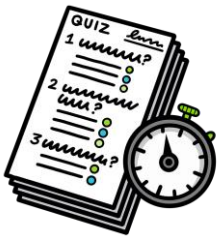
a) VOCs are gases, containing some carbon atoms, that are emitted into the air from products or processes.
b) VOCs are gases, that are only emitted from the human body
c) VOCs are gases, that are only emitted from cleaning products

The correct answer is a). VOCs are emitted by humans and our activities, and are emitted by many cleaning products, but there are lots of other sources of VOCs - in fact, almost anything that you've ever smelt is VOC.

9) What 3 things might directly affect TVOC levels in a classroom?

a) Sawing wood, burning toast and vacuuming
b) Spraying deodorant, opening an orange and painting
c) Turning on lights, exercising and clapping hands

The correct answer is b), spraying deodorants, opening an orange and painting will all be likely to give off lots of VOCs - the fact that they give off strong smells is a clue. The other answers may also give off smells, and some VOCs, but the answers here have stronger effects on the levels of particulate matter.

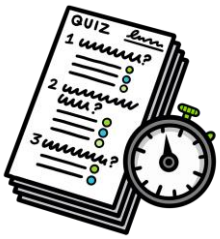


10) If the TVOC concentration in your classroom suddenly increased or decreased, what would be the most likely explanation?

a) My classroom is dangerous

b) There has been a change in environment or activity in my classroom

The correct answer is b), the room would not be dangerous, at most you might notice a change in smell within the room.



SAMHE careers activity

We have collected information from different members of the SAMHE team about what they do in a day at work. This information has been published in a booklet titled 'A day in the life of the SAMHE team – careers resource', which can be found on samhe.org.uk/resources.

This Quiz activity involves pupils reading the booklet and answering questions to discover more about science and science-related careers. It also includes a discussion prompt to encourage students to think about their own interests.

Level
Pupils aged 11+

Estimated time
30 mins

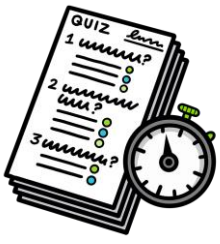
People needed
1+

Equipment needed
Careers booklet

We anticipate that pupils aged 11 and under may find the language in the careers booklet difficult to read and the ideas considered difficult to understand. Older or more advanced learners should be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE pupil worksheets folder.

Learning outcomes
On completion of this activity, pupils will have read about the different roles that SAMHE team members have, and the different types of science careers involved in research.



Directions:

This activity involves your pupils reading about the careers of the SAMHE team, and then answering some questions about those careers. At the start of this activity, pupils should spend some time reading the SAMHE 'A Day in the Life' booklet that can be found on samhe.org.uk/resources. Your pupils may find it useful to refer to the booklet throughout the activity.

Questions and Answers

1) SAMHE is a big research project, which involves people from 6 different organisations all doing different jobs. Whose job is it to organise and manage SAMHE?

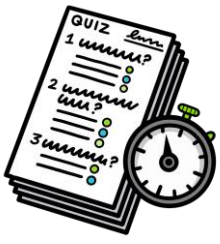
- **a) Project Coordinator**
- b) Lecturer in Building Physics
- c) Research Fellow in Citizen Science

The correct answer is a). The Project Coordinator oversees all aspects of the project, from managing the different teams, to seeing what information is being sent to schools, to making sure that SAMHE is reaching its deadlines. By contrast, the main role of a lecturer is to teach university students about a particular subject.

2) An important part of projects like SAMHE is sharing information about the project with the public and schools. Whose job is it to create and edit information for the SAMHE website and social media accounts?

- a) Project Coordinator
- b) Technical Specialist Software Developer
- **c) Communications Specialist**

The correct answer is c). In SAMHE, the Communications Specialist designs and carries out strategies to communicate aspects of the research to the public and encourage schools to get involved. The main role of software developers is to add the information to the website (rather than create and edit it).



3) The SAMHE project uses a Web App to collect data. Who in the team used code to create the SAMHE Web App?

a) Project Coordinator and Communications Specialist
b) Technical Specialist Software Developer and Software Developer
c) Postdoctoral Research Associate

The correct answer is b). The software developers wrote code to create the SAMHE Web App, and to add information, activities, images, and graphs to it. Although postdoctoral researchers often also write code for SAMHE they have used this to build models to analyse air quality data that has been collected through the Web App, rather than create the app itself.

4) Rhys, Sam, Henry, Sarah, and Carolanne all do research as part of their jobs. What is a researcher?

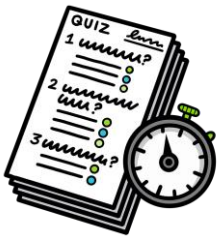
a) Someone who studies a subject to invent new products
b) Someone who studies a subject to discover new information and create new knowledge
c) Someone who studies a subject to teach others about it

The correct answer is b). To discover new information, researchers are likely to spend their time gathering data, analysing that data, and then presenting their findings to others through articles or presentations. Inventing new products would be the job of an inventor.

5) Rhys and Sarah are Citizen Science researchers. What does a Citizen Science researcher do?

a) They study how the public, or citizen scientists, engage with scientific research
b) They study Citizenship
c) They study science that affects citizens

The correct answer is a). This may include designing activities to include the public in research, reaching out to community groups to tell them about research projects they may be interested in, and speaking to other researchers about including citizen scientists in their research. Citizen science researchers may be interested in citizenship and will often study science that affects citizens, but neither is their core focus or their area of expertise.



6) Both Henry and Carolanne talk about how their work relates to Civil Engineering. What is a Civil Engineer?

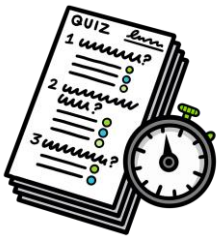
a) Someone who designs, constructs, and maintains mechanical products and systems
b) Someone who designs, constructs and maintains planes, spacecraft and satellites
c) Someone who designs, constructs, and maintains the structures in our cities, towns, and villages

The correct answer is c). Civil Engineers are involved in the design, construction, and maintenance of everything you see that is built around us. They also think about how these structures connect to one another and to the public. Designing mechanical systems is the job of a Mechanical Engineer, and someone who designs planes, spacecrafts and satellites would be an Aerospace Engineer.

7) Sam Wood talks about his studies in Chemical Engineering. What is a Chemical Engineer?

a) A Chemical Engineer develops, improves, and builds products and processes relating to health and biology
b) A Chemical Engineer develops, improves, and builds processes to change raw materials into safe everyday products using chemical processes
c) A Chemical Engineer develops, improves, and builds processes and systems that use electricity

The correct answer is b). Chemical Engineers develop and design chemical manufacturing processes. They use chemistry, physics, and engineering to design equipment and processes that are used to manufacture products that we use every day. Engineers that develop processes around electricity are called Electrical Engineers, and engineers that develop processes relating to health and biology are called Biomedical Engineers.



8) Victoria talks about her previous role as a Wildlife Scientist. What is a Wildlife Scientist?

a) A Wildlife Scientist studies the biology, behaviour and habitats of wild animal populations

b) A Wildlife Scientist studies how to treat animals that are unwell

c) A Wildlife Scientist looks after animals in zoos, safari parks and aquariums

The correct answer is a), a Wildlife Scientist usually studies the biology, behaviour, and habitats of a variety of animal populations in the wild. People that care for unwell animals are called Veterinarians (Vets) and looking after animals in captivity would be the job of an animal keeper or aquarist.

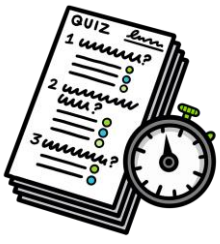
9) In the booklet, Professor Sarah West talks about a typical day in her job. What is a Professor?

a) Someone who has a university degree

b) Someone who is a scientist

c) Someone who has done lots of research and/or teaching in a subject

The correct answer is c). In the UK, a Professor is someone who has been promoted to the highest grade possible based on their research and/or teaching in a particular subject. Not all professors work in science and not everyone with a university degree is a professor.



10) Rhys, Henry, Carolanne, and Sam's title is 'Dr'. Rather than being medical doctors, this title means that they all have PhDs. What is a PhD?

a) PhD stands for Philosophy Degree and is a qualification awarded after finishing a university degree
b) PhD stands for Doctor of Physics and is a qualification awarded after completing an advanced degree at university
c) PhD stands for Doctor of Philosophy and is a qualification awarded after completing a doctorate at university

The correct answer is c), a PhD, or Doctor of Philosophy, is a specific type of advanced degree that is awarded following research in a particular field. To gain a PhD the student must generate new knowledge. A person who completes a degree in Philosophy would receive a Bachelor of Arts degree, which is referred to as a BA.

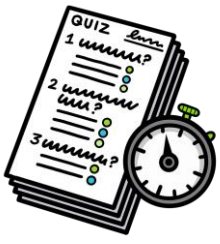
Discussion

Once your pupils have answered the questions, facilitate a discussion using the following prompts:

Now that you know more about Science careers, and the type of roles it takes to run a project like SAMHE, have a think about the following:

- What is something you learnt which you didn't know before?
- If you were working on the SAMHE project, what role would you like to do?
- There are many different routes into jobs that involve research, did anybody's route to their role surprise you?

Our booklet highlights just a portion of the careers of the people involved in SAMHE. Look on the team page to find out more about the rest of the team: **samhe.org.uk/about/team**!



Learning about Clean Air Zones

This Quiz activity involves pupils learning about outdoor air pollution and the ways in which outdoor air quality can be improved, and then answering multiple-choice questions about Clean Air Zones.

Level
Facilitation needed for all pupils

Estimated time
20 mins

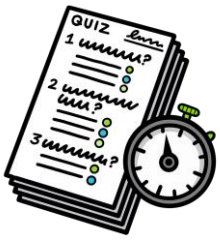
People needed
1+

We anticipate that younger pupils who have minimal understanding of outdoor air pollution will need significant teacher input to consider and understand the concepts in this activity. Older or more advanced pupils may still need some teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have been introduced to the concept of outdoor air pollution, and some methods used to improve it, especially Clean Air Zones.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.



Information on air pollution

Air pollution is the release of pollutants into the air around us, indoors and outdoors. Pollutants are chemicals and substances that may be harmful to our health or the natural environment, and could cause damage to the land, air or water.

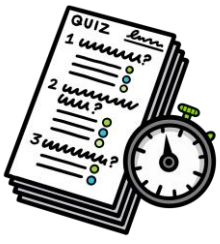
Outdoor air pollution in areas with busy roads tends to be caused by petrol and diesel cars, whereas, in the countryside, it's more likely to be caused by farming and industry.

Nitrogen dioxide and hydrocarbons affect outdoor air quality and are emitted from car exhausts along with a variety of other things which we'll touch on later in the activity. Different levels of nitrogen dioxide can be defined using the chart shown below:

Index	1	2	3	4	5	6	7	8	9	10
Band	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Very High
µg/m³	0-67	68-134	135-200	201-267	268-334	335-400	401-467	468-534	535-600	601 or more

A moderate level means that the general population can enjoy usual outdoor activities. Moving to a high level means that the general population can start experiencing discomfort such as sore eyes, cough or sore throat, while people with underlying health conditions and elderly might be even more negatively impacted.

Table from DEFRA: uk-air.defra.gov.uk/air-pollution/daqi?view=more-info&pollutant=no2#pollutant



Information on Clean Air Zones

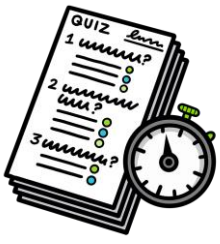
The Clean Air Strategy (2019) and Clean Air Zone framework (2022) are documents that give information on the government's plans to take action to improve air quality. You can find the Clean Air Strategy and Clean Air Zone framework on gov.uk.

One of the key measures to reduce emissions from transport is through creating Clean Air Zones (CAZ) in major cities. They are also sometimes called LEZ (Low Emission Zone) or ULEZ (Ultra Low Emission Zones).

A Clean Air Zone is an area of a city that vehicles can only enter if they meet certain standards. These standards are a set of limits on the amount of harmful exhaust emissions the vehicles emit, because exhaust gases from cars contribute to air pollution, especially in urban areas such as cities. In addition to CO_2, cars also emit the following pollutants:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Nitric oxide (NO)
- Particulate Matter (PM)
- Hydrocarbons (HC)

Clean Air Zones have been introduced with specific focus on tackling NO_2 concentrations but will also help reduce exposure to other pollutants in vehicle exhausts, including particulate matter.



Questions and Answers

1) Whose job do you think it is to protect air quality?

a) It is my job
b) It is our government's job
c) It is everyone's job

The correct answer is c), we should all work together to protect our air.

2) There are many different ways that we might try to improve our outdoor air quality around schools. Which of these methods have you heard of before?

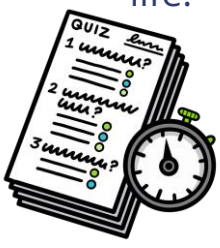
- ☐ School streets initiatives
- ☐ Walk/cycle to school campaigns
- ☐ Anti-idling zones (for cars)
- ☐ Green barriers/passive control systems e.g. hedges on the school boundary
- ☐ Clean Air Zones
- ☐ Another method not listed
- ☐ None

If pupils are aware any of these methods, or any of these methods are being used in your local area, you may want to spend some time here talking about them. The remainder of this activity will focus on Clean Air Zones.

3) What are the main reasons for setting up Clean Air Zones?

a. To reduce air pollution and negative impacts on people's health
b. To reduce negative impacts on people's health and to encourage people to stay at home
c. To reduce air pollution and to encourage people to stop buying cars

The correct answer is a). Both short- and long-term exposure to air pollution can lead to a wide range of health issues. It can affect your brain, and your ability to learn, as well as your mental health. It can impact your breathing and cause respiratory diseases like asthma or make symptoms worse. Nitrogen dioxide also makes acid rain when it mixes with water in clouds – this causes damage to wildlife and plant life.



4) What could happen if a vehicle does not meet Clean Air Zone standards?

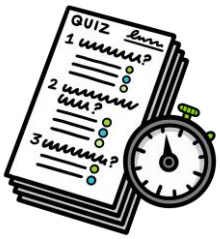
a) The driver might be charged a fee
b) The driver will have to buy a different car
c) The driver will lose their driving licence

The correct answer is a). A driver might be charged a fee for entering the Clean Air Zone, however this depends on the vehicle and the location. In some places there is no charge, while in others there is a daily fee, or penalty.

5) In Clean Air Zones that require vehicles which don't meet the standard to pay a fee, are there any reasons why a vehicle could enter without paying the fee?

a) No, there aren't any vehicles that could enter without paying the fee
b) Vehicles used by a disabled person, taxis, and military vehicles would be allowed to enter without paying a fee
c) Expensive cars would be allowed to enter without paying a fee

The correct answer is b). Certain types of vehicles are not required to pay the charges and penalties. Some examples would include: vehicles that are ultra low emission such as electric cars or hybrid cars, vehicles used by a disabled driver or registered disabled passengers, taxis and military vehicles.



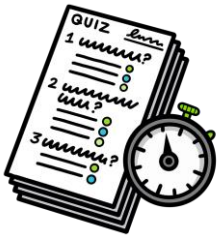
Discussion

Once your pupils have answered the questions, facilitate a discussion using the following prompts:

Clean Air Zones are being introduced to cities across the UK. Discuss whether you think a Clean Air Zone would work in your local area. You might want to think about:

- Are there any reasons for or against Clean Air Zones where you live?
- How do you think this would affect your daily journey to school?
- How would others be affected?

If you want to learn more about outdoor air pollution, and what we can do about it, you might want to look at the Clean Air for Schools framework at transform-our-world.org/programmes/clean-air-for-schools and our page on 'What can we do about air pollution' at samhe.org.uk/resources/air-pollution#what-can-we-do-about-air-pollution.



End of term SAMHE quiz

This Quiz activity involves pupils answering questions on indoor air quality. This activity is designed to be completed after the other activities in this Pack. It will improve general knowledge and understanding of indoor air quality.

Level
Facilitation for younger pupils

Estimated time
10 mins

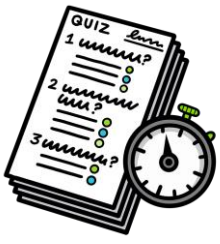
People needed
1+

We recommend that this activity is completed once learners are familiar with the concepts that have been introduced through previous quizzes. We anticipate that younger learners will need teacher input to complete this activity.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have revised their understanding of indoor air quality, particularly on metrics such as CO_2, $PM_{2.5}$, temperature, humidity, and VOCs.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.



Questions and Answers

1) CO_2, $PM_{2.5}$, temperature, humidity, and VOCs are all measures of indoor air quality - which of these metrics would we expect to be affected when the seasons change?

- **a) All of them**
- b) None of them
- c) Just temperature and humidity

The correct answer is a). We would expect temperature and humidity to change throughout the year depending on the weather. Particulate matter can change with the seasons as the weather changes and as plants and trees produce more or less pollen. Carbon dioxide (CO_2), $PM_{2.5}$, and VOC levels are likely to change as changes in outdoor temperature will affect the ventilation of the classroom, for example windows may be opened more often in warmer seasons.

2) Which of the following can you sometimes see floating in your classroom air, especially when bright sunlight is shining?

- a) Carbon dioxide
- b) The emissions from a smelly paint
- **c) Small particles of dust**

The correct answer is c). You can often see dust floating on air when bright sunlight shines indoors. You could complete the video activity 'The Science of ventilation' on page 94 with your pupils to explore this further. The answer could not be a) because carbon dioxide is an invisible gas and b) is also incorrect as VOCs are almost always invisible to human eyes.

3) If your friend gets excited and starts jumping up and down in your classroom what changes to the environment might happen?

- **a) The carbon dioxide levels would likely rise.**
- b) The temperature would rise.
- c) Nothing, there's no chance this would make any difference.

The correct answer is a). You do produce more heat when you jump up and down; however, it is extremely unlikely that this would affect the environment. The carbon dioxide levels would likely rise as when you do more activity you breathe out more CO_2 - you might want to complete the 'CO_2 levels before and after exercise' activity on page 54 with your pupils to test this.

4) What should you do if the carbon dioxide in your classroom rises quite high to above 2,000 ppm due to increased activity in your classroom?

a) Nothing
b) Try to increase the ventilation; for example, by opening a window

The correct answer is b), even though CO_2 levels this high are not dangerous, high CO_2 in a classroom indicates poor ventilation and a higher proportion of re-breathed air so the risk of catching colds or flu might increase.

5) Which of these can tell us about indoor air quality?

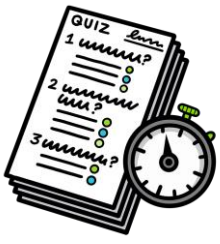
a) Nitrogen dioxide
b) Helium
c) A Newton-meter

The correct answer is a), though as the main sources are burning appliances (such as stoves, ovens, gas boilers, and fireplaces) we would expect the nitrogen dioxide levels in your classroom to be low. Helium is a gas that is much less dense than air (you often see balloons filled with helium) and so helium rises up and out of our buildings so is not a factor for indoor air quality. A Newton-meter measures forces - this can be useful for physics but is not helpful
for measuring indoor air quality!

6) Approximately how many breaths does the average person take in a day?

a) 100,000
b) 5,000
c) 20,000

The correct answer is c). That means that your classroom could have a lot of re-breathed air in it by the end of the day, which is why it is important to ventilate.



7) In what situation would the carbon dioxide outside your classroom window be higher than usual?

a) If it's warm outside
b) If our classroom is near to a main road and it's rush-hour
c) If it's snowing outside

The correct answer is b), vehicles emit carbon dioxide, and so if your classroom is next to a main road the carbon dioxide outside may be higher when the road is busy. When it is snowing outside CO_2 levels *inside* might be higher than usual because ventilating the room by opening windows or doors might result in lower thermal comfort due to the cool air. In these circumstances CO_2 monitors can help you make decisions about when to open doors/windows (or keep them closed).

8) What is the difference between $PM_{2.5}$ and PM_{10}?

a) PM_{10} includes particulate matter that is bigger than $PM_{2.5}$
b) PM_{10} describes particles that are smaller than $PM_{2.5}$
c) Nothing, they are the same

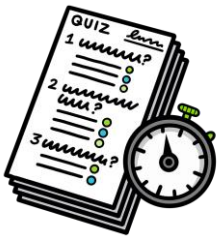
The correct answer is a). PM_{10} is particulate matter 10 µm or less in diameter, whereas $PM_{2.5}$ is particulate matter 2.5 µm or less in diameter. Therefore, PM_{10} particles are bigger than $PM_{2.5}$.

9) Which of the following pieces of equipment could be used to measure humidity?

a) Fathometer
b) Thermometer
c) Hygrometer

The correct answer is c). Some of the first hygrometers measured the curl in hair to determine how much moisture was in the air! Fathometers are used to measure the depth of water, and thermometers are used to measure temperature.

Discussion
Once your pupils have answered the questions, facilitate a discussion by asking if anything surprised them about the answers.



Sources of indoor air pollution

This quiz activity shows a drawing of a classroom to help pupils understand what the sources of air pollution might be in their classroom, and what can cause changes in temperature and relative humidity.

Level
Facilitation may be needed for younger learners

Estimated time
15 mins

People needed
1+

Equipment needed
Sources of indoor air pollution image (overleaf)

We anticipate that younger pupils who have minimal understanding of indoor air quality will need some teacher input to consider and understand the concepts in this activity. Older or more advanced pupils should be able to complete this activity with minimal input.

The following pages contain quiz questions and answers. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will understand what can cause indoor air pollution and relate this back to their own classrooms.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

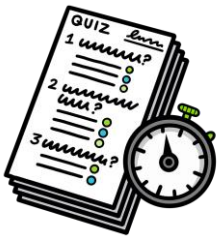
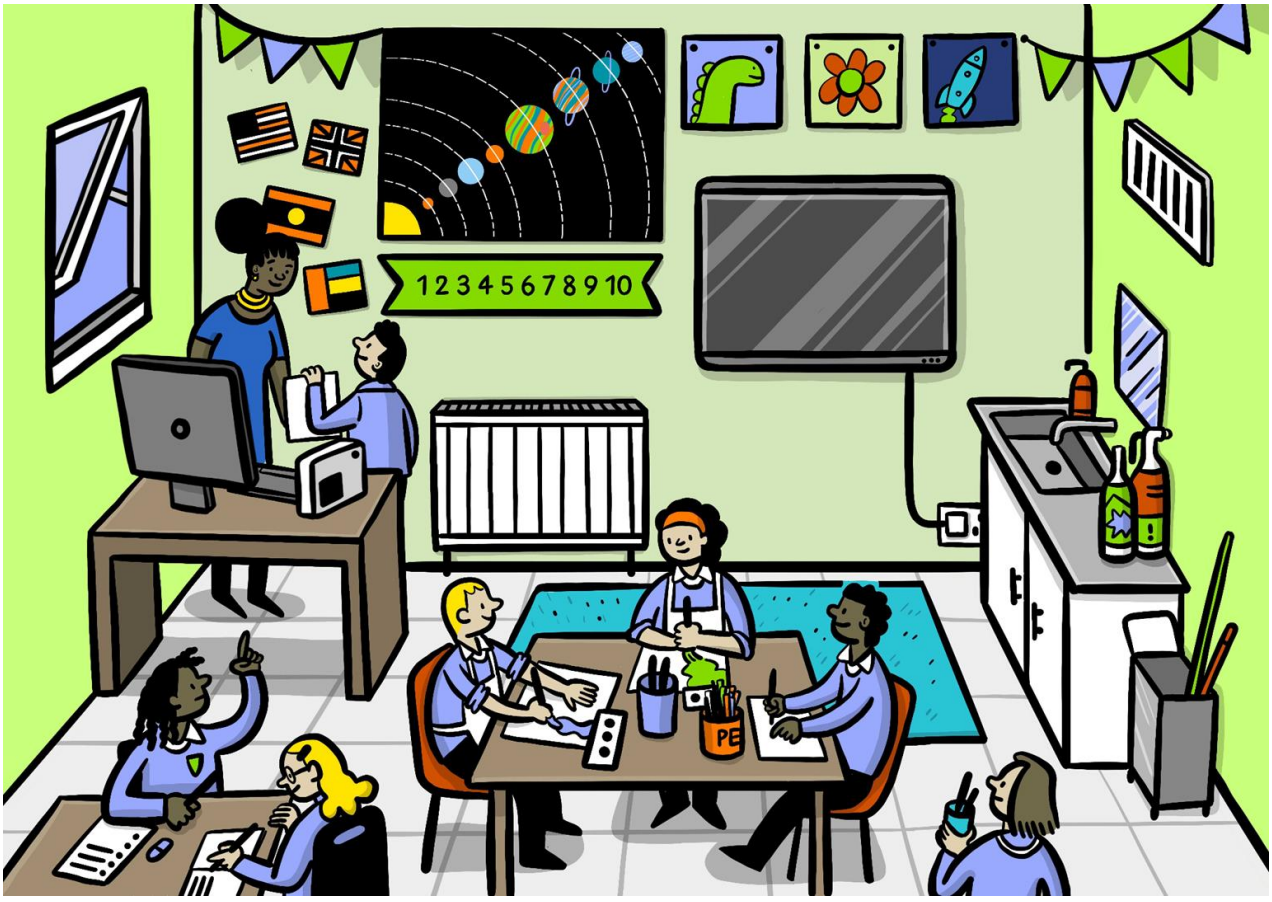
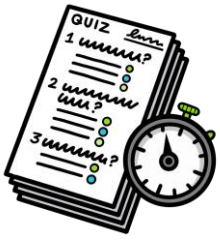


Image for the activity

Below is a drawing of a classroom with different activities taking place. Ask your pupils to look at it and to think about which of these activities might lower the air quality of the room. The rest of this activity will ask your pupils questions about the potential sources of air pollution shown in this picture, so you may wish to show this image on a screen or print the student worksheets so pupils can refer to the image throughout the activity. You could also ask students to circle sources of air pollution on the image itself, using the questions as a guide.





Questions and Answers

1) What are the sources of carbon dioxide (CO_2) in the picture?

a) People in the classroom
b) People in the classroom and the window
c) The radiator

The correct answer is b). All animals breathe out carbon dioxide, but it can also come from outside sources, mainly from burning coal, oil and gas.

2) Which one of the following is NOT a source of temperature changes in the picture?

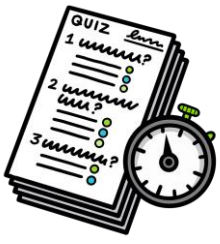
a) People in the classroom
b) The carpet
c) The window
d) Electrical equipment
e) The radiator

The correct answer is b). Carpets and other furnishings are not a source of heat, although if you sat underneath a rug you would feel warmer as your body heat would be trapped by the air between your body and the rug, but the rug itself does not emit heat.

3) Which one of the following shown in the picture does NOT affect relative humidity?

a) People in the classroom
b) The window
c) The radiator
d) Cleaning products
e) Furniture
f) Sink

The correct answer is e). Furniture and other objects that do not give off heat or water do not affect relative humidity. People, windows, radiators, cleaning products, and sinks all contain water or increase the moisture in the air, therefore affecting the relative humidity.



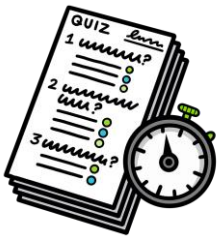
4) **Looking at the picture, which of the following does NOT cause particulate matter (PM) to change?**
   a) Cleaning products
   b) Opening or closing the window.
   c) Carpet and other soft furnishings
   d) Electrical equipment

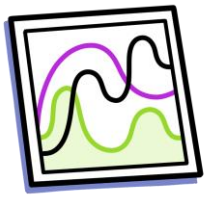
The correct answer is d). Computer screens and other electrical equipment are not sources of PM in classrooms. An exception is printers, especially laser printers which can produce lots of fine particulate matter. Carpets can be a source of particulate matter as dust and other particles fall down onto them, and then get moved back up into the air as people walk over them, or when the carpet is hoovered. Traffic fumes, dust from tyres, smoke, and pollen are all sources of particulate matter that can come into the classroom through an open window, and particles are released into the air when cleaning sprays are used. Dusting also moves settled dust into the air so increases levels of particulate matter.

Discussion

Once your pupils have answered the questions, facilitate a discussion using the following prompts:

- Having seen what could affect the air quality in the classroom image, what features and objects are there in our classroom which could affect air quality?
- What changes could these features make?





Data analysis activities

These activities are designed to encourage pupils to critically think about and interpret findings from data.

CO_2 before and after exercise

This activity involves your pupils moving around the classroom to see what happens to the levels of carbon dioxide (CO_2) in the air. To do this activity you will need a CO_2 monitor where you can see live readings.

Level
Facilitation needed for all learners

Estimated time
15 mins

People needed
10+

Equipment needed
CO_2 monitor (any type), stopwatch

We anticipate that all learners will need supervision to complete this activity as it includes moving around the classroom. Younger learners may need more significant facilitation to understand the concepts in this activity.

The following pages contain teacher notes and directions. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will understand how moving around contributes to CO_2 in the air, learning about concepts such as re-breathed air, and the impact of occupancy and exercise on CO_2 levels in the classroom environment.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils are encouraged to interact with the CO_2 monitor during periods of exercise and rest to see what happens. Please exercise your discretion when deciding whether this activity is suitable for your group of students. If there are any students within the group who are not feeling well or are clinically vulnerable, this may be an exercise you choose to avoid.

When everyone in your classroom is exercising, they will be breathing out more CO_2, so researchers would expect CO_2 levels to increase (due to the increase in re-breathed air), and when everyone has stopped moving, researchers would expect the CO_2 level to go back down. On a graph, researchers would expect to see this with a sharp peak in CO_2, followed by a steady decline.

If you complete this activity and your pupils do not see an increase in CO_2 levels that's probably a sign that your classroom is very well ventilated! To test out this theory you may like to repeat the activity with more people or a lower level of ventilation, for example, with the windows more closed.

Directions

1. Pupils should prepare a table (as shown below), or use the worksheet provided to record information throughout the activity. The first things to note before getting started are which room they are in, and how many people are in the room.

Name:
Which classroom are you in?:
How many people are in your classroom?

	Time	CO_2 reading	Notes
Before exercise			
After exercise			

Example table

2. Pupils should then discuss what they think will happen to the CO_2 level if everyone in the room was to exercise for 2 minutes; do they think the CO_2 level would go up, go down, or stay the same? They should record their own response.

3. Next, ask the pupils to look at the most recent CO_2 reading and make a note of it.

4. Now it's time to start the experiment. Your stopwatch should be set for 2 minutes. When it starts ask everyone to move around as much as they can. They could jump, run on the spot, wave their arms, or do star jumps – whatever physical activity that is safe and appropriate for your pupils to perform. Make sure that they are aware of their surroundings to avoid bumping into anything and encourage them to stop if they or you feel uncomfortable. Everyone should stop moving when the 2 minutes are up.

5. Once the 2 minutes are up, set your stopwatch for another 3 minutes and press start. Pupils can use this time to get their breath back. Try to avoid reading the CO_2 reading before the 3 minutes are up.

6. Once the timer is up, ask your pupils to check the CO_2 reading. They should make a note of this value and record if the CO_2 reading has changed - has it gone up, down, or stayed the same?

Discussion

Once your pupils have recorded all of their data, facilitate a discussion using the following prompts:

- Did you notice a difference in your breathing whilst you were performing the physical activity?
- Can you think of any reasons why CO_2 levels might not change, or might go down?
- Why does exercising, and breathing out more, make the CO_2 level go up?
- How could you reduce the level of CO_2 in the classroom?

CO_2 levels of an empty classroom

This activity involves your pupils trying out ways of reducing indoor CO_2 levels by ventilating the room and leaving the classroom for a short period of time. Pupils then investigate whether there have been any changes in the CO_2 levels. You will need a CO_2 monitor where you can see live readings.

Level
Facilitation needed for all learners

Estimated time
25 mins

People needed
10+

Equipment needed
CO_2 monitor (any type), stopwatch

We anticipate that all learners will need supervision to complete this activity as it involves leaving the classroom. Younger learners may need more significant facilitation to understand the concepts in this activity.

The following pages contain teacher notes and directions. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will understand how moving around contributes to CO_2 in the air, learning about concepts such as re-breathed air, and the impact of occupancy and exercise on CO_2 levels in the classroom environment.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils are encouraged to interact with the data from the CO_2 monitor after leaving the classroom for a short time (we recommend 15 minutes) to see what happens. When you and your pupils are in your classroom, you will be breathing out CO_2, so, when you leave the room, researchers would expect CO_2 level to decrease, particularly if ventilation has been increased by opening windows and doors. When everyone has returned to the room and windows and doors are reset, researchers would expect the CO_2 level to go back up. On a graph, researchers would expect to see this with a decrease in CO_2 during the time when you and your pupils were outside of the room, followed by a steady increase once you returned.

If you complete this activity and your pupils do not see a decrease in CO_2 levels that's probably a sign that you need to wait a bit longer, or try again, this time, opening the windows more widely. Equally, depending on the refresh rate of the monitor you are using, it might take a bit of time to see the difference in readings come through.

Directions

1. Pupils should prepare a table (as shown below), or use the worksheet provided to record information throughout the activity. The first things to note are which room they are in, and how many people are in the room.

Name:
Which classroom are you in?:
How many people are in your classroom?

	Time	CO_2 reading	Notes
Before leaving			
When returned			

Example table

2. Pupils should then discuss what they think will happen to the CO_2 level once all of the windows have been opened and the class leaves the room for 15 minutes.; do they think the CO_2 level would go up, go down, or stay the same? They should record their own response.

3. Next, ask the pupils to look at the most recent CO_2 reading and make a note of it in their table.

4. Now it's time to start the experiment. Start by opening all the windows and doors. You and your pupils are now going to leave the classroom for 15 minutes. Just before you leave, ask your pupils to make a note of the time and set your stopwatch to keep track of how long you've been out of the classroom.

5. Once you are back, feel free to return the windows and doors to their usual positions and ask your pupils to check the CO_2 reading. They should make a note of this value in their table and record if the CO_2 reading has changed - has it gone up, down, or stayed the same?

Discussion

Once your pupils have recorded all of their data, facilitate a discussion using the following prompts:

- Have you managed to change the air quality in your classroom?
- Thinking about the investigation you have just completed, discuss with your classmates whether you can you think of any reasons why CO_2 levels might not change, or might go up, when the windows and doors are opened.

Opening the windows and doors is a way to increase ventilation in rooms, and by leaving the room, you removed the source of CO_2, so we would expect the CO_2 level to go down.

Temperature changes throughout the day

This activity involves your pupils looking at the example data provided to identify maximum and minimum temperature readings.

You can complete this activity either using the example data, and ask pupils to create their own graphs, or by referring to the example temperature graphs in our Data Pack.

Level
Facilitation needed for younger pupils

Estimated time
20 mins

People needed
10+

Equipment needed
Data Pack

We anticipate younger learners will need significant teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain teacher notes and directions. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will understand how temperature of a classroom can change throughout the day, and think about what might cause these changes.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils are encouraged to interact with the example temperature data and/or graphs in the SAMHE Data Pack. This data shows the temperature of a classroom throughout a typical school day. Pupils will be asked to record the temperature at the start of the school day, the minimum and maximum levels of temperature throughout the day, and any instances of sharp changes in temperature. Pupils will also be encouraged to think about what could cause changes in temperature throughout the day.

We would expect that changes in temperature throughout the day would be dependent on factors such as opening windows, and heating devices, as well as what type of classroom is being monitored (we would expect higher temperatures in rooms with a computer suite, for example). We also expect behaviours around opening windows and turning on heating to depend on the time of year and outside temperature. To find out more about the changes in temperature we've observed in UK classrooms, you may like to read the technical reports summarising our findings from the project from the 2023 Autumn term, and the 2024 Spring term. You can find all of our technical reports here: samhe.org.uk/resources/outputs

Directions

1. Pupils should prepare a table (as shown below), or use the worksheet provided to record information throughout this activity.

	Time	Temperature reading (°C)	Notes
Beginning of the school day			
Middle of the school day	1pm		
Maximum level for the day			
Minimum level for the day			

Are there any sharp increases or decreases in temperature throughout the day? If so, what are the readings, and when do they occur?

Example table

2. Using their table, pupils should make a note of what the temperature was at the start of the school day. Next, they should record what the temperature is at 1pm and comment on if these two measurements different.

3. Now, ask the pupils to identify what was the maximum and minimum temperatures were in the room on the same day, including the time at which they happened and add this information to their table.

4. Finally, ask your pupils if they can see any other times where the temperature changed very quickly, either increasing or decreasing and ask them to record the times and temperatures whenever this happens in the dataset you are using.

5. Now that the pupils have made a note of the temperature values, and the times at which they occurred, encourage your pupils to share and compare their data with each other. If there are any differences, investigate why this might be with your pupils.

Discussion

Once your pupils have recorded all their data, facilitate a discussion using the following prompts:

- What happens during the day that could change the classroom temperature?
- Would could have caused the sharp increases and decreases in the data?
- What do you think happens during the weekends or at night?
- What would be different if the data was from summer? How about if the data was from winter?

Investigating a particulate matter event

This activity involves your pupils looking at graphs of SAMHE data and comparing them to graphs of outdoor air quality data to explore the trends found by SAMHE scientists. They will explore trends found in relation to global events.

Level
Facilitation needed for younger learners

Estimated time
20 mins

People needed
1+

We anticipate younger learners will need significant teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain teacher notes and directions. You can find a pupil worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have developed their data analysis skills, by reading graphs and identifying maximums . They will have also considered the reasons behind some of the trends that are seen in the data collected by SAMHE monitors, relating to global events.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Information on the particulate matter event described in this activity

By looking at the data collected from SAMHE monitors our SAMHE scientists identified that in September 2023, the levels of $PM_{2.5}$ rose in classrooms across the UK. Our scientists have linked this rise to a weather event, where strong winds picked up dust from the Saharan Desert and carried it to the UK in the atmosphere.

This finding has been written into a technical report that is shared with other scientists, teachers and policy makers to show that global weather events can be detected in UK classrooms. In this activity guides pupils will complete steps that follow the main findings of the technical report. The pupil worksheet for this activity shows the two graphs and asks discussion questions.

You and your pupils can read the technical report on the Saharan dust event, as well as other findings found by SAMHE scientists, by visiting the SAMHE outputs page: samhe.org.uk/resources/outputs.

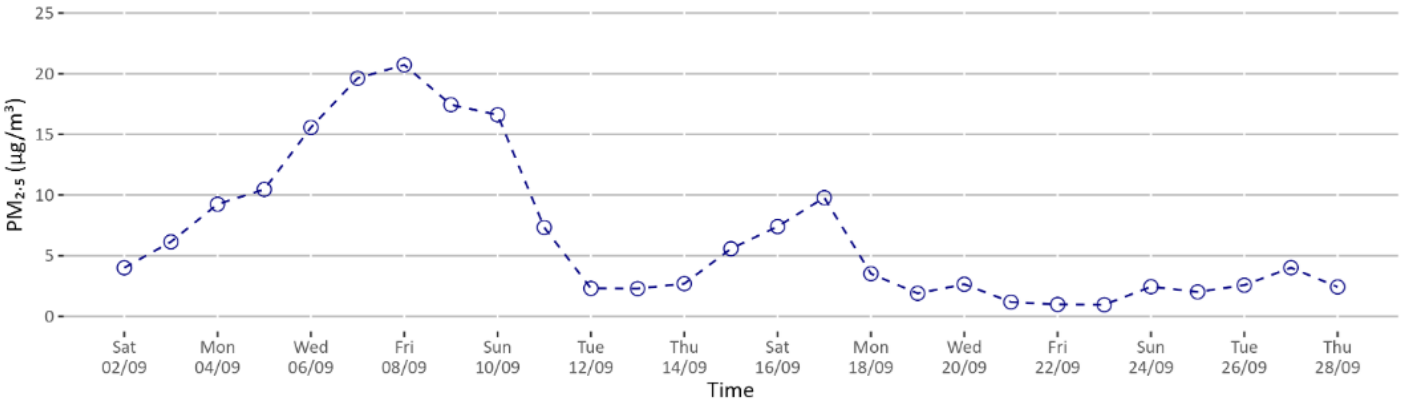
Please note this information is not supplied to pupils at the beginning of the activity, as they are asked to investigate the data patterns observed during the relevant time period and consider possible causes before the Saharan Desert Dust event is introduced.

Notes

Our SAMHE scientists have been looking at particulate matter ($PM_{2.5}$) from SAMHE monitors in classrooms across the UK. Throughout this activity, your pupils are going to be looking at these $PM_{2.5}$ levels as well as outdoor $PM_{2.5}$ levels.

Directions

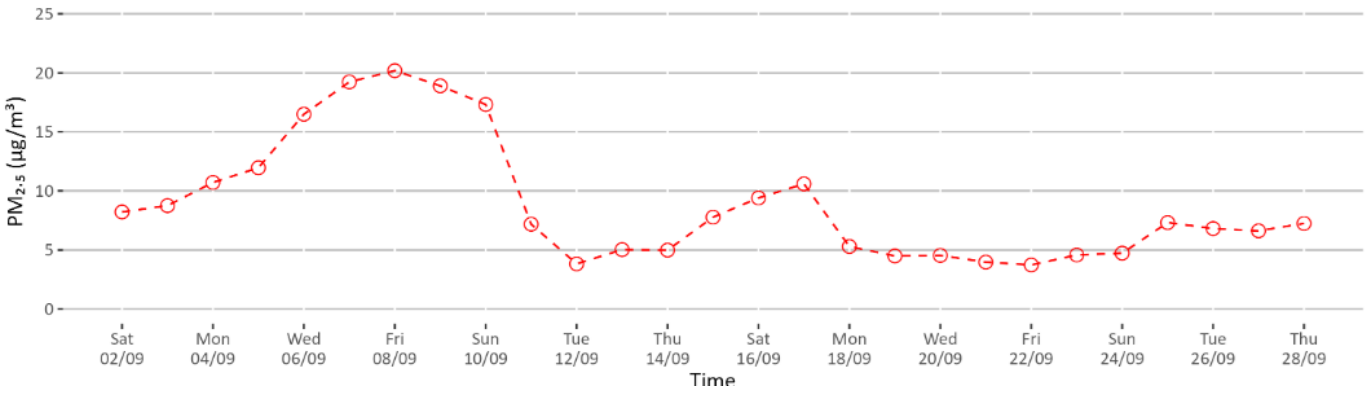
1. To start the investigation, direct your pupils to look at the plot of the $PM_{2.5}$ data below. This shows the levels of $PM_{2.5}$ across SAMHE monitors in September 2023. This data was collected from 212 classrooms across the UK, and a daily average was plotted. The particulate matter concentration levels are on the y axis. The time, given in two-day intervals, is on the x axis.



2. In September, our SAMHE scientists found a data event when the levels of $PM_{2.5}$ increased in classrooms across the country. The levels were much higher towards the start of the month than later on. Ask your pupils if they can find out on which day the concentration was highest.

3. The maximum recorded $PM_{2.5}$ level over September was on 8th September and was recorded at just over 20 $\mu g/m^3$. This is the point when the line is at its highest point on the graph, which is when the highest levels of $PM_{2.5}$ were detected by SAMHE monitors across the UK.

4. Next, ask your pupils to look at the graph below that has been put together by our SAMHE scientists to show the concentration of $PM_{2.5}$ outdoors across the UK over the same time period in September. The particulate matter concentration levels are on the y axis. The time, given in two-day intervals, is on the x axis.



5. Can your pupils find on which day the highest $PM_{2.5}$ levels outdoors occurred?

6. The maximum recorded $PM_{2.5}$ level outdoors over September was on the 8th and was recorded at 20 µg/m³. This is the point when the line is at its highest point on the graph, which is when the most particulate matter was detected in the UK.

7. Thinking about these graphs, ask your pupils if they notice any relationship between indoor and outdoor PM levels? If so, what do they think might cause these?

8. Your pupils may notice that the concentration of $PM_{2.5}$ was higher between 4th September and 8th September both in classrooms and outdoors. When your pupils think about what might have caused this you may wish to refer to the images overleaf.

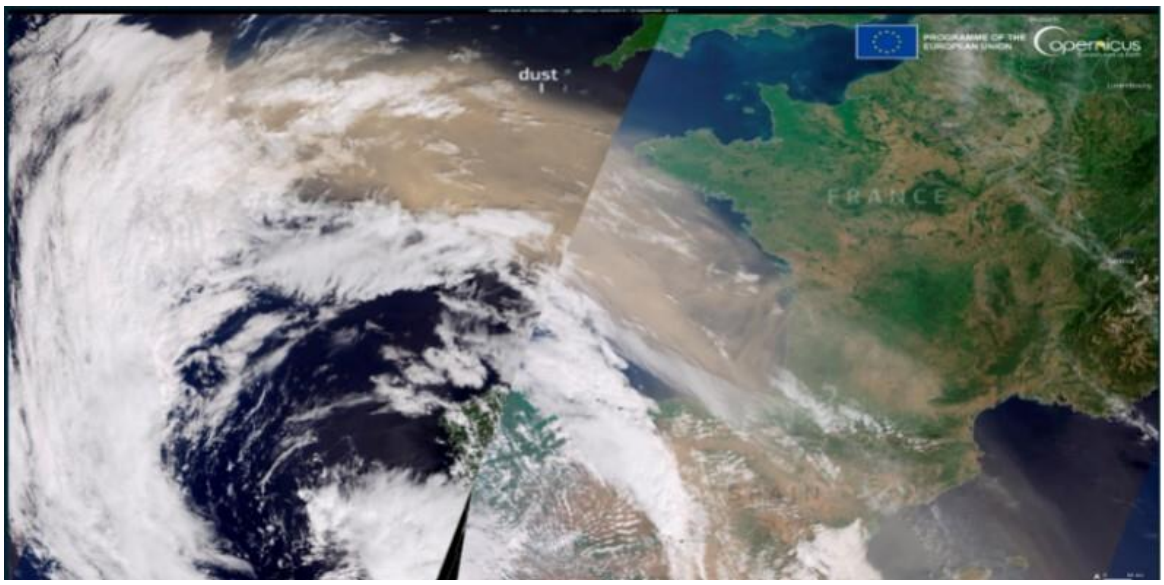


Image credit: European Union, Copernicus Sentinel-3 imagery

9. The image above shows a photograph taken from a satellite on the 4th September. It shows clouds of dust stretching from the Atlantic Ocean and over the southwest coast of England. In early September, many people across the UK noticed that there was a lot of dust settling on cars and sunsets were more red than usual. The images below show a red sunset from September and red dust that has settled on a car.

   Dust is a form of particulate matter, and this is a reason why the levels of $PM_{2.5}$ in the outdoor air rose over the period of 4th to 8th September 2023 across the UK. This happened because strong winds lifted sand and dust from the Saharan desert and carried it to the UK.

   This dust was carried in with ventilation to classrooms, increasing the levels of $PM_{2.5}$ in classrooms.

Image credit: Irishpixel (left), BBC WM (right)

Discussion

Once your pupils have recorded all of their data, facilitate a discussion using the following prompts:

- Did you expect Saharan dust to be the cause of the rise in PM?
- How else do you think that ventilation may affect the air quality in a classroom?
- Can you think of any other events that might cause the levels of pollutants to increase in your classroom?
- What kinds of events that occur outdoors might cause the levels of pollutants to increase outdoors?

Understanding SAMHE graphs

This activity involves your pupils looking at and interpreting the data from different types of SAMHE graphs of CO_2, Temperature, Humidity, and Particulate Matter, and answering a series of questions. The graphs here are similar to those in the Data Pack so this may be a good activity to complete once pupils are familiar with the Data Pack.

Level
Facilitation needed for younger learners

Estimated time
10 mins

People needed
1+

Equipment needed
Optional: Data Pack

We recommend that this activity is completed following an introduction to the SAMHE Data Pack. We anticipate younger learners will need significant teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet that contains questions only here.

Learning outcomes
On completion of this activity, pupils will understand how to interpret data as shown on a single axis scatter plot, a line plot, and a gauge plot, for different air quality measures.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils are encouraged to look at line plots, single axis scatter plots, and gauge plots, and interpret what meaning the of different colours or data points are by answering questions. This is a good activity to do after working with the SAMHE Data Pack to further pupils' learning about how to interpret data from graphs.

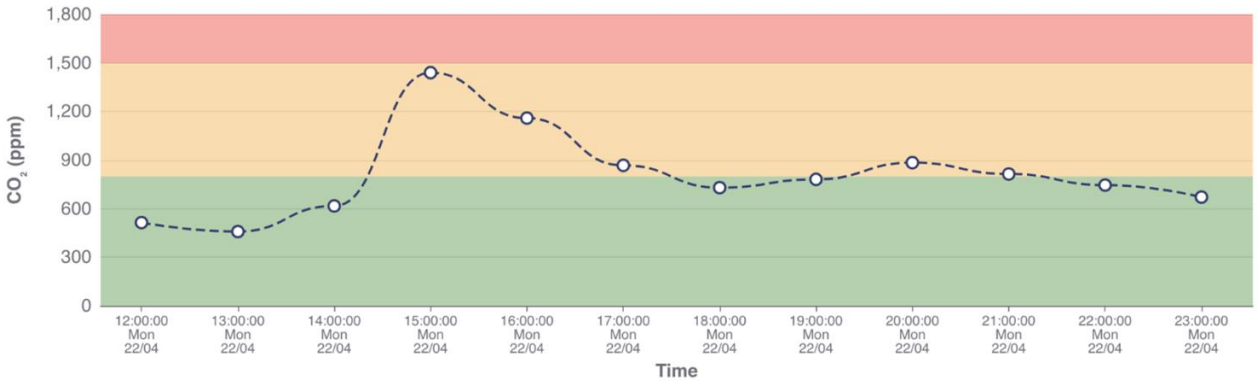
Questions and Answers

1) If you wanted to look at trends in CO_2 readings over time, which graph type would you use?

a) Line plot and single axis scatter plot
b) Single axis scatter plot and gauge plot
c) Gauge plot and line plot

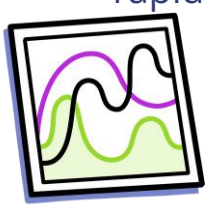
The correct answer is a), with a line plot and single axis scatter plot you can see trends in data over time. By contrast, the gauge plot is best suited for an at a glance summary of readings at one point in time.
In the Data Pack, we use the single axis scatter plot to investigate short periods of time (a day) and include line plots which show the same day's data as well as a full year.

2) Looking at this line plot, what time did the data event in CO_2 start?

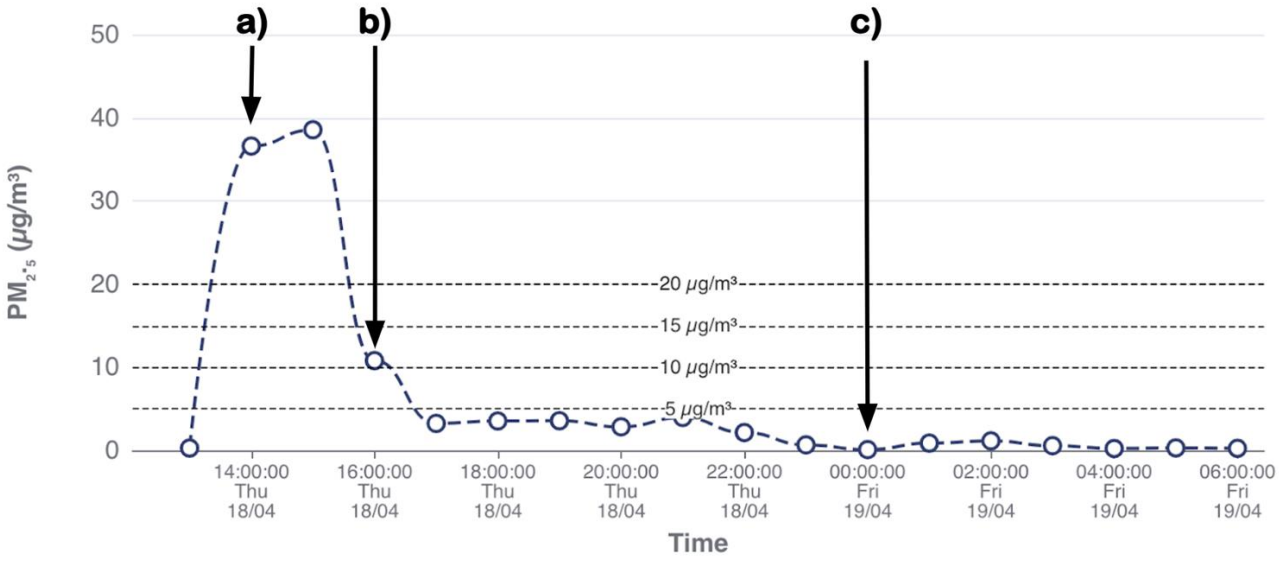


a) 12 pm
b) 2 pm
c) 5 pm

The correct answer is b), since the rise in CO_2 levels at 2pm is large and rapid we would consider this to be a data event.

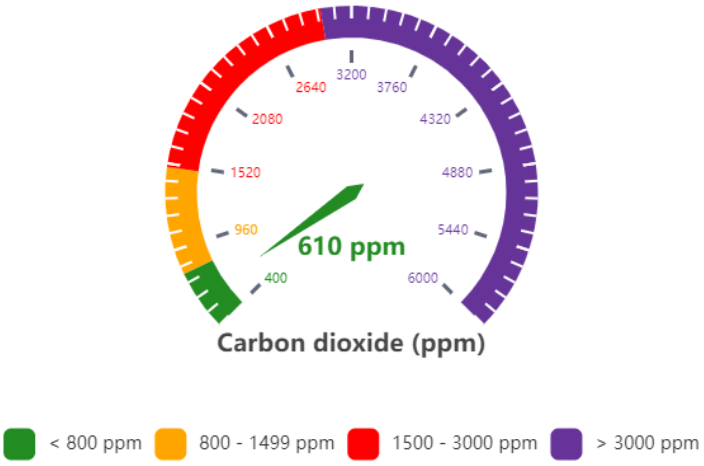


3) Looking at this line plot, which of these would we consider a data event?



The correct answer is a), we would consider the rise to point a) to be a data event as the change in $PM_{2.5}$ levels recorded is large and rapid.

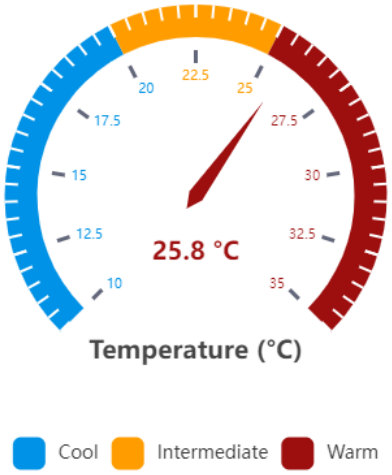
4) If CO_2 was at 1600 ppm on this gauge plot, what colour would this be and what would it mean?



a) The dial would be in green meaning that CO_2 is low
b) The dial would be in red, meaning that CO_2 is high
c) The dial would be in orange, meaning that CO_2 is okay

The correct answer is a), When CO_2 is over 1500, the gauge plot dial points to the red. Readings above this threshold are considered to be indicative of inadequate ventilation per the UK government's guidelines. See samhe.org.uk/resources/monitor-leds for more information. When there are high levels of CO_2, opening the windows or other ways of ventilation may help bring the value down.

5) If the temperature in the room was 21°C, what colour would the dial on this gauge plot be pointing to?



a) Blue
b) Orange
c) Red

The correct answer is b), At this temperature, most people would feel comfortable. Blue indicates temperatures under 20°C and red indicates temperatures over 25°C. At these temperatures, some people may feel uncomfortable in the room, but this is very personal - it's important to remember that we are all different and therefore sense and feel things differently.

6) If the relative humidity in the room was 60% what colour would the dial be pointing to on this gauge plot?

a) Green
b) Purple
c) Blue

The correct answer is b). Green indicates low humidity, and blue indicates high humidity.

Collecting data about classrooms

This activity involves your pupils' collecting data about two rooms and comparing this data to think about how the air quality and ventilation might be affected by factors such as number of windows and doors, size of the rooms, and types of subjects taught in the rooms.

Level
Facilitation needed for younger learners

Estimated time
45 mins

People needed
1+

Equipment needed
Metre ruler, calculator

We anticipate younger learners will need significant teacher input to complete this activity as it involves moving around the classroom to take measurements. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain teacher notes and directions. You can find a student worksheet in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have investigated two rooms and used mathematic skills in measuring and finding the area and volume of rooms, doors, and windows. They will use critical thinking skills to compare the rooms and develop a hypothesis about the air quality and ventilation of the rooms.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils are encouraged to gather data about 2 or more rooms by counting, measuring, and observing their environment.
For projects like SAMHE, this sort information can be used by scientists, along with monitor readings, to learn more about the ventilation rates of the rooms. By comparing the data from two rooms, pupils are encouraged to think about what this could mean for the air quality in each room.

Directions

1. Pupils should prepare a table (as shown below), or use the worksheet provided to record information throughout the activity. One column will be required for each room they'd like to compare.

Investigation questions	Room A	Room B	Notes
How many people usually use this room?			
How old are the people that use this room?			
What subjects are taught in this room?			
How many doors leaving the room are there?			
What is the total area of doors leading to outside (external doors)?			
How many windows can be opened?			
What is the total area of the windows that can be opened?			
What type of windows are in the room?			
What kind of glazing is in the room?			
How far can each window be opened?			
What is the area of the room floor?			
What is the volume of the room?			
Does the room have mechanical ventilation?			
Are there any air cleaners in the room?			

Example table

2. While they are at their desks, pupils should record the names of the rooms they are measuring, allocating a name to 'room A' and 'room B'. Next, ask the pupils to write down the number of people that usually use each room. If the number of people who use the rooms varies throughout the day, they should record the maximum number of people that would normally be in the room. Pupils should also note the range of age groups that usually use the rooms. Pupils should then choose which subjects are taught in the rooms.

The next steps involve measuring items in each room being compared or looking at their features. It may be easiest to complete all of steps 3-13 in one room before moving on to the next.

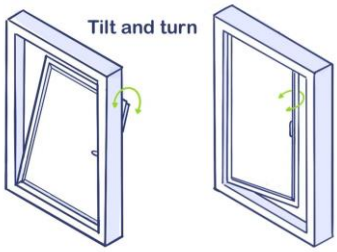
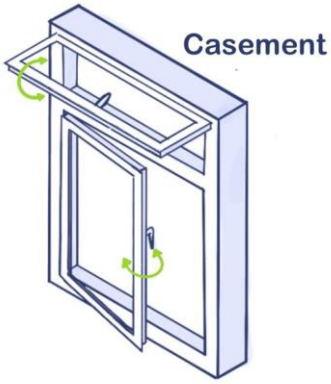
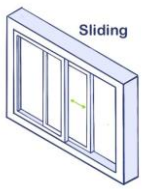
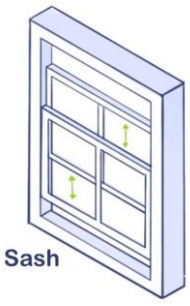
3. Now pupils should count how many doors there are in each room. Only doors that lead to corridors or to outside should be counted. Exclude internal doors e.g. doors leading to cupboards.

4. Using a metre ruler or tape measure, pupils should now measure the width and height of every external door in each of the rooms in metres. An external door is any door leaving the room. They can then calculate the area of each door by multiplying its height by its width. The area of all external doors in the same room should be added together to generate the **total** external door area for that room, using m^2 as the units.

5. Next, pupils should look around the rooms and count how many openable windows there are. Any windows which cannot be opened should be excluded.

6. Pupils should now measure the total area of the openable windows in each of the rooms in the same way as described in step 4. The total window area for each room should be noted, using m^2 as the units.

7. Next, pupils should record what type or types of windows there are in each of the rooms. Pupils can refer to the guidance on window types as given in the worksheet, or overleaf. They should record as many types as needed.

Window types	Description
	A **tilt and turn window** opens in two ways. If you turn the handle 90°, you can swing the window like a door, as can be seen in the right side of the tilt and turn window image shown. But if you turn the handle 180°, you can tilt the window, creating a small opening at the top, as shown on the left side of the tilt and turn window image shown. Tilt and turn windows always open inwards. These windows can be opened in two different ways - either tilting or turning, usually both inwards.
	**Casement windows** are windows attached to their frame by hinges. They can have a single or multiple panels. The hinges can be in different locations. If the hinges are on the side, the window opens like a door. If the hinges are on the top or bottom, the window swings open at the bottom or top. The example casement window shown in the adjacent image has two framed panels, the top panel has its hinges at the top and the bottom panel has its hinges at the side. Every window panel can be opened in one direction, hinges allow the window to swing from the side, top or bottom.
	A **skylight** is a type of window set on the roof of a building. They bring light into the room. The opening mechanism for a skylight can vary. Some skylights cannot be opened. These windows are set within a roof.
	**Sliding windows** have two framed panels that slide horizontally, opening to the side like patio doors. These windows slide horizontally.
	A **sash window** is a type of window that consists of two framed panels that slide up and down. Some have one panel that slides up and down and another one that is fixed. Each panel can have one or more glass sheets. For example, in the sash window shown in the image above, both panels can be moved and each one has two glass sheets. At least one window panel slides up and down.

8. Next, pupils should record whether the windows in the rooms are single or double-glazed. If there is a mix both of types, they can note down both. A double-glazed window has two panes of insulated glass to stop cold air from outside from coming in and hot air from inside from going out. To identify if a window is double-glazed, look at the inside edge of it: if you see two panes of glass separated by a small space, then it's a double-glazed window. If you see one pane of glass, then it's single-glazed.

9. With supervision, pupils should now check how far each window in the rooms can be opened. Can the windows be fully opened, half opened, opened a little, or not at all? Record as many options as apply.

10. Using the metre ruler or tape measure, pupils should measure the length and width of the room's floor in metres and use these measurements to calculate its area. If the rooms are complicated shapes, they may want to calculate the area for each rectangle shaped space and then add them together. The total floor area for each room should be recorded, using m^2 as the units.

11. Knowing the volume of the rooms is also helpful. Pupils should start off by finding the height of each room which can be estimated by putting a metre ruler up against the wall and guessing how many of them it would take to reach the ceiling. If there are sloping roofs, pupils can estimate the height at the highest and lowest point and note down the middle value. Once pupils have made a note of the height in metres, they should multiply this number by the area found in step 10, and write the room volume in the table, using m^3 as the units.

12. Next, pupils should note down if the rooms have mechanical ventilation, though this is unlikely in older building. Pupils can recognise if there is mechanical ventilation in the rooms if there are vents in the wall or ceiling that blow either hot or cold air into the room.

13. Finally, pupils should check if there are any air cleaners in the rooms. An air cleaner is a device that takes the air in the room and filters it to remove dust and other small particles from it. Pupils should note in the table how many air cleaners (if any) are present.

Discussion

During this activity, your pupils have collected the following data about two rooms:

- Number of people and year group.
- Number of windows that can open.
- Total floor area.
- Room volume (and height).
- Total window and door areas, types and how much they can be opened.
- Number of air cleaners.

Pupils should be encouraged to compare the data collected from the two rooms and note down any differences, and then discuss:

- Why do you think this information is important when monitoring air quality?
- Looking at the data from the two rooms, how do you think the air quality might differ between them?
- Can you think of any other information that might be important to scientists?

The information collected can help indicate the air quality in the room. For example, when we breathe, we all produce CO_2 and water vapour as we breathe out. So, the total amount of CO_2 produced in the room depends on the number of people. The amount of CO_2 each person produces is also determined by their approximate age, and how active they are at the time, as when we exercise we produce more CO_2. Therefore, more occupants in a room could mean CO_2 levels increase and older, or more active, pupils in the room would also likely mean higher CO_2 levels.

Telling us about the size of the room (the volume), and the methods to provide ventilation (e.g., windows), allows us to think about how and why the air quality may change throughout the day as larger rooms can mean that pollutant concentrations increase more slowly.

More open windows and doors should mean CO_2 levels will be lower, and mechanical ventilation, and air cleaners, with filters should mean lower particulate matter, but will not affect CO_2.

Thinking about the use of the room is helpful too, as particular subjects, such as art and DT, could mean higher VOCs.

Creative activities

These activities are designed to encourage pupils to think creatively about how to communicate their learning on air quality to others.

Write to your MP

This activity introduces pupils to a way that they can get their voice heard by writing to their MP. The steps in this activity will help pupils write persuasively to encourage their MP to take action on air quality.

Level
Facilitation needed for younger learners

Estimated time
30 mins

People needed
1+

We anticipate younger learners will need significant teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.
The following pages contain teacher notes and directions.

Learning outcomes
On completion of this activity, pupils will have consolidated their learning on air quality, developed their persuasive writing skills, and engaged in an act of citizenship by engaging with the political process in the UK.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity.
You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Directions

1. Pupils should first find out who their Member of Parliament (MP) is, and what an MP is. They should discover that their MP is someone who is elected to represent them and people in their area in Parliament. You may want to tell your pupils who their MP is, or encourage them to find out on the Government website using this address: members.parliament.uk/FindYourMP

2. Encourage pupils to do some research and think about what they would like to say to their MP about air quality. They might want to think about:
   - Whether they'd like to focus on indoor air quality, or outdoor air quality?
   - What air quality is like in your area currently? Global Action Plan have some resources to help you find out. Take a look using this address: cleanairhub.org.uk/forecasts#uk-0. You can also see the real time air quality index on waqi.info/.
   - How air pollution can impact them (You may find it helpful to explore the SAMHE Air Pollution and Health Page at samhe.org.uk/resources/air-pollution-and-health).

3. Once your pupils know what they would like to say, they can start writing. Your pupils should decide on whether they want to send their MP an email or a written letter, then start by writing: 'Dear (name of MP)'. The following pointers can then be used to guide the main body of their email or letter aiming to persuade their MP to understand their point of view:

   Personal - keep your writing friendly.

   Emotive - use words that make your MP have strong feelings.

   Rhetorical questions - to make your MP stop and think.

   Say it again - repeat your message!

   Undermine - mention different opinions to yours and say why they are wrong.

   Anecdote – add a short, funny real-life story to make your MP feel they know you.

   Direct - use the words 'you' and 'your' to make your MP feel special.

   Exaggeration – make a big deal of what you say!

Pupils may also like to ask their MP what they are doing to improve air quality, or perhaps even suggest some ideas of their own.

4. Once your pupils are happy with their letters, gather them and send to your local MP. You could encourage your pupils to tell their family and friends about the exercise and encourage them to write a letter too – the more letters your MP receives, the more likely they are to put the ideas discussed into action.

Discussion

Once your pupils have written and sent their letters, you may wish to facilitate a further discussion on what is happening in your local area about air quality, and other ways pupils can engage with politics and citizenship.

Design an air quality poster

This activity will guide your pupils in designing, creating, and sharing a poster to illustrate a key message about air quality, or something they have learnt through completing SAMHE activities or looking at the SAMHE Data Pack. It can be completed by pupils on their own, in pairs or in a group.

Level
Facilitation needed for younger learners

Estimated time
30 mins

People needed
1+

Equipment needed
Computer and/or arts and crafts materials

Before completing this activity, pupils will need to have engaged in some of the other activities in this pack (or learnt about air quality through other means) so that they have a suitable message to share. We anticipate younger learners will need some teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain teacher notes and directions.

Learning outcomes
On completion of this activity, pupils will have thought creatively about how to share an air quality message, learnt how to summarise information in a concise and attractive way, and used creative and/or technical skills to create a poster to share.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

This activity will guide your pupils to create a poster on indoor air quality. In science, posters are used to show new information to other interested people. Posters are a helpful way to summarise information in a concise and attractive way, to share the information and to start a discussion. Over the next few steps your pupils will be guided to consider the message, audience, and presentation of their poster. Posters can be completed alone, in pairs, or in groups.

We would love to see your pupils' posters and share them with the SAMHE community through our newsletter! Please upload any examples you're willing to share using our newsletter contribution form, which you can find on samhe.org.uk/news.

Directions

1. The first step in designing a poster is for your pupils to consider what they would like their poster to be about. They might want to think about the following, and discuss their ideas with others:
   - Whether learning about air quality encouraged them to think about their environment differently
   - Whether they have made any changes to how they manage classroom air quality since learning about air quality. If they have, have they noticed a difference? If they haven't yet, are there changes they would like to make? What are they and why?
   - Other factors they think are important when considering their classroom air quality and why.
   - (If they have engaged with the example SAMHE data and/or graphs) What they have learned about analysing air quality data?
2. Based on their discussion, pupils should now think about what information they want to show through their poster. They might want to show information that:
   - Helps people learn about air quality
   - Explains the main factors that affect indoor air quality
   - Explains how to improve air quality at school or in the classroom
   - Shows the SAMHE graphs, or their own graphs (these graphs could use data from your own air quality monitor or the Data Pack)

3. When creating a poster, it is also important to think about who will be looking at it, so that the message is as impactful as possible. Understanding their target audience will help your pupils tailor the message so that they can highlight what is most important to whoever they're aiming at. It is helpful to think about their audience's key values, beliefs and considerations and their level of understanding. Some options for their audience could be:
    - other pupils at your school
    - teachers
    - parents
    - politicians
    - someone else
4. Pupils should also think about how to present their message on the poster. There are lots of different ways to communicate an air quality message. Some important points your pupils might want to think about include:
    - What will your title be?
    - Would you like to include images or drawings? If so, what?
    - Will you include data or graphs of air quality? Examples you could use can be found in the Data Pack.
    - What else could you include to make your poster exciting?
5. It's now time for your pupils to create their poster! They can create their poster using pens, pencils and paper, or a computer or tablet if they prefer. They might want to think about:
    - Will the reader be able to understand your message?
    - Are the words written clearly and are the drawings neat and tidy?
    - Are the different parts of the poster organised clearly?
    - Do you want to add lots of colour to catch the viewer's eye?
6. Now that your pupils have created their posters, they can think about how to spread their message. They should consider about where their poster can be displayed in order to reach their target audience. They may want to remember:
    - Make sure it's clearly visible - to show the world their creativity!
    - Keep a copy or photograph of the poster for themselves as a record.

Clean Air Zones debate

This activity involves pupils using their knowledge about Clean Air Zones in a debate activity. They will answer questions and discuss and evaluate reasons for or against the introduction of Clean Air Zones in a fictional place - Greford City.

Level
Facilitation required for most learners

Estimated time
45 mins

People needed
2+

Equipment needed
Greford City information sheet

Pupils should complete the 'Learning about Clean Air Zones' quiz on page 39 prior to completing this activity. We anticipate that most learners will require significant teacher input to facilitate the debate. Advanced learners may require minimal teacher input.

The following pages contain teacher notes and directions. You can find the 'Greford City information sheet' in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have thought about the quality of the air outdoors which is brought into classrooms through ventilating and consider measures that can be taken to improve it. They will have used reasoning and communication skills to share this knowledge through a debate.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Information on air pollution

Air pollution is the release of pollutants into the air around us, indoors and outdoors. Pollutants are chemicals and substances that may be harmful to our health or the natural environment, and could cause damage to the land, air or water.

Outdoor air pollution in areas with busy roads tends to be caused by petrol and diesel cars, whereas in the countryside, it's more likely to be caused by farming and industry.

Nitrogen dioxide and hydrocarbons affect outdoor air quality and are emitted from car exhausts. Different levels of nitrogen dioxide can be defined using the chart shown below:

Index	1	2	3	4	5	6	7	8	9	10
Band	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Very High
µg/m³	0-67	68-134	135-200	201-267	268-334	335-400	401-467	468-534	535-600	601 or more

A 'moderate' level of nitrogen dioxide means that the general population can enjoy usual outdoor activities. Moving to a 'high' level means that the general population can start experiencing discomfort such as sore eyes, cough or sore throat, while people with underlying health conditions and elderly might be even more negatively impacted.

Table from DEFRA: uk-air.defra.gov.uk/air-pollution/daqi?view=more-info&pollutant=no2#pollutant

Information on Clean Air Zones

The Clean Air Strategy (2019) and Clean Air Zone framework (2022) are documents that give information on the government's plans to take action to improve air quality. You can find the Clean Air Strategy and Clean Air Zone framework on gov.uk.

One of the key measures to reduce emissions from transport is through creating Clean Air Zones (CAZ) in major cities. They are also sometimes called LEZ (Low Emission Zone) and ULEZ (Ultra Low Emission Zones).

In a Clean Air Zone, vehicles must meet certain standards to enter. These standards are a set of limits for harmful exhaust emissions as exhaust gases from cars contribute to air pollution, especially in urban areas such as cities. In addition to CO_2, cars also emit the following pollutants:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Nitric oxide (NO)
- Particulate Matter (PM)
- Hydrocarbons (HC)

Clean Air Zones have been introduced with specific focus on tackling NO_2 concentrations but will also help reduce exposure to other pollutants in vehicle exhausts including particulate matter.

Notes

Greford city is a fictional cathedral city that has been created for the purpose of this debate activity. Pupils should have access to the 'Greford City resource sheet' which can be found in the 'SAMHE pupil worksheets' folder and includes information such as the population, size, contextual information, areas of the city, and a map as shown below.

They should take some time at the beginning of the activity to read through the information sheet as they will need this to complete this activity.

Directions

1. As we know from the information sheet, the population of Greford in 2021 was 2,100,000. We also know that Greford city covers an area of 550 km^2. Pupils can work out the population density of the city using this information which is important as it can help explain what living conditions are like in the city. Population density is calculated by dividing the population by the area of the city. Pupils should work this out and answer the question below:

   What is the Greford city population density?
   a) 2,100,550 people per km^2
   b) 3,818 people per km^2
   c) 2,099,450 people per km^2

   The correct answer is b).

2. Pupils should be introduced to the problem that Greford is facing, as explained here:

   Monitoring of Greford's Air Quality Index has revealed that the levels of nitrogen dioxide, primarily released by petrol and diesel cars, are reaching high levels and continuing to grow. In the last six months, the levels of nitrogen dioxide have increased from an average of 280μg/m^3 to 320μg/m^3. This means nitrogen dioxide levels are still 'moderate' according to DEFRA's classification (see page 87) but getting closer to the 'high' level. To tackle this problem, the council is holding consultations with the citizens to collect their views on introducing Clean Air Zones, including a debate that your pupils will take part in as citizens!

3. As mentioned in the previous step; to tackle this problem of high nitrogen dioxide, the council is holding consultations with the citizens to collect their views on introducing Clean Air Zones. Citizens will hold a debate and consider arguments for and against introducing the Clean Air Zone and how it will impact different groups of citizens. This is the activity that your pupils will take part in. Your pupils will take the role of the citizens and will hold a debate to consider arguments for and against introducing the Clean Air Zone and how it will impact different groups of citizens.

   To do this, first separate your pupils into groups and decide if each group is for or against introducing Clean Air Zones.

   - If a group decides to introduce Clean Air Zones, they will present and defend arguments for it and produce a plan including affected areas/zones, charges and exemption rules.
   - If a group decides against introducing the Clean Air Zone, they will need to present and defend their arguments and offer an alternative solution.

4. Now that the groups have been chosen, it is time to for your pupils to start researching Clean Air Zones and preparing their arguments! To build their arguments, they may want to think about:
    - What will be the advantages and disadvantages of introducing the Clean Air Zone?
    - How different groups of citizens will be affected. Who will be advantaged or disadvantaged? They should think of different groups, such as disabled citizens, small business owners, cyclists, car owners, and people living in specific areas of the city.
    - What difficulties might they encounter in creating the Clean Air Zone?
    - Will their Clean Air Zone have any exemptions?
    - Will they introduce fees or penalties for vehicles not meeting the rules? If so, what will they be?
    - Which parts/zones of Greford city will be affected?
    - Do they want to introduce any other rules in relation to the Clean Air Zone? (i.e. times and days when rules are enforced)

    They may also wish to think about the advantages and disadvantages of the following measures which could be introduced either as alternatives or in combination with their plans:
    - Closing some roads to all vehicles (or closing the entire Clean Air Zone to vehicles)
    - Banning the most polluting vehicles
    - Introducing road pricing for all or highly polluting vehicles
    - Banning or significantly reducing parking in the zone
    - Any other measures that they think might work.

5. Before the debate starts, you may want to encourage your pupils to think about setting some guidance to ensure a fair debate. This could include:
    - Stating the facts, not just their personal opinions.
    - Respecting the other group. Good and productive debates leave space for all sides to be heard.
    - Speak, don't shout. Turning up the volume won't make pupils' arguments more convincing.
    - Not interrupting. Pupils should respect others' rights to give their opinions. Pupils should be encouraged to wait for others to finish presenting their argument before they speak.

6. Once your pupils have their arguments prepared, decide which team will present first, and a time limit. This could be anywhere from 5 - 10 minutes. Once the first team has finished, the other team should present their arguments. You should encourage your pupils to take notes of any particularly convincing arguments the other group makes.

Discussion

After the debate, encourage your pupils to think about the following questions and discuss them with their classmates:

- Did you have an opinion on Clean Air Zones before this activity, and has it changed now?
- What is the biggest challenge for introducing Clean Air Zones?
- Are there any alternatives to Clean Air Zones?
- Is there anything else you would like to learn or discuss?

They may also want to look up whether their own local council is thinking about introducing a Clean Air Zone and discuss how they think this might affect their local area.

Video activities

These activities are designed to introduce pupils to more advanced ideas around air quality through video format. Following each video pupils will be asked questions to test their understanding.

Pg #

The science of ventilation

This quiz involves pupils watching a short video on the science of ventilation and answering a few multiple-choice questions about the video. Ventilation is an important aspect of air quality, and by completing this quiz pupils will be able to understand changes to their environment that could cause changes in their air quality data.

Level
Facilitation required for younger learners

Estimated time
15 mins

People needed
1+

Equipment needed
Science of ventilation video

We anticipate younger learners will need significant teacher input to complete this activity. Older or more advanced learners may be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet that contains questions only in the SAMHE Pupil Worksheets folder.

Learning outcomes
On completion of this activity, pupils will have consolidated what they learned about air flow and convection from the video.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils should watch a short video on the 'science of ventilation' and then answer questions. The video can be found here: youtube.com/watch?v=Nn9pRUv8o_8

The video describes how convection creates air flows inside rooms. Studying how air flows in to and around the room is a way to evaluate the ventilation of a room. Since convection is one of the ways that air can be moved around inside of rooms, it directly affects ventilation.

To help when answering the questions, your pupils may like to make notes.

Questions and Answers

1) What does the set-up with the black screen and the dust let us see?

- **a) How the air moves in the room**
- b) Small bits of clouds
- c) How much CO_2 is in the room

The correct answer is a).

2) What happens when Josh puts his hand in the way?

- a) The dust flows down
- b) The dust swirls around
- **c) The dust flows up**
- d) Nothing

The correct answer is c).

3) What is convection?

- a) When something is on fire
- **b) Heat transported by airflows**
- c) Learning something new

The correct answer is b).

Video

4) What happens when the hand is replaced by a hot pan?

a) Nothing
b) The flow slows down
c) The dusts starts getting cooked
d) The flow speeds up

The correct answer is d).

5) What happens when you open a fridge because of convection?

a) Your feet might get cold
b) Nothing
c) Your feet will get wet

The correct answer is a).

6) What is the branch of science that studies air flows and convection?

a) Molecular biology
b) Fluid dynamics
c) Quantum mechanics

The correct answer is b).

Discussion

After the quiz, encourage your pupils to discuss:

- Did you learn something new?
- Did anything surprise you?
- Can you think of any ways to do this experiment in your classroom?

Video

Learning about SAMHE methods

This quiz involves pupils watching a short video and then answering questions about the academic papers published by the SAMHE team. This activity will teach pupils about the methods used for the SAMHE project, co-design, research ethics, and academic publishing.

Level
Facilitation needed for younger learners

Estimated time
15 mins

People needed
1+

Equipment needed
SAMHE methods video

We anticipate younger learners will need teacher input to understand the concepts in this activity. Older or more advanced learners should be able to complete this activity with minimal teacher input.

The following pages contain quiz questions and answers. You can find a student worksheet that contains questions in the SAMHE pupil worksheet' folder.

Learning outcomes
On completion of this activity, pupils will have been introduced to the concept of academic papers and the importance of research ethics. They will also get an overview of the SAMHE Methods Papers.

Glossary terms
There are some terms in this activity that your pupils may not be familiar with, these have been underlined within the activity. You can find descriptions for these terms in the glossary on the SAMHE website: samhe.org.uk/resources/glossary.

Notes

For this activity, pupils should watch a short video on 'SAMHE methods' and then answer questions. The video can be found here: youtube.com/watch?v=vraKJUbT_xY.

In the video, Professor Sarah West, who leads schools engagement on the SAMHE project, describes the two academic papers that have been published by the SAMHE team describing the project's methods. The video also includes information on what academic papers are, what co-design involves, and considerations around ethics in research.

To help when answering the questions, your pupils may like to make notes.

Questions and Answers

1) Which of these is the best description of academic papers?

- **a) Written articles that are published in academic journals where researchers can share their research with other researchers**
- b) University exam papers
- c) Newspaper articles that are about academic research

The correct answer is a). Academic papers are written by researchers who are experts in their field to share information about research findings. Sometimes, newspaper articles will talk about academic research, but these aren't considered to be academic papers as these usually are not written and reviewed by experts.

2) What did the 'SAMHE Methods paper' report?

- a) The names of everyone involved in the SAMHE project
- b) What was learnt from the SAMHE air quality data collected
- **c) That the SAMHE project was going to send air quality monitors to classrooms, and provide a Web App where pupils and staff can see air quality data from their monitors and enter contextual data so that SAMHE scientists can learn more about the air quality of classrooms across the UK**

The correct answer is c). The SAMHE methods paper described what the project as a whole was going to do, including how we planned to use the data we would collect through the project and how we would combine it with data from other sources. Although the names of those involved in the SAMHE project were included in the paper, this was not the main aim of the paper.

3) What did the 'SAMHE Co-design paper' report?

a) The names of everyone involved in the SAMHE project
b) How the SAMHE team worked with schools to shape the SAMHE project
c) How many schools helped co-design the SAMHE project

The correct answer is b). The co-design paper reported on the methods used to co-design the SAMHE project with schools across the UK. This included hosting Zoom sessions with pupils and teachers to get an understanding of what they wanted to see in the Web App and getting their feedback on different examples we'd produced. This process helped us to make SAMHE what it is today. Although the names of the researchers involved in the co-design process, and the number of schools involved were both included in the paper, communicating this information was not the main aim of the paper.

4) What ethics considerations did the SAMHE team need to think about?

a) How to protect animals from poor air quality
b) Whether pupils would like the colour of the SAMHE monitor
c) How to share information on air quality without worrying staff and pupils and how to protect pupils' identities

The correct answer is c). To conduct research that involves people, researchers have to submit their ideas for ethics approval. This involves explaining how you are going to make sure that your research project won't cause harm to others. You also have to explain how you will protect any information you collect that relates to people. As the SAMHE project did not work with animals, this wasn't a consideration for the team, however research that does work with animals would have the explain how the animals would not be harmed.

5) What is something that the SAMHE team learnt from the co-design process?

a) That teachers and pupils are interested in the people involved in science as well as the subject matter
b) That people aren't interested in their air quality
c) That co-design is a quick and easy method

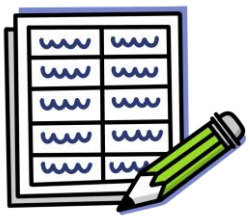
The correct answer is a). Through the co-design process, the SAMHE team discovered that teachers and pupils were also interested in the people behind the project. Because of this, we created a careers booklet and activity. You can find the activity on page 33, and the booklet on the website at samhe.org.uk/resources.

6) Can pupils read the SAMHE methods papers?

a) No, only scientists can read academic papers
b) Yes, though the language may be complex
c) No, only teachers can read academic papers

The correct answer is b). The SAMHE methods papers are open access, which means that anyone with internet access can read them. If you would like to read the papers, you can find them by visiting samhe.org.uk/resources/outputs. However, some of the language may be complicated for some pupils which is why we have created lay summaries and technical reports on our website.

Research projects



The SAMHE Data Pack is a brilliant tool to use for research projects and investigative pieces of work such as for the EPQ.

You can use the activities in this pack to develop your pupils' understanding of indoor air quality and data handling skills, enabling them to identify the areas they would like to study further. We have also provided a Data Pack containing example SAMHE data and graphs for further analysis. The SAMHE website hosts information about air pollution, air quality monitoring and health and links out to additional resources to support your pupils' projects.

You could use the quizzes in this pack to check your pupil's knowledge and understanding at the start and end of their projects, as part of evaluating their learning. In addition to their written project report, they could present their findings to school management, to inform the school's air quality/ventilation strategy, and also share their conclusions beyond the school community through the 'Write to your MP' or 'Design an air quality poster' activity.

Some examples of research projects could be:

- An investigation comparing classroom temperature and CO_2 levels
- Investigating ventilation via investigation of carbon dioxide levels in classrooms
- Comparison of air quality metrics between Winter and Summer
- Methods of improving indoor air quality in classrooms

If your pupils do use SAMHE in a research project, please mention SAMHE in your acknowledgements, and let us know via the newsletter contributions form which you can find on samhe.org.uk/news.

Keeping in touch

If you would like to hear about new ideas for using SAMHE in the classroom, inspirational stories from other schools, further research findings, and developments such as funding to continue this work, please use the contact form to sign up for our newsletter. We'd also love to hear how you are using SAMHE so that we can celebrate your work and share it with others to inspire them! If you're happy to share your story, please use our newsletter contributions form to do so. You can also find us on X with the handle @SAMHEProject.

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AirGradient supplied the SAMHE air quality monitors that were sent into schools during the project, and HDSDev supplied web development consultancy for the creation of the front-end Web App.