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OXFORD CITY COUNCIL

STOP Project

Schools Tackling Oxford's Air Pollution

Air Quality School Toolkit

Building a world-class city for everyone

Contents

Section 1: Introduction

Impact on human health is the primary reason for efforts to improve air quality in the UK. Every year thousands of people in the UK are known to die prematurely due to the effects of air pollution. Thousands more have to be admitted to hospital.

Most healthy adults are unlikely to be affected by the levels of air pollution normally found in the UK. However, some sections of society are more vulnerable to negative impacts of air pollution. Those most at risk are the young, the elderly and those who are already suffering from existing lung and heart conditions.

What is the main air pollutant in Oxford?

To find what our air quality is like, we need to measure the concentration of pollutants (harmful gases and dust) in the air. Air quality is measured by monitoring stations across Oxford, and the results can be viewed online at https://oxfordshire.air-quality.info/
In Oxford, the pollutant of most concern is nitrogen dioxide (NO_2).

Nitrogen dioxide is a harmful gas produced by burning fossil fuels. Petrol and diesel fuels used in car engines are one of the biggest sources of NO_2, so levels are highest near roads. Other sources include burning of coal and gas in power stations to produce electricity and gas boilers used for heating.

NO_2 can make it harder to breathe and can damage people's lungs if they are exposed to it for a long time. NO_2 particularly affects children, and people who already have breathing problems such as asthma.

The whole of Oxford is declared an Air Quality Management Area (AQMA) as the city fails to meet the annual mean objective for nitrogen dioxide (NO_2) of 40 $\mu g/m^3$.

What is being done by the local authorities?

In order to help tackle air pollution, the City Council have introduced the first extensive Low Emission Zone outside of London; launched the Oxfordshire Air Quality website to make historic and real time air quality data more readily accessible; increased the number of diffusion tube monitoring locations in the city by 50% from January 2015; launched Oxford Park and Pedal which has seen over 100 cycle parking spaces introduced at two of our park and ride sites; and expects to implement the worlds very first zero emission zone in the city centre, starting in 2020.

However there is still more to do in order to reduce the air pollution we all face every day and we all play a role in helping to tackle it.

What is the STOP Project and what are its aims?

The STOP project was created by Oxford City Council with the aim of raising awareness of the main sources and health effects of air pollution emissions among the school community.

The main objectives of the project are:

- **To increase awareness and understanding of air pollution issues amongst pupils, parents, teachers and school governors**
- **To empower the entire school community to adopt less polluting behaviours such as walking to school – and to encourage others to do the same**
- **To reduce car idling activities around sensitive areas**
- **To increase cycling; and the use of public transport.**

It is expected that this initiative can contribute to the behavioural change that is needed to tackle air pollution. Every day decisions can have an impact on the air we breathe and we all have a role to play and we can all be part of the solution.

Section 2: The STOP Project AQ Toolkit

This air quality toolkit provides science teachers with a series of interesting scientific activities to present to pupils, which are expected to promote understanding of the causes and impacts of air pollution, as well as tools to identify areas of poor air quality around the school.

It is expected that the use of this air quality toolkit will:

- **Provide tools to identify areas of poor air quality around your school**
- **Promote pupil understanding of the causes and impacts of air pollution**
- **Give ideas for engaging staff, pupils and parents/carers in improving air quality**
- **Help to reduce children's exposure to air pollutants, within the school and through their travel.**

This STOP Project toolkit has been adapted from:

- A similar initiative previously developed by London Sustainability Exchange for schools around London area, and supported by Transport for London, the Mayor of London and Cleaner air for London.
- Educational packages provided by Deliver Change Ltd.

It is expected that the citizen science activities presented in this toolkit will help raise awareness and assist in reducing children's exposure to air pollutants, within the school and through their travel in the city of Oxford.

What is Citizen Science?

Citizen science is a fun and interesting way of getting people involved in understanding and tackling environmental issues. By collecting scientific data we can better understand an issue like poor air quality.

How to deliver the STOP Project toolkit?

This toolkit includes a number of different science activities and experiments for your school to carry out as part of an air quality project. These can be integrated into a lesson, or completed as part of an extracurricular activity with an environment club, Green Team or Eco-committee. The full programme could be extended across a year group, or even as a whole school initiative with different classes and year groups carrying out different activities as part of a themed term or year.

Citizen Science and air quality activities can be of particular benefit to school children, because of their links to the National Curriculum. The following programme of activities

can be used together or individually to introduce issues of air pollution to children, and to better understand the causes of pollution and how to effect change.

How does the AQ Toolkit link with the National Curriculum?

This Toolkit develops key concepts and skills which are fundamental to curriculum subjects, including:

- **Science:** planning and carrying out scientific investigations; gathering, analysing and evaluating evidence; generating and testing theories; and communicating scientific information.

- **PSHE/Citizenship:** recognising that individual choices and behaviour can affect issues and political and social institutions; researching, debating, talking and writing about their own and others' viewpoints on issues that affect themselves and society; and playing an active role as citizens, making real choices, participating in decision making and leading a healthier, safer lifestyle.

- **English:** developing skills of speaking, listening, reading and writing for a purpose, investigating, planning, predicting, debating, and communicating to the wider community in the context of an issue which is real, relevant and motivating.

- **Geography:** undertaking a geographical enquiry, asking geographical questions, collecting and recording evidence, recognising how people can improve or damage the environment, explaining their views on a geographical issue, identifying opportunities for their own involvement in managing environments sustainably and communicating in ways appropriate to the task and audience.

- **ICT:** developing research skills, preparing and interpreting information using ICT, presenting information via desk-top publishing or multi-media presentations, sharing information via the internet.

Timelines

The timeline below is an example and illustrates how this toolkit can be used as part of a 12 week programme investigating air quality. This shows how it is possible to carry out the programme over the course of a single term, but some schools may find it beneficial to spread the activities over a full academic year.

This would also have the added benefit of continually reinforcing messages about air pollution and sustainable travel, encouraging more staff and parents to take up sustainable travel over time.

The City Council is happy to contribute to this activity by ordering and providing **diffusion tubes and ozone badges*** for activities B and C, as well as providing an air quality presentation for pupils at for example an Assembly related to air quality or on a day and time to be agreed with the school.

** Contribution only available for schools enrolled in the STOP Project*

Table 1: Example of possible timeline for the delivery of Oxford City Council's Primary school Air Quality toolkit

Week	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Lessons	**Teacher Preparation**	**Introduce Air Quality & Plan an Investigation**	**Investigating Air Quality**			**Analysing data**			**Action Planning**	**Taking Action**		**Evaluating Success**	
Citizen Science Activities			Diffusion tubes Put Out		Collect	Analyse Results							
			Surface Wipes										
				Ozone Badges									
					Lichen Study								
Social Marketing Activities									Badges Competition Manufacture				
									Moth pledges				
									Other activities (Plays, AQ champions, poster & story competitions, letters to MP, *etc*)				
Optional Surveys		Idling Survey										2nd Survey	
		Travel Questionnaire										2nd Survey	
Evaluation												Evaluate results	
Present problem/Findings	Assembly 1 Air Quality Officer												Assembly 2 –Findings presented by pupils

Section 3: Structure

The following section introduces a six-part procedure, recommended to be followed by teachers for the implementation of the citizen science activities available in section 4.

Part 1: Introducing Air Quality and planning an investigation

Objectives
Pupils will learn how to:

- Make predictions
- Ask scientific questions
- Plan how to answer their questions
- Decide what kind of evidence to collect
- Use large-scale maps
- Research and discuss topical issues.

National Curriculum links

- Science SC1: 1b, 2a, b,
- Geography 1a, 2c, 6a, e
- PSHE/Citizenship 1a, c, 2a, 3a,
- English Speaking and Listening 2a, b, e, 3a, b, c, d, f, 10b

Resources needed

- Air pollution Lesson Sheet (below)
- A big large-scale map of the area around the school (e.g. projector showing a Google Maps with a radius of approximately 500m around your school)
- Copies of large scale A4 maps showing the same area around the school (e.g. printouts from Google maps) – one for each group of 4-5 pupils
- Red and green sticky dots for each group
- You will need to decide in advance which of the Citizen Science methods of data-gathering you will be using in the next session and, if necessary, order the equipment (see "*Section 4: Citizen Science Activities* ", below).

Introduction

Tell the class that they will be investigating air quality. Explain what this means. Explore types of pollution, causes and health effects (*Use air **pollution sheets 1 and 2** - below for support*).

Ask pupils:

- How they think air quality might be different on a busy road and in a quiet area away from traffic

- To turn their predictions into a scientific question that can be investigated
- How they think they could find an answer to their question.

Tell them some of the ways that air quality can be measured (relating them to their suggestions) and the method they will be using in the next session.

Air Pollution Lesson Sheet

What is air pollution?

Air pollution is anything that causes the air to become contaminated with pollutants at levels harmful to our health or the environment.

What makes the air dirty?

Generally, air pollution comes from the burning of fossil fuels such as coal, oil, natural gas, petrol or diesel. This happens when we use energy supplies to do everyday activities, such as cooking or washing at home and traveling by cars.

The UK has suffered from air pollution since the beginning of the industrial revolution in the 18th century. Smoke and fog create "smog" which makes it really hard to breathe and see clearly. More than 4000 people died in London in the great London smog in 1952! Industrial processes and domestic heating were the main contributors to air pollution back then, and until the 1970s.

Air pollution today

Today, when we think about air pollution, we should think of transport, especially cars. Today there are about 23 million vehicles on the road in Britain, and 20 million of them are cars!. The fuel they use – petrol and diesel – cause bad gases to be ejected from the exhaust. These gases can be very dangerous for children.

Health Alert – how does air pollution affect you?

Air pollution is known to cause breathing problems, lung and heart diseases, such as asthma. Children are particularly at risk, as your bodies are less resilient and the pollutants have a more concentrated effect. Air pollution can:

- Affect your immune system, so that you can catch infections more easily
- Make you cough, splutter, wheeze, sneeze, dizzy and it can make your eyes itch
- Give you green snot, and more bogeys than your nostrils have space for
- Pollution can be blamed for an estimated 276 premature deaths (Age 25+) in Oxfordshire and innumerable serious health incidents requiring hospital admission each year.

What are the pollutants?

Most pollutants are much too small to see without a microscope, but they still get into our lungs and affect our health. The main nasty pollutants in the UK are NO_2 and PM:

NO_2 – Nitrogen dioxide: also contributes to acid rain, which damages trees and the stone of buildings. You can see the effect of NO_2 on a hot day in summer, when it combines with other chemicals to make the sky look heavy and brownish grey.

PM – Particulates: tiny particles of dust and soot that are released into the air. When you breathe them in, they settle in the lower parts of your lungs. There are natural sources of particulates. However, the biggest source is attributed to traffic. Lorries and diesel vehicles produce the most particulates in cities.

Everyone can help make our air cleaner!

Actions CHILDREN can take

Travel to school

- ✓ Walk, cycle or scooter to school! It is a good exercise and can reduce air pollution.
- ✓ Use public transport: take the bus, tube or train instead of the car.
- ✓ If you have to travel to school by car, try car-sharing with other friends

No Idling

- ✓ If you have to be picked up by car, tell your parents not to leave the engine on while they wait for you. This is called “idling” and it is a big cause of air pollution around schools. Turning off the engine could reduce air pollution and also save your parents money.
- ✓ You can design signs and posters to tell people “no idling” around your school.

Spread the word!

- ✓ Discuss air quality issues with your teachers, friends and family.
- ✓ Make sure everyone you know is aware of the dangers of air pollution.

Actions PARENTS & TEACHERS can take

Promote sustainable travel

- ✓ Encourage your children and their friends to walk and cycle.
- ✓ Encourage friends and family to walk and cycle or car-share.
- ✓ Reduce the amount your family uses the car.
- ✓ Discuss air quality issues with your school, friends and family.

If you <u>must</u> drive

- ✓ Fully inflate car tyres so your car uses less petrol.
- ✓ Switch the engine off while waiting for your children after school.
- ✓ Ensure that you have your vehicle serviced at regular intervals.
- ✓ Try to use your car less frequently to reduce pollution, particularly for journeys under 2km.
- ✓ Don’t start your engine until you are ready to travel. Turn the engine off if you are waiting or stuck in a traffic jam.
- ✓ Avoid rapid acceleration and heavy braking: they both increase fuel consumption and air pollution.
- ✓ Stay within the speed limit: you use 30% more fuel to travel the same distance at 70 mph instead of 50 mph.

Group activity

Ask pupils to work in groups of 4-5. (If time is limited you can do this as a class activity and miss out the feedback stage below).

Give each group a large-scale A4 map of the area around the school and some red and green stickers. Ask them to discuss in their groups where they think the air will be most polluted and why. They should mark these places on the map with a red dot.
They should then discuss where they think the air will be cleanest and mark these on the map with a green dot.

Class discussion

Ask one group to tell the class one of the places where they thought the air would be most polluted and why. Did the other groups agree? Mark this place with a red dot on a large map displayed at the front of the class. Then ask the next group to say a different place and repeat the process until all the most polluted places have been marked.

Now do the same with the least polluted places. Mark these with green dots.
As a class, choose 6-8 places near to the school for investigation during the next session. Make sure these include a range of sites e.g. busy and quiet roads, inside school grounds away from roads, next to traffic lights, at school gates, in car park (or identify sites as suggested in the instructions for the chosen method of data-gathering).

Give each site a name or number so that data can be easily referenced back to the map.

CLASS DISCUSSION

Part 2: Investigating air quality

Objectives

Pupils will learn to:

- Collect scientific evidence
- Use scientific equipment
- Carry out fieldwork investigations
- Make a labelled field sketch.

National Curriculum links

Science SC1: 1b, 2e, f
Geography 1b, 2b, 7c

Resources needed:

- Activity sheets and worksheets for your chosen method of data-gathering (see *Section 4: Citizen Science Activities"* below).

Class/group activity

- Carry out your chosen method of data-gathering as advised in the relevant Toolkit Resources.
- Ask pupils to do a labelled field sketch of the place or places where they carry out their data gathering.

Some of the data-gathering methods will need two sessions – see instructions for each method.

Part 3: Analysing the data

Objectives

Pupils will learn to:

- Draw conclusions from scientific data
- Recognise patterns
- Communicate data appropriately
- Recognise how people can improve or damage their environment
- Make informed choices
- Identify problems and suggest solutions.

National Curriculum links

Science SC1: 1b, 2h, i, j, k, l,
Geography 1c, 2e, f, g, 3e, 5a, b, 6a, e
PSHE/Citizenship 1a, c, 2a, 3a, e,
English Speaking and Listening 2a, b, e, 3a, b, c, d, f, 10c
ICT 1a, b, c

Resources needed

- Data gathered in previous session or analysis from lab (as appropriate);
- Equipment for chosen method of presenting data, e.g. plain and graph paper, computers;
- Scrap paper and pencils for group note-taking;
- Large sheet of paper.

Introduction

Present the data analysis to the class, or ask groups to present their data, depending on data-gathering method used in Part 2.

Class discussion

Discuss the results:

- What did pupils notice?
- In what kinds of places is the air most polluted?
- Did the evidence confirm or disprove their predictions?
- Did anything surprise them?
- What do they think happens when people breathe in air in the most polluted places?
- What could be done to reduce the amount of pollution in the air?
- What could they do to limit their exposure to air pollution?

The class should decide on the most appropriate way of presenting the data, e.g. displayed around their 'prediction' map, on a sketch map of the area, in a graph or spread sheet - this could then be done as a class, group or individual activity.

Group activity

In groups of 4 or 5, ask pupils to make a list of recommendations based on their findings. These could include:

- Long term (e.g. to reduce traffic, redesign engines to use less petrol, promote electric cars)
- Medium term (e.g. campaign to reduce idling outside school gates, develop a school travel plan)
- Short term (e.g. take a different route to school).

The groups should also think about who would be responsible for carrying out each of their recommendations (e.g. government, car manufacturers, the school, parents, children).

Take feedback from the groups and write up a class list of recommendations on a large sheet of paper. This should be kept for the next session.

Extensions

1) Pupils could gather more evidence before finalising their recommendations, e.g.:

   • Carry out traffic surveys
   • Survey and time engines left idling in particular places
   • Interview passers-by for their opinions on the issue of air pollution.

2) Pupils could investigate air quality on the internet, e.g.:

• compare their data to air quality information for other parts of Oxford on https://oxfordshire.air-quality.info/

• view a 4 minute video on the status of air pollution in Oxford https://www.youtube.com/watch?v=m2Uy54fmqes

Part 4: Action planning

Objectives

Pupils will learn:

- How decisions and actions can affect the quality of people's lives
- Different ways in which people can improve their environment
- How to present a persuasive argument
- To make real choices and decisions.

National Curriculum links

Geography 4g, 5a, b, 6a, e
PSHE/Citizenship 1a, c, 2a, b, 3a, e, 5a, d
English Speaking and Listening 1b, c, 2a, b, e, 3a, b, c, d, f,

Resources needed

- Class list of recommendations from previous session
- Scrap paper and pencils – one per group.

Introduction

Display the list of recommendations from the previous session and read them through together.

Group activity

Ask pupils to work in groups of 4 or 5. They should discuss the four points below and one person in each group should note down the group's decisions.

1. Decide on one recommendation that they would like to take action on.
2. Discuss what would be the best way to take action: for example:

- influence someone in a position of power (e.g. by writing a letter or inviting them into school to respond to questions);
- influence their parents or local people (e.g. by designing a leaflet, putting on a play, sharing their findings in the school newsletter);
- take action as a school (e.g. by developing a school travel plan, a campaign, a walking bus);
- inform other pupils (e.g. through an assembly presentation, designing posters, talking to them in the playground, publicising quieter walking or cycling routes).

3. Think about the most effective way to influence, inform or encourage others by:

- Deciding on the message they want to get across
- Deciding who they want to share their message with

- Thinking about what will appeal to this group of people (e.g. Should their message seem ‘cool’, fun, important, interesting …? Would this audience respond best to facts, stories, pictures …?).

4. Decide how they would know whether their action had been successful.

Class activity

- Ask each group to briefly present their ideas
- Collect in the notes made by each group. They will be needed for Part 5 and 6.

Either: Vote on which action the class would like to carry forward together.
Or: Each group could develop its own plan.

Part 5: Taking action

Objectives

Pupils will learn how to:

- Explain their views on issues that affect them and others
- Communicate in ways appropriate to the task and audience
- Take responsibility for taking action to improve their health and environment.

National Curriculum links

Science SC1: 1b, 2b, g, m
Geography 1d, e, 2a
PSHE/Citizenship 1a, c, 5a, d
English Speaking and Listening 1b, c, d, e, 10c, Writing 1a, c, e, 2a, b, c, d, e, f, 9a, b, c, 11
ICT 2a, 3a, b

Resources needed

- Notes from Part 4
- Other resources will depend on the actions and methods pupils have chosen.

Individual, group and/ or class activity:

Write the letters, design the posters or leaflets, and decide how and where to distribute or display them, plan and deliver the presentation or campaign …

Pupils could research further information to inform their actions, e.g. about air pollution and its impacts or about safe and clean air walking or cycling routes.

Part 6: Evaluating success

Objectives

Pupils will learn how to:

- Evaluate the effectiveness of their chosen actions
- Identify what they need to do next to achieve their aims.

National Curriculum links

Science SC1: 1b, c, 2g, j, k, l, m
PSHE/Citizenship 1c, 5a

Resources needed

- Notes from Part 4
- Other equipment will depend on the activities taken but may include another set of the air quality measuring equipment used in Part 2.

Class activity

After the actions have been implemented, discuss with the class:

- If they think their actions have achieved their aims
- How do they know?
- How they could find evidence that their actions worked.

Return to the suggestions the groups made in Part 4 and look at the ideas there.
The best way to evaluate success will depend on the action taken. They might include:

- Re-measuring air quality outside the school gate after a campaign against idling cars,
- Surveying modes or routes of travel to school after implementing a school travel plan, using a hands up survey
- Considering the kinds of responses they had from parents or the local community to an article or leaflet

Once they have evaluated the effectiveness of their actions they should:

- Decide how to publicise results to the target audience
- Plan the next steps

Section 4: Citizen Science Activities

Citizen Science Activities offer different methods of enabling pupils to see tangible indicators of air pollution. These vary in complexity, from activities which need no investment and little planning, to those which require more specialised equipment and span a period of weeks.
In this chapter we describe the following citizen science activities:

a) Lichen Bio-Indicator Study
b) Diffusion Tube Samples
c) Ozone Badges
d) Surface Wipe Analysis
e) Running Campaigns in School, including:

- Badge competitions
- Plays
- Assemblies
- Anti – Idling Campaigns
- Peppered moth pledge.

We recommend you use as many of these activities as time allows to reinforce learning and spark action!

The importance of citizen science is in the investigation, and in understanding the factors that contribute to your local air quality.

Once you have received the results for the particular tests you have chosen to carry out, it's time to consider how you want to best use this information in your school. The results can be analysed as closely as you feel useful to best identify sources and levels of air pollution, or can simply be used as a platform to communicate the concerns of air quality to others in your community.

Consider, for example, some of the following:

- Create a large simplified road map of the school, and mark on it the areas of high/low pollution
- Create posters to display the test results, and the impacts this may have on the health of the school community
- Upload information to global community science projects, such as the Eye on Earth network or Mapping for Change Community Maps.

a) Lichen Bio-Indicator Study

Suitable for Years: 4-6
Duration of Activity: 1 -1.5 hours (plus travel if offsite)

What is it?
Lichen monitoring is an easy way to observe the level of air pollution in your surrounding area, simply by identifying types of lichens that are present. This provides a basic idea of the extent of air pollution in your surrounding area, by identifying the presence of lichens which are sensitive to nitrogen and those which flourish in environments with high nitrogen level.

How to use it:
See the lichen identification guide and monitoring sheets for information on how to conduct your study. Lichen monitoring can be carried out as part of a lesson activity in and directly around the school or as an activity by those walking to and from school. This will help to identify levels of air pollution not just at the school site itself, but also along the primary travel routes to and from the school. As some lichens change colour in the rain, this activity is ideally carried out when the weather is dry.

Costs of activity:
This activity solely requires observation and monitoring, and should incur no additional costs. Magnifying glasses are useful tools for this activity.

Resources Included:
Lichen Identification Guide
Lichen Monitoring Sheet

The Open Air Laboratories (OPAL) network: Lichen and air survey, guide and quiz:

https://www.opalexplorenature.org/airsurvey
https://www.opalexplorenature.org/lichenquiz

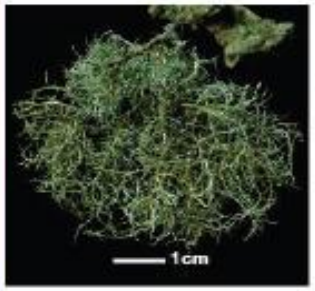
Lichen Identification Guide

Resources from OPAL https://www.opalexplorenature.org/airsurvey

The Clean Team : Nitrogen-sensitive

Nitrogen-sensitive

1. *Usnea*



- branches thread-like
- grey-green all round

Tree lichen/ beard lichen

Nitrogen-sensitive

2. *Evernia*

- lobes flattened, strap-like
- grey-green on top, white below

Oak lichen

Nitrogen-sensitive

3. *Hypogymnia*

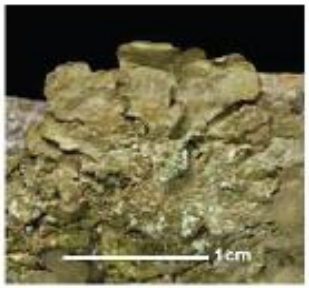
- lobes greyish on top, pale brown below
- lobe ends often become powdery
- lobes puffed up and hollow

Tube lichen

The Grow-Anywhere Gang: Intermediate

Intermediate

4. *Melanelixia*



- dull brown lobes, closely attached to the bark
- paler areas show when surface is rubbed

Intermediate

5. *Flavoparmelia*

- broad, apple-green lobes
- wrinkled surface on which powdery spots may develop

Intermediate

6. *Parmelia*

- lobes thin, loosely attached to the bark
- lobes grey on top, dark brown below
- pattern of white lines on the surface

The Pollution Gang : Nitrogen-loving

Nitrogen-loving

7. Leafy *Xanthoria*

- lobes broad and spreading
- lobes yellow/orange to greenish yellow
- orange fruiting bodies often present

We have different colours from orange to green!

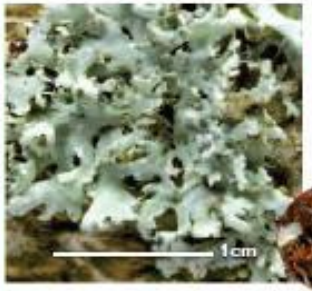
Nitrogen-loving

8. Cushion *Xanthoria*

- lobes small and clustered
- lobes yellow to green-grey
- orange fruiting bodies usually present

Nitrogen-loving

9. *Physcia*



- lobes grey on top, whitish below
- lobe ends raised up becoming powdery
- black-tipped whiskers on the lobe edges

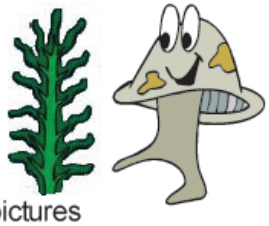
Lichen Monitoring Sheet

School: _____

Date: _____ Time: _____ Location: _____ Weather: _____

Names of champions/ participants: _____

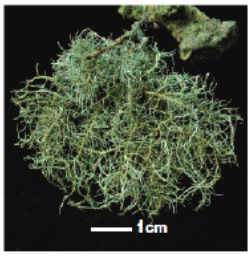
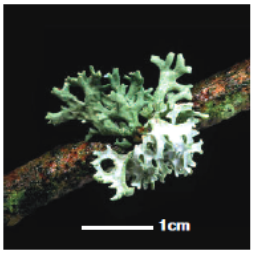
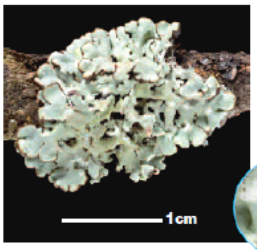
A lichen is made up of two organisms living together: a fungus and an alga. Lichens usually attach themselves to trees, but they can also be found other surfaces. So what kind of air do they like?



- Nitrogen-sensitive lichens only live in clean air
- Nitrogen-loving lichens can live in dirty air
- Some lichens are not affected by air quality and can live anywhere!

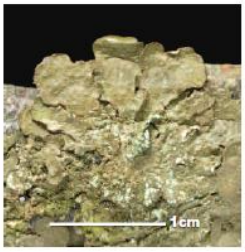
You can work out if the air is polluted by looking at the types of lichen growing. Different lichen species display different shapes and colours. These pictures and magnifying glasses will help you to identify them.

The Clean Team : Nitrogen-sensitive

Can you find these lichens?	How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
Nitrogen-sensitive **1. *Usnea***   • branches thread-like • grey-green all round	*I have other names:* *"Tree moss" and "beard moss"*	
Nitrogen-sensitive **2. *Evernia***   • lobes flattened, strap-like • grey-green on top, white below	*You can call me "oak moss"!* *I can be used to make perfumes.*	
Nitrogen-sensitive **3. *Hypogymnia***   • lobes greyish on top, pale brown below • lobe ends often become powdery • lobes puffed up and hollow 	*My nickname is "tube lichen"!*	

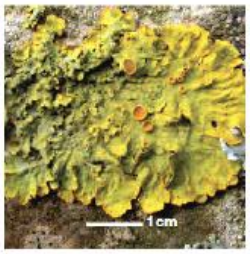
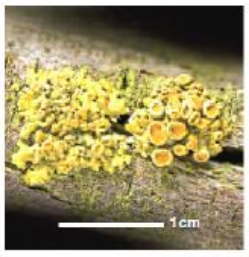
Air quality makes no difference to us.
We're happy anywhere.

The Grow-Anywhere Gang : Intermediate

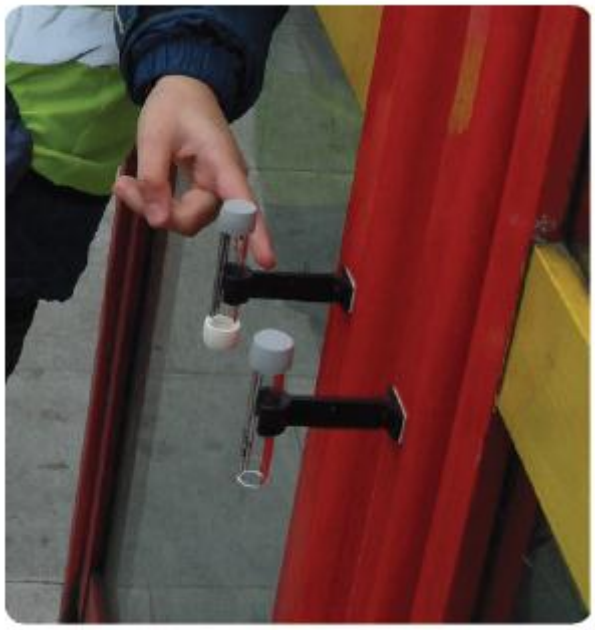
Can you find these lichens?	How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
Intermediate **4. *Melanelixia***   • dull brown lobes, closely attached to the bark • paler areas show when surface is rubbed	*Some people also call me "camouflage lichen"*	
Intermediate **5. *Flavoparmelia***   • broad, apple-green lobes • wrinkled surface on which powdery spots may develop	*I am found in woodland but becoming common in towns!*	
Intermediate **6. *Parmelia***   • lobes thin, loosely attached to the bark • lobes grey on top, dark brown below • pattern of white lines on the surface	*I am pretty hardy! Bird droppings do not kill me!*	

Lichen Monitoring Sheet p3

The Pollution Gang : Nitrogen-loving

Can you find these lichens?	How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
Nitrogen-loving **7. Leafy *Xanthoria***  • lobes broad and spreading • lobes yellow/orange to greenish yellow • orange fruiting bodies often present 	*We have different colours from orange to green!*	
Nitrogen-loving **8. Cushion *Xanthoria***  • lobes small and clustered • lobes yellow to green-grey • orange fruiting bodies usually present		
Nitrogen-loving **9. *Physcia***  • lobes grey on top, whitish below • lobe ends raised up becoming powdery • black-tipped whiskers on the lobe edges	*I am popular in big cities and major roads.*	

b) Diffusion Tube Samples



Suitable for Years: 3-6
Duration of Activity: Depends on the number of participants. A teacher and two pupils working together may take up to two hours to deploy 12 tubes across 12 different sites. After two weeks, collecting tubes may take one hour.

What is it?
Diffusion tubes are primarily used to measure the levels of harmful nitrogen dioxide in the air, by use of a specialised sampling tube. These provide an accurate measurement of levels of certain types of air pollution.

How to use it:
Tubes should be left outdoors on the school site for about two weeks. Children should follow the instructions included in the resources section on how to collect samples, which should then be returned to the supplier for analysis and report. Information can then be used to map out nitrogen dioxide levels around your school. Children will benefit from learning scientific sampling techniques, such as taking data samples along a transect, mapping and analysis of data.

Resources Included:
Diffusion Tube Factsheet
Diffusion Tube Sampling Instructions
Diffusion Tube Record Form

Please contact Oxford City Councils air quality officer* via airquality@oxford.gov.uk to inform them of when you intend to do this activity, so that diffusion tubes can be ordered.

** Activity costs are supported by OCC only for the schools that are enrolled in the STOP Project*

Diffusion Tube Factsheet

Hello, I'm Paul, the Palmes Diffusion Tube!

About me:

I measure how much of different types of gases there are in the air, but my favourite thing to do is to measure Nitrogen Dioxide (NO_2). If there is a lot of Nitrogen Dioxide in the air it usually means that the air is very polluted. A lot of this pollution is caused by cars, as Nitrogen Dioxide is one of the gases that come out of cars.

How I work:

I have a special steel mesh which is coated in a special chemical, which is hidden under my colour cap (it may be red, grey, or other colours!). When gases pass over this mesh the chemical changes slightly. This chemical change tells us how much Nitrogen Dioxide there is in the air.

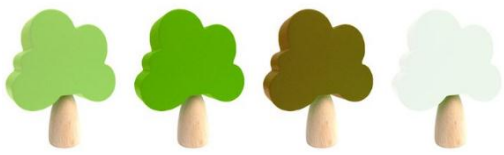
How to use me:

The first thing to do is to take off the white plastic cap at the bottom of my tube. After that I need to be left outside, with my black mount stuck to a wall, for about two weeks. I need to have my colour cap pointing towards the sky; otherwise I will fill up with water if it rains. After two weeks I will have measured the gases in the air, the lab will analyse me and tell you if the amount of Nitrogen Dioxide is safe or dangerous to your health.

Top Tips:

You need to be careful where you put me as I can't measure gases well if I'm in a windy spot

Don't put me in a doorway or hole in a wall because I won't be able to reach the air.



It's a good idea to write down what the weather is like when I'm outside because this can affect how much Nitrogen Dioxide I can reach

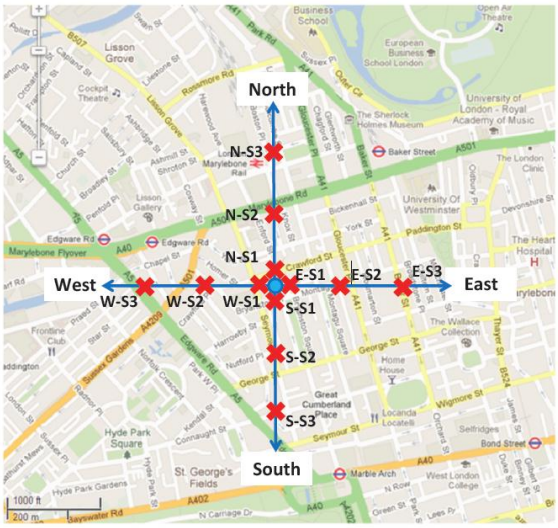
Diffusion Tube Sampling Instructions

What you will need:

- 13 Diffusion tubes (12 sampling tubes and 1 control tube)
- 13 black plastic diffusion tube mounts
- 12 “Do not disturb” signs
- 4 record forms
- Map of your school neighbourhood. The map should have your school in the middle and cover 400m toward North, South, East and West.
- Ruler
- Pencil
- Re-sealable plastic bag
- Permanent marker pen to label tubes

Where to put your tubes:

Take your map and, using your ruler, draw four lines pointing North, South, East and West. These sampling lines should cross over with your school in the middle, just like the picture below. Looking at the scale at the bottom of the map you can see these lines cover 400m on the ground.



On each of your lines draw three crosses. The first cross will be in your school building or the street next to your school. The next two crosses are 200m and 400m away from your school. These crosses show you where you will need to put your diffusion tubes.

1) On each line, number the crosses 1, 2 and 3 with number 1 closest to your school, number 2 in the middle (200 away from your school), and number 3 the furthest (400m away from your school).

2) Write your name, today's date and the name of your school at the top of your sampling sheet. Write your name and the name of your sampling line (North, South, East or West) on your plastic bag. When you collect your tubes in two/three weeks' time, you will put them into this bag.

3) Circle the name of your sampling line (North, South, East or West) at the top of your sampling record sheet.

4) Take three of your tubes and a waterproof marker pen. Write the name of your sampling line (N,S,E or W) and the tube number 1, 2 and 3 on their colour caps. These will be your "sampling tubes". On your record sheet write the six digit ID number found on each tube, in the box that has the same number as the colour lid.

5) Take your map, sampling sheet, and diffusion tubes and walk north to cross 1 on your sampling line.

6) When you get to your first site, look for a good place to put your diffusion tubes. **Remember!** Your site needs to be:

    a. Not covered by trees, bushes or other plants
    b. On an open wall

    You might be able to minimise the risk of the tubes going missing by trying to site them in locations that you know (i.e. neighbours' walls, other schools etc), or by placing them up to 3 meters high.

7) When you have picked a good place to put your tubes, measure between 2-3 meters from the ground and mark a point on the wall. This is where you will put your first diffusion tube!

The picture shows the first sampling tube and the control tube in place on the school ground.

Putting your tubes up

8) Take you tubes and put them into black plastic wall mounts. Peel the tape off the back of the mounts and stick them onto the wall.

9) Write what time it is on your sampling sheet under "time cap removed", and then remove the white plastic cap on the bottom of the sampling tube with N-1 written on it. Put the white plastic cap in your plastic bag.

10) Stick one of your signs underneath the tubes so that no one tries to move them.

11) When you have done this spend 5 minutes making some notes about the area around your sampling site in the box labelled *'Site Characteristics'*.

    a) Are you near a main road?
    b) Are there any trees nearby?
    c) Is there a crossing near your tubes?
    d) Is there a car-park nearby?
    e) Write as much as you can because this will help you work out why pollution levels might be different later on.

12) Go to your next sampling point and repeat steps 8 to 11 with your tube labelled 'N-2', making notes in the boxes for 'Sample Site 2'.

13) Move onto your third and final sampling point and repeat steps 8 to 11 with the tube labelled 'N-3', writing your notes in the boxes for 'Sample Site 3'

14) Repeat the process for the three other directions (East South and West).

15) Prepare the control tube, and put it up in the same way as the other tubes. Locate it somewhere in the school site, such as in your classroom or next to another tube in the school grounds. Do not remove either cap from the control tube.

16) Check that you've done everything correctly and give your sampling sheet and map back to your teacher. Everyone's information is very important so we need to make sure it has all been collected the same way.

Well done! You have started your pollution monitoring!!!

Collecting your tubes

17) After two weeks, go back to where you placed your tubes.

18) When you get to your first sampling site check that your open sampling tube is still there. Have they been damaged at all? Has anything in the area changed? Write down anything that you think is interesting in the box on your sampling sheet labelled 'Tube condition'.

19) Remove the open diffusion tube from where you stuck it, and put the white plastic lid back on the sampling tube, and place it back into the bag. Check the date and time and write this in the 'date and time cap replaced' box for this tube on your sampling sheet.

20) Walk along to your next sampling site and repeat steps 17 to 19.

21) Next, move to your last sampling site and repeat steps 17 to 19.

22) Repeat for each sampling line (North, South, East and West), until all tubes are collected.

23) When you get back to school, work out how many hours each of your tubes was outside for. Your teacher can help you with this. Write the number of hours the tubes at each sampling site were outside in the box 'Hours tubes outside for'.

24) Once at school, take down your sealed control tube and check that it doesn't have any cracks. If it does, make sure that you write these down in the 'Tube conditions' box on your sampling sheet. Then, put your sealed control tube into your plastic bag.

25) Make sure you check over all of your notes with your teacher and get them to check that everything is correct! We don't want any little mistakes to mess up your results!

26) Once you have collected all the tubes, and made sure all the plastic lids were correctly inserted, preventing the exposure of the tube's interior to air, you are ready to send the tubes to the lab for analysis. Please discuss this step with the Air Quality officer. He will be able to give you the address where to send the tubes to.

Congratulations! You are all finished!

Now you just have to wait to get your results back and look over them with your class.

Diffusion Tube Record Form

Name: **School:** **Date:**

North Line				
Sampling Tube N-1	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics (building/road works/traffic diversions)		Tube condition (Dirt? Insects? Fallen?) Has anything changed in the area?	
Sampling Tube N-2	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	
Sampling Tube N-3	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	

South Line				
Sampling Tube S-1	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics (building/road works/traffic diversions)		Tube condition (Dirt? Insects? Fallen?) Has anything changed in the area?	
Sampling Tube S-2	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	
Sampling Tube S-3	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	

East Line

Sampling Tube E-1	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics (building/road works/traffic diversions)		Tube condition (Dirt? Insects? Fallen?) Has anything changed in the area?	
Sampling Tube E-2	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	
Sampling Tube E-3	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	

West Line

Sampling Tube W-1	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics (building/road works/traffic diversions)		Tube condition (Dirt? Insects? Fallen?) Has anything changed in the area?	
Sampling Tube W-2	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	
Sampling Tube W-3	Six digit ID number	Date and Time cap removed	Date and Time cap replaced and tube collected	Hours Tubes outside for
	Site characteristics		Tube condition	

Control Tube	Six digit ID number	Site characteristics	Tube condition

c) Ozone Badges

Suitable for Years: 3-6
Duration of Activity: Depends on the numbers of participants and samples. It takes 10 minutes to expose one badge and 10 minutes to compare the colour and record the result.

What is it?
Ozone badges are used to easily identify concentrations of harmful Ozone in the air, and provide a near immediate result displayed through a colour change in the badge.

How to use it:
Ozone badges usually require simple removal of their seal, and exposing the badge or test strip to the air for a predetermined amount of time (usually around 10 minutes). The colour change is then compared to the control sheet, to measure the amount of ozone measured.

Please contact OCC's air quality officer* to let him know when exactly you intend to do this activity, so that the ozone badges can be ordered in time.

** Activity costs are supported by OCC only for the schools that are enrolled in the STOP Project*

Ozone Badge Activity Sheet

How does it work?

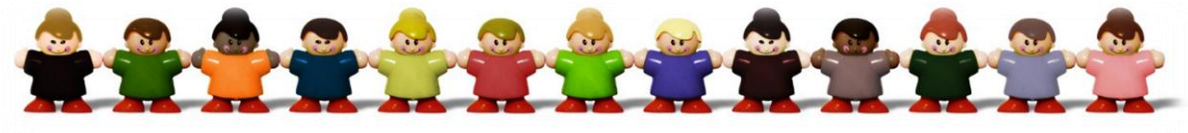
Ozone badges are very easy to use - all you need to do is remove their seal and leave them for about 10 minutes. If you watch closely you will see the badge slowly change colour, you can then compare the final colour to the control sheet to see how much Ozone there is.

How many Ozone badges do you need?

Around 10 badges should be enough for this activity. You can expose them at different locations (such as your school playground, a road and a park near the school) and/or at different date and times (such as morning, lunch time and afternoon).

How to organise your pupils:

Pupils should divide into two/three groups. Each group will spend half to one hour visiting different locations: school, roads and parks. You will need to spend about 20 minutes at each location to give 10 minutes to expose badges and 10 minutes to compare colours and record the data.



Ozone Badge Record Form

School: _____ Date:_____ Weather: _____

Group: ☐Morning ☐Noon ☐Afternoon

Participants: _____

Location 1: School			
Location Description	Exposing Time (10 minutes)	Sample Code	Result
	____:____to____:____	School –1	
	____:____to____:____	School –2	
	____:____to____:____	School –3	
	____:____to____:____	School –4	
	____:____to____:____	School –5	
Location 2: Road/ busy main street			
Location Description	Exposing Time (10 minutes)	Sample Code	Result
	____:____to____:____	Road – 1	
	____:____to____:____	Road – 2	
	____:____to____:____	Road – 3	
	____:____to____:____	Road – 4	
	____:____to____:____	Road – 5	
Location3: Park/ green area			
Location Description	Exposing Time (10 minutes)	Sample Code	Result
	____:____to____:____	Park – 1	
	____:____to____:____	Park – 2	
	____:____to____:____	Park – 3	
	____:____to____:____	Park – 4	
	____:____to____:____	Park – 5	

d) Surface Wipe Analysis

Suitable for Years: 3-6
Duration of Activity: 1 hour

What is it?
Surface wipe analysis is a cost-effective and easy way to identify levels of particulate matter, specifically in relation to their concentrations at different heights and locations.

How to use it:
Surface wipe analysis uses a piece of sticky tape or moist cotton wool ball to sample the particulate matter that is deposited on surfaces. You can use this technique to sample the deposition of particulate matter on surfaces in different locations, or at different heights. You can sample a range of surfaces using this technique including, leaves on trees, poles, walls or doors around school. Your sample provides an immediate visual indication of levels of pollution. It is also useful to explore how levels of pollution may vary depending on height and distance from roads. Greater concentrations of particulate matter at lower levels pose a greater risk to children.

Costs of activity:
Costs for this activity are minimal, requiring only cotton balls or sticky tape, to wipe surfaces.

Resources Included:
Surface Wipe Instructions
Surface Wipe Record Form

Basic info on:
www.opalexplorenature.org/sites/default/files/7/file/OPAL-SE-Roadside-Soot-Activity.pdf

Surface Wipe Instructions

What is it?

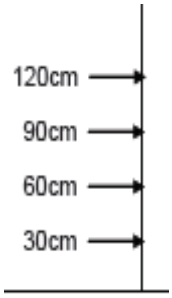
Surface wipe analysis is an easy way to measure how much particulate matter there is at different locations and different heights.

How to use it:

Surface wipe analysis uses a piece of sticky tape or a moist cotton wool ball to sample the particulate matter on surfaces. You can sample lots of surfaces using surface wipe analysis including leaves on trees, poles, walls or doors around school. Your sample will show you how much pollution there is straight away. It is also useful to explore how levels of pollution may be different at different heights and different distances from roads. If there is a lot of pollution at low heights this could be dangerous to children.

What do you need?

1) 2cm wide clear sticky tape or cotton wool balls
2) A tape measure at least 120 cm long



Sampling steps:

1) Find the surfaces you want to measure (tip: avoid wet surfaces). We suggest three different surfaces: a door inside school, a wall outside school, and a pole of street/traffic sign.

2. Use the tape measure to identify four spots at different heights: 120cm, 90cm, 60cm and 30cm.

3. For sticky tape - cut the clear tape into 10cm strips. Press the sticky side of the tape firmly onto the surface, leave for 10 seconds and then remove it. For cotton wool – dampen a cotton wool ball in a little water and wipe over a small area (about 10cm by 2cm)

4. Dirt and pollutants from the surface will have stuck to the tape or ball. Paste the tape or ball on the record sheet.

5. Repeat the steps above, and then compare the levels of pollution at different heights from the same surface.

6. Mark the pollution level from 1 to 4: 1 for the dirtiest sample and four for the cleanest sample. Could you tell if lower or higher heights are more polluted?

7. Repeat steps 1 to 6 for two other surfaces. Can you tell which surface is more polluted?

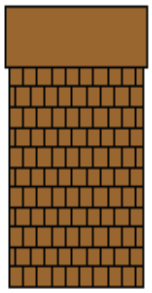
Surface Wipe Record Form

School: _____ **Date:**_____ **Weather:** _____

Participants: _____

Paste your tape or cotton wool samples below. Can you see the differences between them? Try to compare the samples and mark their levels of pollution: 1 for the dirtiest sample, 4 is the cleanest sample.

Location 1: Door inside school			
Surface details	Height	Paste your tape samples here!	Level 1 to 4
	120cm		
	90cm		
	60cm		
	30cm		

Location 2: Wall outside school			
Surface details	Height	Paste your tape samples here!	Level 1 to 4
	120cm		
	90cm		
	60cm		
	30cm		

Location 3: Pole of street/ traffic sign			
Surface details	Height	Paste your tape samples here!	Level 1 to 4
	120cm		
	90cm		
	60cm		
	30cm		

e) Running Campaigns in School

There are a number of social marketing activities, designed to increase engagement and awareness of issues surrounding air quality which have proved successful in school.

Badge competition – classes can compete to design the badges which best represent their understanding of air quality, the winner being made into a badge for Air Quality Champions to wear

Estimated Cost: £0.20-£1.00 per badge depending on size and number required.
Approximated cost for orders of 50 units. Equipment can be ordered from:

www.ecoincentives.com/
www.ecoeveryday.biz
www.simoney.co.uk

Plays - these have been successful in several schools to promote green issues and sustainable transport in an easily accessible way to all ages. This can be especially useful to engage parents and increase awareness amongst them of their children's and school's endeavours. This has also been used as a successful method for fundraising, charging a nominal admission fee to parents and the community to attend.

Assemblies – these can be delivered by a class or teachers to easily explain to the school community the efforts and activities designed to investigate and improve air quality. Some school events, such as cultural day, coffee mornings, and parents evening, are good opportunities to approach parents and raise their awareness of air quality.

Peppered Moth Pledges – the Peppered Moth is a good case study that teaches students about air quality and air pollution. Story-telling or competitions about peppered moth can be used in conjunction with School Travel Plans to commit to more sustainable forms of travel into school.

Resources Included:
Peppered Moth Activity Sheet
Peppered Moth Pledges Sheet

Electing Air Quality Champions – pupils, teachers, parents and school governors can make up an Air Quality team, who will drive forward activities designed to investigate and improve air quality around school. The pupil members of air quality team should be gender-balanced and across different classes.

Idling Surveys/Travel Questionnaires – surveys used in conjunction with School Travel Plans to investigate levels of idling cars outside of school, as well as most common methods of travel currently being used in schools.

Resources Included:
Idling Survey Instructions
Idling Survey

Case Study: Green Theatre Touring Local Schools

Wandsworth Council used theatrical performances to successfully raise awareness of green issues and promote sustainable travel across the borough. Organising a tour of the Big Wheel Theatre Company, ten schools were visited with each performance providing practical examples of how pupils can improve their local environment.

"This is a fantastic and fun way to get these important messages across. The children clearly loved every minute of it and went away thinking hard about how they can do their bit tackle climate change and pollution."

Cllr Jonathan Cook, Wandsworth Council's Environment Spokesman.

Peppered Moth Activity Sheet

Air pollution affects not only people but also plants and animals. The Peppered Moth is a good example that students can learn air quality and air pollution!

The Peppered Moth

The Peppered Moth is widespread in Britain and Ireland and is frequently found in back gardens. It is one of the best known examples of evolution by natural selection, Darwin's great discovery, and is often referred to as *'Darwin's moth'*.

The Peppered Moth and Air Pollution

Peppered Moths are normally **white** with **black** speckles across the wings, giving it its name. Originally, the peppered moths wing colours camouflaged them against the light-coloured trees and lichens that they rested on.

However, in the nineteenth century, during the Industrial Revolution in England, widespread pollution killed off lichens and blackened urban tree trunks and walls. Therefore the normal, pale, speckled forms of the Peppered Moth were no longer camouflaged from predators on the soot-blackened trees. Black Peppered Moths thrived in these situations and the normal pale form became rare. Over successive generations, the black moths came to outnumber the pale forms in our towns and cities. In the mid-twentieth century controls were introduced to reduce air pollution and as the air quality improved tree trunks became cleaner and lichen growth increased. As pollution has been greatly reduced, the balance swung back the other way.

Peppered Moth Activities

Key Message: White peppered moths indicate less pollution, better air quality
The peppered moth story: Tell students about the story, including the relationship between the moth and air quality, its evolution in UK history.
Observation: Ask pupils if they have seen moths before? Are they peppered moths? What colour are they? Encourage pupils to observe moths in school, gardens, parks, and other places they visit.
Moth competition: It can be an activity to promote sustainable travel. Get your class to draw and cut out a big black moth. Each member of the class can make an air quality pledge e.g. to walk or cycle to school, each morning the class can put a white dot on the black moth if they have done their pledge until covered in white dots. It can be competition between classes in your school, or between groups in one class.

More information about peppered moth: http://www.mothscount.org/

(Photograph by Chris Manley from http://www.amentsoc.org/about/news/0111/)

Peppered Moth Pledges Sheet

My name is ....

My pledge to improve air quality is ....

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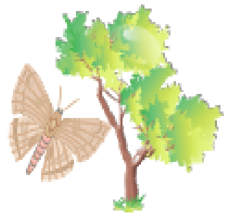

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My pledge to improve air quality is ....

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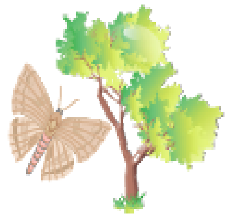

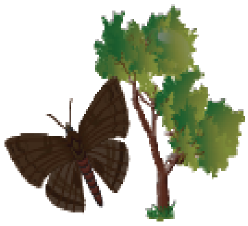

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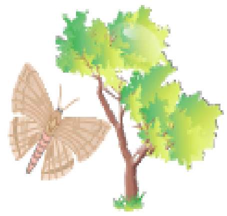

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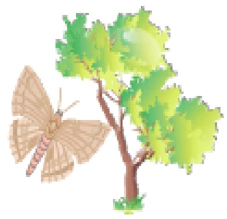

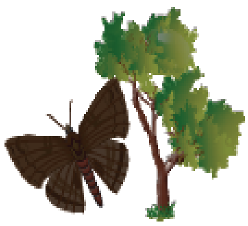

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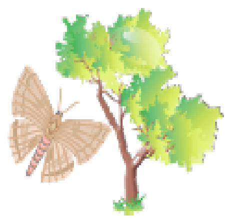

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My pledge to improve air quality is ....

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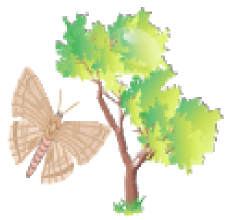


Idling Survey Instructions

Is car idling contributing to air pollution around your school?

What is idling?
When people leave their car engine running while they have stopped, this is called 'idling'. A car is 'idling' if it has been left running for over one minute after stopping or parking.

Idling can cause pollution around school when parents pick up or drop off children. Their cars cough out dirty, smelly fumes. Yuck!

How do we monitor idling?
To work out if idling is causing pollution around your school, you can count the number of parents' cars outside your school that are idling.

It's best to count parents cars idling during the busy time in the morning before school starts and again in the afternoon when school ends. For example, if your school starts at 9:00 and ends at 3:30, you should do the survey from 8:30 - 9:00am and 3:15 - 3:45pm, because parents may come earlier to drop off or wait for their children.

Choose to do your idling survey on a day when most pupils leave school around the same time. Your teacher will send you, in groups, to a location beside the road near your school where parents drop off their children.

Instructions
Fill out the form on the next page with your name, the date, and your location. You will be counting cars in two 15 minute blocks. Follow the steps below so we can compare everyone's results later on.

1) In a group of three, choose who you will be:
- Champion 1 Observer : spot and identify parents' cars
- Champion 2 Timer: time how long parents' cars are left idling
- Champion 3 Recorder : record the number of cars idling and not idling

2) What is the time? Write the time in the column 'Start Time' (e.g. 8:30am). What time should you stop counting cars? The Timer should make sure that you stop counting cars after 15 minutes.

3) The Observer looks for parents' cars that are idling and not idling and tells the Timer.

4) The Timer uses a stop watch to time if cars have been idling for at least one minute.

5) The Recorder puts one dash in the column 'Number of cars idling' every time the Observer and the Timer find an idling car, and one dash in the column 'Number of cars not idling' every time the Observer spots a parked car that is not idling.

6) At the end of 15 minutes, the Timer tells the Observer to stop counting and the Recorder writes the finish time in the column 'End Time' (e.g. 8:45 am). Add up the number of cars idling and not idling and record this in the 'total' column.

7) After a 1 minute break, you can swap jobs. Repeat steps 1-6 and record your findings in the second row.

8) When you finish counting cars for the second time, add up all the cars idling and put this number in the 'total, column on the bottom row. Add up all the cars not idling and put this number in the 'total' column on the bottom row.

9) Repeat steps 1-8 again in the afternoon.

10) At the end of the day, give your record form to your teacher. Do you think idling is a problem at your school? **If yes, what can you do about it?**

Congratulations!

You have completed your idling survey.

Idling Survey Record Form

School: _____ Date: _____ Location/ street: _____

Supervisor: _____ Observer: _____ Timer: _____ Recorder: _____

Morning AM

Session	Start time	End time	Number of cars idling	Total	Number of cars NOT idling	Total
Morning Session 1						
Morning Session 2						
Total number of			cars idling		cars not idling	

Afternoon PM

Session	Start time	End time	Number of cars idling	Total	Number of cars NOT idling	Total
Afternoon Session 1						
Afternoon Session 2						
Total number of			cars idling		cars not idling	

Section 5: Extra Activities

This Chapter of the toolkit provides several air quality activities to be adopted by teachers, in addition to the citizen science activities previously described in section 4 of this toolkit. These can be used as an extra source of material, for teachers that want to explore the importance of air quality even more, or want to replace some of the activities proposed in section 4.

The extra activities have been provided by Deliver Change Ltd, and are meant to address specifically different research areas and ages, with direct links to the national curriculums in England.

Extra Activities – Key Stage 1 (Year 1)

(SCIENCE)

Lesson 1: "Some animals need air to breathe - How long can you hold your breath for?"

Length of Lesson: 20 minutes
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Animals including humans

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pages 148 – 149

CURRICULUM

Animals, including humans.
Statutory requirements: To be able to describe and compare the structure of a variety of common animals - birds and mammals, fish, reptiles, pets.

- Commonality: breathing through our noses and mouths.

CURRICULUM

Animals, including humans.
Statutory requirements: identify, name, draw, label basic parts of the human body and say which part of the body is associated with each sense.

- Understand the mouth and nose for taking in air. Recognising that we can smell fresh and dirty air.

LESSON PLAN

This lesson is made up of a short class activity, followed by an introduction to the importance of breathing, and some questions for the class, with answers provided.

First, using a timer, time students to see how long they can last without taking a breath.

After the class has tried a few times, discuss with the class that after a while of holding our breath, we gasp, and have to breath in a really deep breath!

Class question: Why can't we hold our breath for very long?
Answer: Because our bodies always need air to keep working.

Class question: Why are our noses important?
Answer: They allow us to smell, and they also allow us to breathe in and out.

Class question: Which other part of the human body do we use to breathe air in and out?
Answer: Our mouth.

Class question: Which other animals also have a nose and a mouth?
Using pictures of a number of common animals from a book, or using the pictures provided, ask the class what each animal is, and next point out where they think their noses are. Here teachers can also ask in which food-category they lie: Herbivore, carnivore, and omnivore

LESSON OBJECTIVES

- Pupils will understand that air is something animals, including humans need in order to live.
- Learn about common animals and some of their similarities.

LESSON REQUIREMENTS:

- Timer
- Images of common animals
- Image of human nose & mouth

Can you find out where their noses and mouths are, which let them breathe?

Sources:

Horse: http://forums.elderscrollsonline.com/en/discussion/169987/this-is-a-minor-thing-butzos-please-do-something-about-horses-rear-legs
Cow:http://www.alternet.org/story/154567/holy_cow!_how_senators_and_movie_stars_use_livestock_to_game_the_tax_code
Monkey: http://www.fastcompany.com/3034115/we-asked-a-bunch-of-lawyers-who-owns-thecopyright-to-this-amazing-monkey-selfie
Snake: https://doowansnewsandevents.wordpress.com/2013/10/03/snake-medicine/
Polar bear: http://www.huffingtonpost.com/news/polar-bears/
Dog: http://www.sciencekids.co.nz/pictures/animals/dog.html
Pig: http://www.sciencekids.co.nz/pictures/animals/piglet.html
Eagle: http://www.sciencekids.co.nz/pictures/animals/baldeagle.html

Lesson 2: "The quality of the air in rural and urban areas"

(GEOGRAPHY)

Length of Lesson: 30 minutes
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Place Knowledge; Geographical Skills and Fieldwork

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pages 184 - 187

CURRICULUM

Place Knowledge.
Statutory requirements: To understand geographical similarities and differences through studying the human and physical geography of a small area of the United Kingdom, and of a small area in a contrasting non-European country.

CURRICULUM

Geographical skills and fieldwork.
Statutory requirements: Use of aerial photographs and plan perspectives to recognise landmarks and basic human and physical features.

LESSON PLAN_

Start the class by showing the class a clear plastic box, with nothing inside. Ask the class what is inside: the answer is AIR. Next write the definition of Ambient Air on the board:
Ambient Air = the outdoor air present in the surrounding environment
Explain to the class that when we are inside, and outside, there is always air around us, but that the quality of the air can change in each environment. The students are introduced to the idea that the quality of ambient air can vary between difference places, and can be clean or dirty. Add to the board:
Clean air has good gases that we need to live healthily
Dirty air has bad gases that can make us sick.

Split the class up into pairs or small groups and hand out the print out photographs provided. There are a total of 4 sets of images, two from the UK and two from India, which can be mixed and matched. Ask the class to describe the difference between the four locations (two are cities, two are villages). Get them to think of why they are different (what they can see in one image that is not present in the other) and what it would be like to live in either of these (10 minutes).

Bring the class back together and ask each pair or group to give feedback on what they have come up with. Explain to the class how in cities (London, Delhi) there is a lot of traffic and factories, a big population and therefore the air is not as clean as in the more quiet, vegetative towns with less buildings and traffic and a smaller population density. (5 min)
As an extra activity, ask the children to point on a map where the UK is, and if the class is capable, where India and North America is (2 min).

LESSON OBJECTIVES

- To understand what air is, what makes air clean and what makes it dirty.
- Compare the differences between cities (urban) and the countryside (rural). Map the location of the photographs provided.

LESSON REQUIREMENTS:

- Handout of UK and India images for pairs / groups *(attached resource).*
- Whiteboard
- Clear plastic box

Take a look at these pictures, can you tell the difference? What is causing these differences? What are they both like to live in?

Discuss with your neighbour and write down your answers.

London, UK

Delhi, India

Lake District, UK

Korta, India

Extra Activities – Key Stage 1 (Year 2)

(SCIENCE)

Lesson 3: "The Pollution Catchers"

Length of Lesson: 30 minutes (+ 45 minutes when collecting and analysing the data the following week or two)
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Animals including humans

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf Pages: 152 – 153

CURRICULUM

Animals, including humans.
Statutory requirements: find out about and describe the basic needs of animals, including humans, for survival: water, food, air.

- *Air is a one of the basic needs*

CURRICULUM

Animals, including humans.
Statutory requirements: describe the importance of human exercise, the right and different types of food, hygiene.

- *Healthy living: breathing polluted vs clean air for good health*

LESSON PLAN

Start the lesson by writing on the board, or asking the class **'What is air made of?'**

Next, explain that the air is made of many different gases, but despite this, we cannot see them. Sometimes we can feel the air moving, and we call that wind. But we still cannot see the wind; we can just see what it does! There are ways that we can see what is in the air, if we are a little patient and clever about how we look for it!

Activity: In this activity we are going to see what little bits of the air we can catch! In this exercise, students will learn that air consists of many things, even though we can't actually see it. This exercise is important for understanding why clean air is essential for good health, and through this exercise, pupils will see that air consists of very small solids, which are known at this stage as **dust**.

Aim: Before the class, prepare the activity by collecting paper plates (one for each student). These plates are called the Pollution Catchers. Use a meter of string per plate and glue one end of the string to the middle of the plate before the class. In class, ask the students to smear the side of the paper plate with string with Vaseline. In this case the vaseline side faces up, so that the plate can be hung up and hover in the air. If possible, let the students dictate where they would like their plate to be hung. Don't forget to tell the class to write their name at the bottom part of the plate (side without vaseline).

Return to the plates in one or two weeks time and ask the class whether they can see any dust. If so, it has been trapped and removed from the air. Explain to the class that dust is everywhere, but that it can be more prominent in some places.

When plates are re-visited and children can see what has collected on their Vaseline lined plates, hold a class discussion and ask the class:

- What can we see on the pollution catchers?
- Where did this come from?
- What might have caused it to get into the air?
- What does this mean for us when we breathe in the air?

NB: If your school has an AirSensa, teachers may be able to take part in the 'Additional Activity' using the AirSensa Data. Please see 'Additional Activity' provided for further information on this.

LESSON OBJECTIVES

- Students will learn that we need clean air to be healthy.
- Students will understand that dust is not clean, but it is so small that we cannot see it directly. It accumulates over time on the plates.
- Students will learn that it is best to live in places where there is not so much dust.

LESSON REQUIREMENTS:

- Paper plates (1 per student)
- Hole puncher
- String
- Vaseline

Additional Activity

In this activity, teachers can use AirSensa data to compare the amount of dust on the paper plates (inside) to the amount of dust measured in the ambient air, around the outside of the school. In this case, the school will need to have an AirSensa attached to their building.

Accessing the AirSensa data

To access the AirSensa data please add in the school specific log-in code, that is shared with the head teacher or head of faculty. If you (the teacher) have not yet received access to the log-in code and data it may be good to get in touch with them.

Once you have typed in the log-in code you will a dashboard page which contains graphs of key air pollutants as well as dust, with their level of each against a time gradient. Teachers can alter the time average by adding in the time-frame of the dust measurements in the task bar at the top of the page. The data can also be downloaded.

What to do with the Dust Data:

With the dust data collected, whether in graph format or simple numbers, see if the class can see whether there is a regular pattern of dust, for instance in the morning and evening, or over the course of the week/2 week period.

Lesson 4: "Health impacts of air pollution"

(SCIENCE)

Length of Lesson: 1.5 hours
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Animals including humans

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf Pages: 152 - 153

CURRICULUM

Animals, including humans.
Statutory requirements: find out about and describe the basic needs of animals, including humans, for survival: water, food, air.

- *Air is a one of the basic needs*

CURRICULUM

Animals, including humans.
Statutory requirements: describe the importance of human exercise, the right and different types of food, hygiene.

- *Healthy living: breathing polluted vs clean air for good health*

LESSON PLAN

As a follow up from lesson 3, ask the students about their understanding of air, and whether they know what is in air, even if we cannot see anything. The answer here is dust, and is applicable tell them that there is also pollution in the air in cities. Ask the class whether they can think of objects and activities that cause the outside air to be polluted (cars, buses, factories, heating homes, burning waste).

Tell the class that even though you cannot see what is in the air, sometimes we can feel that the air is bad.

Class discussion

Inform the class that polluted air can be a health risk; causing asthma and making people feel poorly. Ask the class whether anyone has felt their eyes water when they are outside in a very busy area with lots of traffic, or their throat feel scratchy. Another way to see whether there is pollution in the air is by blowing your nose, and seeing if there is any black bits. Once the types of health risk have been detailed, students can start their class activity.

Class activity!

Get each pupil to place a few drops of ink at the bottom centre of their page. Now ask them to take a deep breath and blow the ink across the page. The resulting pattern will resemble the branches within a human lung.

Compare the drawings with the diagram/picture of a lung. Get pupils to imagine the air outside and inside and the pollutants that we inhale as travelling down the tubes of the lung, just like their ink travelled in tubes across the page. You can also link this activity to the effects of smoking.

NB: There is an additional class activity available, using the AirSensa Data. Please see 'Additional Activity' provided for further information.

NB: If your school has an AirSensa, teachers may be able to take part in the 'Additional Activity' using the AirSensa Data. Please see 'Additional Activity' provided for further information on this.

LESSON OBJECTIVES

- Students will be introduced to 'air pollution'.
- Students will learn about some sources of air pollution.
- Students will learn that breathing air is necessary for life and that clean air is good for healthy living.
- Students will understand that breathing air pollution can affect our health, especially our lungs.

LESSON REQUIREMENTS:

- Ink
- A straw
- A3 sheets of thick paper for each pupil

Additional Activity
In this activity, teachers can use AirSensa data to compare the amount of dust on the paper plates (inside) to the amount of dust measured in the ambient air, around the outside of the school. In this case, the school will need to have an AirSensa attached to their building.

Accessing the AirSensa data
To access the AirSensa data please add in the school specific log-in code, that is shared with the head teacher or head of faculty. If you (the teacher) have not yet received access to the log-in code and data it may be good to get in touch with them.

Once you have typed in the log-in code you will a dashboard page which contains graphs of key air pollutants as well as dust, with their level of each against a time gradient. Teachers can alter the time average by adding in the time-frame of the dust measurements in the task bar at the top of the page. The data can also be downloaded.

What to do with the Dust Data:
Teachers can make simple graphs of the various air pollutants present in the air. Students will not need to understand what these pollutants are, but it may be helpful for them to see when there is more and when there is less pollution recorded outside.
With this data, teachers can express to students when it is healthier to be outside and when it is not.

Extra Activities – Key Stage 2 (Year 3 & 4)

(GEOGRAPHY)

Lesson 1: "Sources of air pollution"

Length of Lesson: 40 minutes
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Locational Knowledge; Place Knowledge; Human and Physical Geography

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pages 186 - 187

CURRICULUM

Locational Knowledge
Statutory requirements: locate the world's countries, using maps to focus on Europe and North America.

CURRICULUM

Place knowledge
Statutory requirements: understand geographical similarities and differences through the study of *human* and *physical* geography of a region of the United Kingdom, European country, & a region within North or South America.

CURRICULUM

Human and Physical Geography
Statutory requirements: describe and understand key aspects of: physical geography, including climate zones, vegetation belts, water cycle & human geography including types of settlement and land use, economic activity including trade links, distribution of natural resources.

LESSON PLAN

At the start of the lesson, split the class into pairs or small groups. Each group is given a printed copy of the resource available. Get the groups to look at both sets of photos and answer the 16 questions that follow in the spaces provided.

Once the students have all finished the questions, bring the class back together and ask each group (picking one speaker for each) to give feedback of what they have discussed and written down for one or two of the 16 questions. Make sure that each group is given enough questions to answer to the class.

Before the end of the lesson, ensure that all the bases have been covered such as population density, development, hygiene, the roles of traffic and factories in polluting our air.

The aim is to get the class thinking about air pollution and where it all comes from. In this class students will learn about what it is that we pump into the atmosphere, and that the atmosphere and the air that we breathe can be clean and polluted.

As an extra activity you can ask the students to point on a map where the UK and North America are. There is also a homework exercise that can be given to the students at the end of the class:

Homework
Ask the class to talk to their parents when they are at home and ask whether they take part in outdoor activities that pollute the air. Make a list of 4 points and draw a picture of these activities (e.g. driving a car, flying on holiday, using plastic and creating waste).

LESSON OBJECTIVES

- Introduce students to the idea of air pollution, what it is and where it comes from.
- Learn about what makes up the air we breath
- Be able to compare what it's like to live in different places and why they are different.
- Be able to point on a map the location of the pictures (Europe and North America).

LESSON REQUIREMENTS:

- KS2 resource,
- Map of the world,
- Pencils
- Exercise book and pencils for drawing

Lesson 2: "Sources of air pollution"

(SCIENCE)

Length of Lesson: 50 minutes
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Animals including humans (Year 3); Living things and their habitats (Year 4)

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pages 158 (year 3) & 161 (year 4)

CURRICULUM

Animals including humans (Year 3)
Non-Statutory requirements: Students should be introduced to the main body parts associated with the skeleton and muscles, finding out how different parts of the body have special functions.

CURRICULUM

Living things and their habitats (Year 4)
Non-Statutory requirements: human impact on environments: negative effects of population and development

LESSON PLAN

Start the class by asking the students whether they think the air outside their school is clean or a little dirty, and why. Are there parks and green spaces near by or surrounding the school for fresh air? Are there roads nearby with heavy traffic, and if so which time of day do they think there is most traffic, or do they think it is constant? Ask the class what makes outdoor air polluted, e.g. a result of population, travel, industry and development. Explain to the class that a high amount of combustion into the immediate atmosphere can cause the air to be more polluted, and that in London the amount of pollution in various parts of the city can cause people to feel unwell. These are in particular major junctions such as Brixton Junction, Marylebone Junction, Oxford Street, Clapham Junction etc.

Ask the class what type of health problems polluted air can cause: from shortness of breath, a tickle in the throat and irritated eyes, coughing and increased asthma cases and attacks, to larger problems such as lung cancers.

Next, get the materials ready for the **class activity**!

Get each student to place a few drops of ink at the bottom centre of their A3 sheet of paper. Now ask them to take a deep breath and blow the ink across the page. The resulting pattern will resemble the branches within a human lung.

Compare the drawings with anatomical diagrams of the lung, provided. Pupils should understand that we need lungs for breathing and the type of air we breathe impacts the health of our lungs. Get pupils to imagine the air with any bad polluted air travelling down the into the lung, just like their ink travelled in tubes across the page. This class can also be linked to the effects of smoking.

LESSON OBJECTIVES

- Introduce students to the idea that the type of air we breathe impacts the health of our lungs.

Students should learn which processes impact our air: positive from trees and plants, negative from types of human activities such as cars, factories, aeroplanes

LESSON REQUIREMENTS:

- Ink,
- A straw,
- A3 sheets of thick paper for each student.

KEY TERMS

- Air pollution
- Air quality
- Health risk
- Health problems
- Human development activities

Lesson 3: "Ways to travel and the impact on outdoor air"

(SCIENCE & GEOGRAPHY)

Length of Lesson: 1 hour
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Working Scientifically (Year 4); Human and physical geography (Year 4 and year 6); Animals including humans (Year 6). Key Stage - Geography, Lower Key Stage 2: Year 4 - Science & Upper Key Stage 2: Year 6 - Science

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pg 161: science Yr 4, 172: science Yr 6, 186: geography

CURRICULUM

Lower & Upper Key Stage 2 Geography: Human and physical Geography
Statutory requirements: human geography: Types of settlement and land use, economic Activity including trade links, distribution of Natural resources including energy.

CURRICULUM

Place knowledge
Year 6 Science: *Animals including humans.*
Statutory requirements: recognise the impact

CURRICULUM

Year 4 *Science: Working scientifically.* Statutory requirements
- Gathering, recording, classifying and presenting data.
- Recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables.
- Reporting on findings from enquiries, including presentations of results.

LESSON PLAN

Explain to the class that humans impact the environment through land use change. Ask the class whether they can think of ways that we have changed the natural landscape (for instance building houses, business, factories, transport routes, farming etc).

In this lesson students learn about travel and transportation. Ask which ways humans can get from place A to place B (walk, cycle, bus, train sail, fly etc). Next, ask the class what the type of transport routes are around the school - this may involve them having a look around the school and document their findings.

Ask the class to carry out a survey on how everyone usually gets to school in the morning. The survey resource is provided below. Do they walk, cycle, take the bus, use the car (do they car share?). Here the class will split into pairs and each member of the pair will ask the other member the set of questions. This should take no more than 5 in total. Have them use the data they have collected to create simple pictograms, bar graphs or pie charts to present their findings, as well as a written description. You could also have them create simple percentages.

After investigating how everyone travels to school, students will be divided into three teams where they will each discuss and write down pros and cons of one of the following:

1. Walking and cycling,

2. Taking the car, or

3. Taking public transport.

The teams should discuss themes surrounding environment and pollution, health (impact of air pollution, the need to exercise), safety and cost. The teams present their findings and there can be a vote on what they think is the best way to go to school. Teachers will have to remind the students that parents have to make the final decision on how they get to school. Students can then complete a homework exercise, discussed below.

HOMEWORK EXERCISE

Ask the students to go home and talk to their parents about and what they could do to reduce air pollution in their lives. This might include changing the way they travel to school, and have them try and think of more examples outside of this, such as reduce energy use, planting trees. Students write up their findings.

LESSON REQUIREMENTS:

- Survey per student,
- Graph paper,
- Pens & pencils,
- Rulers
- Safety outfits for going outside (if applicable)

name .....

Class Survey

How many times a week do you get to school by **car**?	How many times a week do you get to school by **bus**?	How many times a week do you get to school by **Underground or train**?	How many times a week do you get to school by **bicycle**?	How many times a week do you get to school by **foot**?
..... times a week	..... times a week	..... times a week	..... times a week	..... times a week

Do you go to school using another form of transport that is not in the survey? Please make a circle around the correct answer.

Yes / No

If your answer is ***Yes***, please write down which mode of transport below:

……

Extra Activities – Key Stage 2 (Year 5)

Lesson 4: "Everyday activities and outdoor air pollutants"

(SCIENCE)

Length of Lesson: 40 minutes
National Curriculum in England, for teaching from September 2015
Curriculum Topic: Properties and changes of materials

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425601/PRIMARY_national_curriculum.pdf pages: 170-173

CURRICULUM

Properties and changes of materials (Year 5)
Statutory requirements:
Understand how gases may be separated: filtering
Give reasons for the particular uses of everyday materials: metals, wood and plastic

LESSON PLAN

In this lesson the teacher will use the resources provided to explain to the class the gases in the atmosphere, and that the gases made from natural processes differs from the gasses that are manmade. Ask the class which materials are not natural and which ones are.

Answers should include: Natural - wood, oil, coal, some metals. Manmade: plastic, aluminum foil, glass.

Students will be given a picture of 'Sources of air pollution' caused by everyday activities, to help understand what causes manmade pollutants to be in the air from everyday use: burning wood for fire, heat and cooking food, burning plastic from rubbish, fumes to travel around. Students do not need to know the names of many pollutants, but a basic knowledge of carbon dioxide and it's over-abundance on the planet as a result of human combustion is encouraged. The teacher resource information is divided into three parts.

Briefly discuss the Great London Smog from 1952, the material of which is required. Next, ask the class whether they think air quality in London, as well as other cities if applicable, is better or worse today. Inform the class that technology has improved and there are now filter systems which trap some pollutants, but that there are now smaller pollutants formed as a result of burning everyday materials which you can hardly see and cannot be filtered, unlike the big black haze over London in 1952.
Ask the class whether they have been noticing or are aware of the climate becoming more different, such as changes in global temperature, warming of the sea, decrease of ice on the north and south pole, warmer winters, higher summer temperature. They can answer yes or no.

Class Homework: Ask the class to make a list of all the plastic things they have in their kitchen. Ask them to bring it to the next class, and write the most common plastics on the board.

OBJECTIVES

- Students learn about the natural atmospheric composition and the impact that burning everyday materials can cause an increase in air pollution.
- Understand where various pollutants come from and their impact: acid rain,
- Students consider the changing natter of air pollution from industrial sources (The Great London Smog) to traffic and other sources.

LESSON REQUIREMENTS:

- Reading piece about the London Smog of 1952 for each pupil/group
- Picture
- Whiteboard
- 4 sets of images for each pupil/group

name …….

Sources of outdoor air pollutants

Reading Task

The Great London Smog of 1952

What happened in London on the 5th of December, 1952?

A fog so thick and polluted it left thousands dead wreaked havoc on London in 1952. The Smoke-like pollution was so toxic it was even reported to have choked cows to death in the fields. It was so thick it brought road, air and rail transport to a virtual standstill. This was certainly an event to remember, but not the first smog of its kind to hit the capital.
During the day on 5th December, the fog was not especially dense and generally possessed a dry, smoky character. When nightfall came, however, the fog thickened. Visibility dropped to a few metres. The following day, the sun was too low in the sky to burn the fog away.

That night and on the Sunday and Monday nights, the fog again thickened. In many parts of London, it was impossible at night for pedestrians to find their way, even in familiar districts. In The Isle of Dogs area, the fog there was so thick people could not see their feet.

What is SMOG?

SMOG is a type of large-scale outdoor pollution. It is caused by chemical reactions between pollutants derived from different sources, primarily automobile exhaust and industrial emissions. Cities are often centres of these types of activities, and many suffer from the effects of smog, especially during the warm months of the year. SMOG can easily be remembered as the combination of **SM**oke and f**OG**.

Impacts of the smog:

Officials believe that as many as 12,000 people may have died. Many of those killed were elderly people or those who were already weak or already suffered from chronic respiratory or cardiovascular complaints.

- Many people suffered from breathing problems
- Travel was disrupted for days

Teacher Information

Part 1. Air Quality – A Global Problem

Students will learn that air pollution has been around for a long time, as a result of natural influences (volcanoes and natural forest fires) but that since the industrial revolution the amount of fumes emitted into the atmosphere has increased substantially.
Students will learn that there has been a changing nature of air pollution from industrial sources to traffic and other sources.

Part 2. Gases in the atmosphere.

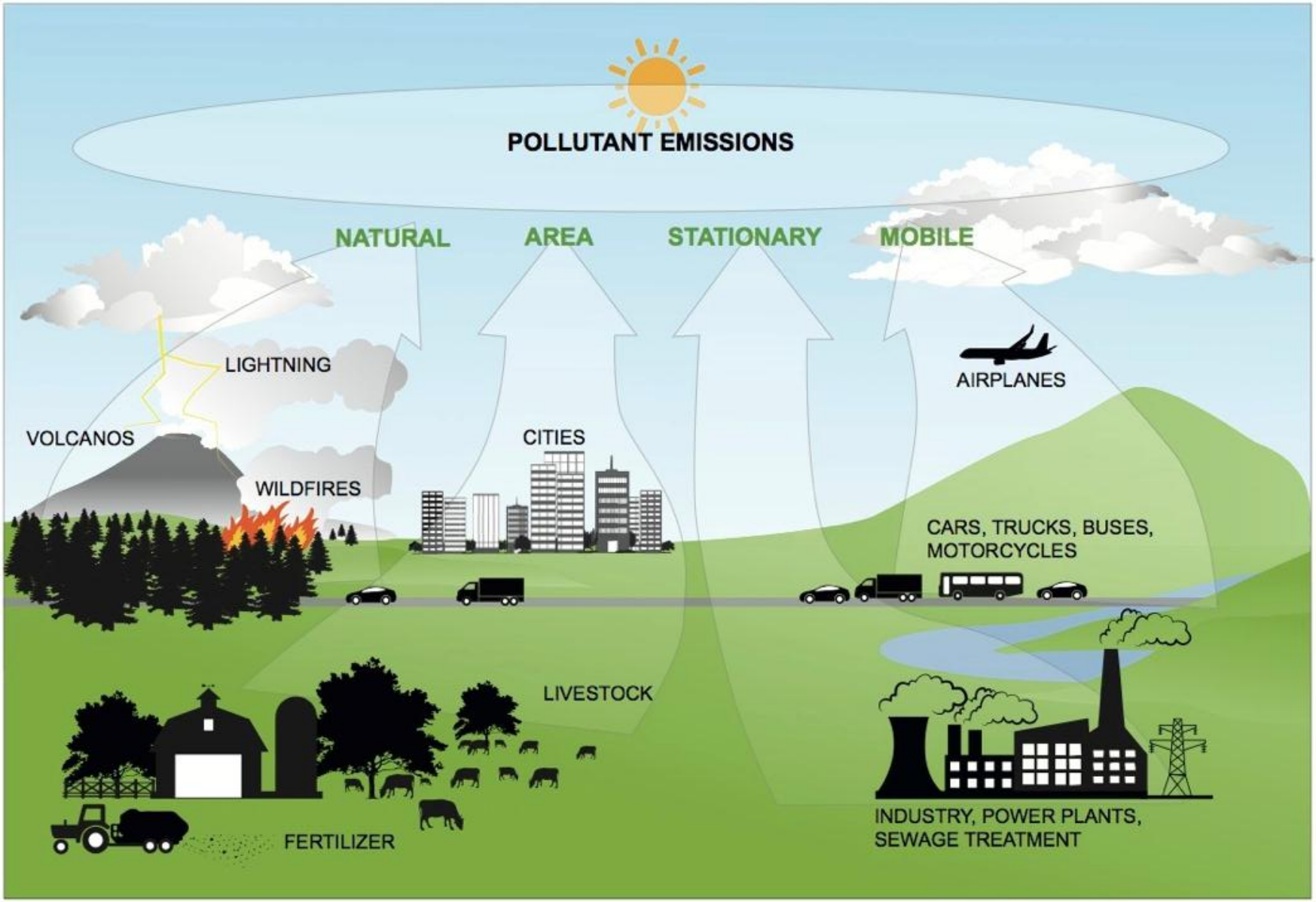
- Students are taught that before there were humans, the Earth's atmosphere was most likely formed by volcanic activity and consisted mainly of carbon dioxide and water vapour. This produced a natural atmospheric balance.
- Students are taught about how human activity has changed the composition of the atmosphere by adding small pollutants as a result of daily activities. These activities include:
    - burning waste such as plastic,
    - burning excess wood,
    - creating materials such as glass and plastic,
    - burning oil for transportation,
    - burning coal to heat the comes and produce electricity.

Part 3. What is emitted from the burning of everyday materials?

Wood
Wood is a very popular material to burn as it gives heat and is used mostly for cooking and heating the home. A lot of burning takes place inside the home, leaving air pollutants with no place to go. Carbon dioxide is the most common gas produced by burning wood. Wood is mostly made up of carbon, which during burning turns into the carbon dioxide gas.

Plastic
Home burning of waste is an activity that takes place daily all over the world. Air emissions from home burning are released directly into the house or outside.
* Please note, students are expected to complete a homework task where they make a list of the plastic in their kitchen. They should look at packaging: in the shelves, fridge and cupboards.

Oil for travel: cars, airplanes, boats, buses
The pollutants emitted from transportation makes up a large proportion of the global atmospheric change and can alter the natural amount of gases in the air.


POLLUTANT EMISSIONS
NATURAL
AREA
STATIONARY
MOBILE
LIGHTNING
VOLCANOS
WILDFIRES
CITIES
AIRPLANES
CARS, TRUCKS, BUSES,
MOTORCYCLES
LIVESTOCK
FERTILIZER
INDUSTRY, POWER PLANTS,
SEWAGE TREATMENT

Extra Activities – Key Stage 3 (Year 7 & 8)

Lesson 1: "What is air pollution and air pollution vocabulary?"

(SCIENCE, BIOLOGY, CHEMISTRY)

Length of Lesson: 1 hour 15 minutes
National Curriculum in England, for teaching from September 2015

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf Science Introduction page 58, Biology page 61, Chemistry page 62 & 64

CURRICULUM

Science
Introduction:
- Develop the use of scientific vocabulary

CURRICULUM

Biology
Interactions and Interdependencies:
- How organisms affect and are affected by the environment, including the accumulation of toxic materials.

CURRICULUM

Chemistry
Atoms, elements and compounds:
- Chemical symbols and formulae for elements and compounds
Earth and Atmosphere:
- The composition of the atmosphere.
- The production of carbon dioxide by human activity and the impact on climate.

LESSON PLAN

Part 1: Hand out the Word Search available so that students become acquainted with the vocabulary around air pollution. Students will complete the activity, which may take approximately 5 minutes.

Using the information from the Word Search activity, ask the class what hazardous pollutants are and ask if they can think of some examples and of sources of these pollutants. The hazardous air pollutants definition table is available in the handout.

Part 2: Ask the students to take a look at the table called 'The Pollutants: their origins and effects'. Next, divide the class into groups (to form five groups in total) and ask each group to create a small poster about one of the pollutants, and its sources and effects. Have them use the information in the table as a basis, and if possible, see if they can conduct any further research. In this case students will need to access the web.
Finally, have them present their poster to the rest of the class.

Bring pupils to the mindset that we can often be unaware of how our activities and behaviours contribute to global air pollution. Discuss ways in which air pollution may be reduced through personal behavioural change.

LEARNING OBJECTIVES

- Understand the terminology around air pollution.
- Stimulate further discussion about air pollution at a local and global level.

LESSON REQUIREMENTS:

- Air Pollution Word Search Handouts,
- Pollutant table handouts,
- Poster paper (max. 6),
- Pencils,
- Erasers
- Web access, if applicable.

PART 1 name.....

Word Search!

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

Key

AMBIENT AIR
CLEAN AIR
LEAD
NITROGEN OXIDES
LUNGS
VOCS
PHOTOCHEMICAL PROCESS
COMBUSTION
CARBON MONOXIDE
OXYGEN
ASBESTOS
CONTAMINANT
THERMAL INVERSION
OZONE
METHYLENE
ASTHMA
NATURAL SOURCES
MERCURY
BENZENE
PARTICULATE MATTER

Hazardous Air Pollutants: Definition

Hazardous Air Pollutants are chemicals that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.

Examples	Sources
Particulate Matter, Ground Level Ozone, Carbon Monoxide, Oxides of Nitrogen (NOx), Oxides of Sculpture (SOx) and Lead	These are generally found in higher concentrations in the air. They are emitted from the use of gasoline run vehicles; coal fired power plants, use of fossil fuel in home and industries to meet energy demand.
Hydrocarbons (e.g. benzene, toluene and xylenes,) and other toxic organic pollutants (e.g. polycyclic aromatic hydrocarbons (PAHs), pesticide and polychlorinated biphenyls (PCBs).	They are generally found in very small amounts in the atmosphere. They are also emitted from vehicles, chemical industries paintings, pesticides.

Part 2. The Pollutants: their origins and effects

Pollutant	Sources	Effects on humans	Other effects	Comments
Particulate matter	- Motor vehicle exhaust - Construction - Agriculture and mining - Industrial plants and burning of coal for power Natural sources: wind-blown dust, forest fires, volcanoes	- Irritates nose and throat and reduces lung function - Lowers resistance to respiratory infection can worsen our lungs and heart - Increases the likelihood of lung diseases and cancers	- Reduces visibility - Discolours statues, buildings, - painted surfaces Corrodes metal - May damage crops - May alter climate	75% of their presence in the air comes from the emissions of motor vehicles
Carbon monoxide	- Vehicles emissions and power plants - Burning of wood - Natural source: forest fires	- Reduces ability to perform tasks - Most serious for those with heart illnesses	At high concentrations, toxic to animals	Colourless gas 85% of carbon monoxide comes from vehicles
Ozone	- Formed when other pollutants react in the sun - Natural source (of pre-cursors): plants	- Chest pains, coughing, wheezing, shortness of breath, nausea - Irritates respiratory system - Can worsen existing lung & heart diseases, allergies, asthma	- Deteriorates some building materials - Damages fruits and seeds - Affects whole ecosystems by altering wildlife habitat	- 50% of ozone created comes from motor vehicles - What time of year would we see most ozone? (think about when in the year there is most sunlight)
Nitrogen dioxide	- Combustion of fossil fuels in motor vehicles and at power plants and industries - Natural source: lighting	- Irritation of the lungs, especially in people with asthma - Effects of short-term exposure still unclear - Damages eggs of fish	- Reduces visibility - Can form acid rain Deteriorates statues & buildings - Damages natural vegetation & crop plants	- Almost 50% of nitrogen dioxide created comes from motor vehicles - Can create ozone (another pollutant)

Sulphur dioxide	- Coal and oil-burning power plants/ industries - Oil refineries - Natural source: volcanoes	- Can affect breathing - Reduces the lung's ability to defend against disease - Can cause asthma attacks	Can form acid rain Deteriorates statues & buildings	

Lesson 2: "Global use of resources: The Air Pollution Edition"

(SCIENCE, BIOLOGY, CHEMISTRY)

Length of Lesson: 1 hour 15 minutes
National Curriculum in England, for teaching from September 2015

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf Chemistry page 63 & 64, Physics page 64, Geography page 92

CURRICULUM

Chemistry
Earth and Atmosphere:
- Earth as a source of limited resources and the efficacy of recycling
- The composition of the atmosphere
- The production of carbon dioxide by human activity and the impact on climate.

CURRICULUM

Physics
Energy
- Fuels and energy resources

Energy changes and transfers
- Other processes that involve energy transfer: burning fuels..

CURRICULUM

Geography
Human and Physical Geography:
Understand how human and physical processes interact to influence, and change landscapes, environments and the climate; and how human activity relies on effective functioning of natural systems.

LESSON PLAN

Part 1. Start the lesson by describing how fossil fuels were formed and what such fuels may be (see teacher handout). Next, ask the class what they think coal, oil and natural gas are used for around the world. This section focuses on how humans are using fossils on global uses, including Europe, America, Asia and Africa.

Part 2: Here, students will learn about pollution in the atmosphere. To help students understand this, they can watch a video about the increasing production of air pollution, the product of burning fuels. The class is then asked to answer three questions about what they learnt in the video.

Students can take a look at the images provided to help them understand the formation of air pollution, its sources, transport, transformation, deposition and effects.

This is followed by asking the class a number of questions. Please write the four questions on the board or use power point slide:

1. What is your understanding of Air Pollution and of Air Quality?
2. Do you think the quality of air in your area is good or bad?
3. How do you know? What evidence is there to prove there is air pollution?
4. *Why do we need to talk about air quality?*

Guide the students to identify the importance of clean air. Explain that bad air can contribute to a variety of illnesses such as asthma and cancer.

Part 3: Depending on how much time there is, students can complete this task in class or at home as homework. Here students are asked to make a list of the pollutants they know, and to learn about the difference between primary and secondary pollutants.

LEARNING OBJECTIVES

- Students will know that fossil fuels are non-renewable sources of energy
- Students are introduced to the natural and human sources of air pollution
- Students will learn about the problem of air pollution and which pollutants to look out for.

LESSON REQUIREMENTS:

- White board
- Note book and pens
- Access to video weblink,
- Access to images: fossil fuels & pollution

Part 1

Teacher Hand-out and Notes

1. Fossil Fuels

Fossil Fuels are made of organisms. That means things that are alive, like plants and animals. But fossil fuels were formed in the past over millions of years.

The fuels might be:

- Coal
- Oil
- (Natural) Gas
- Natural gas forms from the plants, animals, and microorganisms that lived millions of years ago
- Natural gas deposits are often found near oil deposits.

All three are found under the Earth's outer layer called the crust. Please see the images below for more information.

Humans gather the fossil fuels by digging them out of the ground and then use them for energy.

The problem with using fossil fuels is that they will run out! Because of this reason they are called **non-renewable** sources of energy. When they are gone, they are gone forever.

For this reason, it is very important for us to **recycle** a lot of the products that these non-renewable energy sources can transform into.

Ask the class:

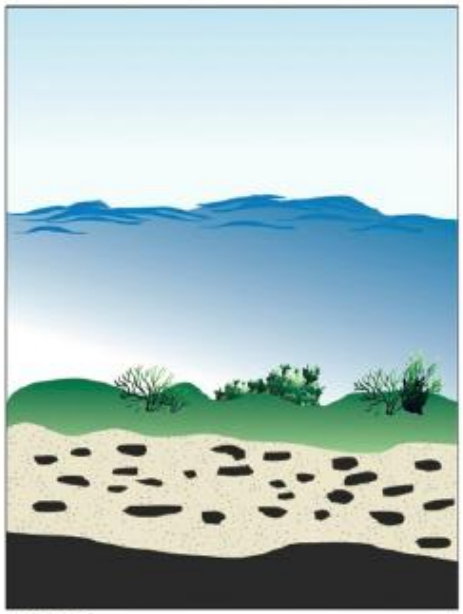
Which products are recycled in your household, and which products does the school recycle?

Do you think that we recycle enough?

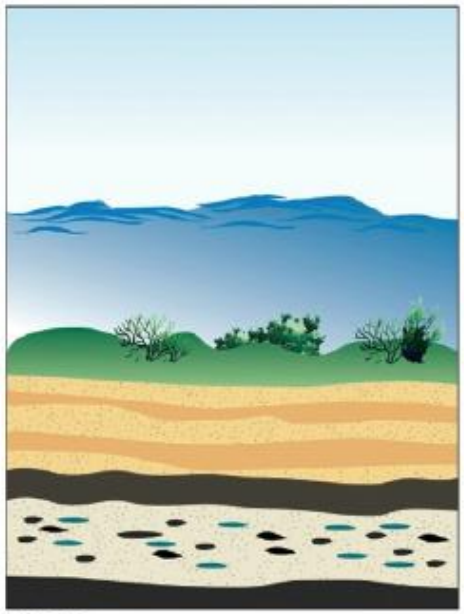
Which products do you think are especially important to recycle?

Name .....

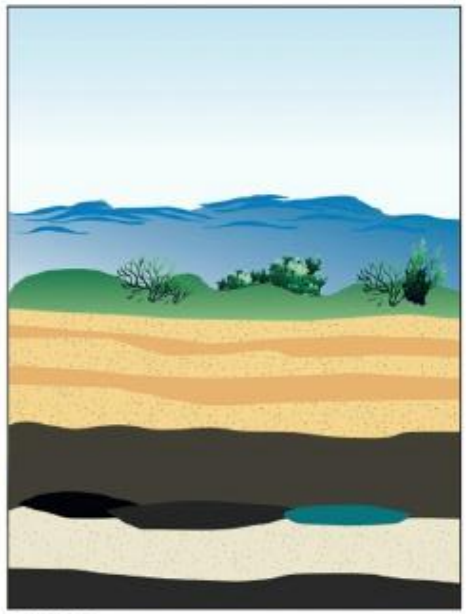
The Formation of Fossil Fuels



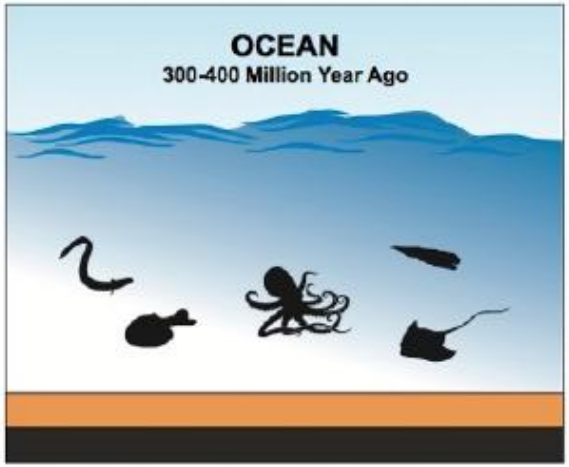
PART 1



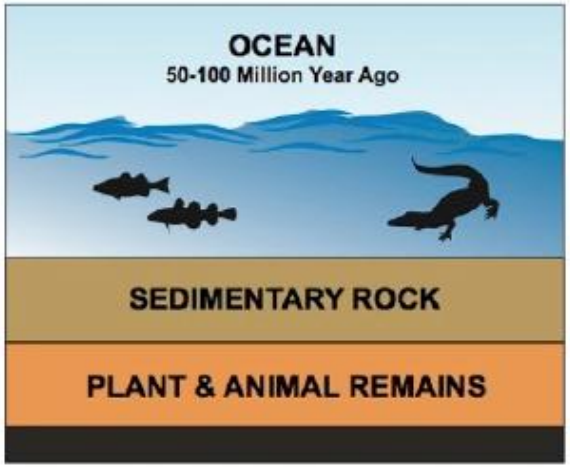
PART 2



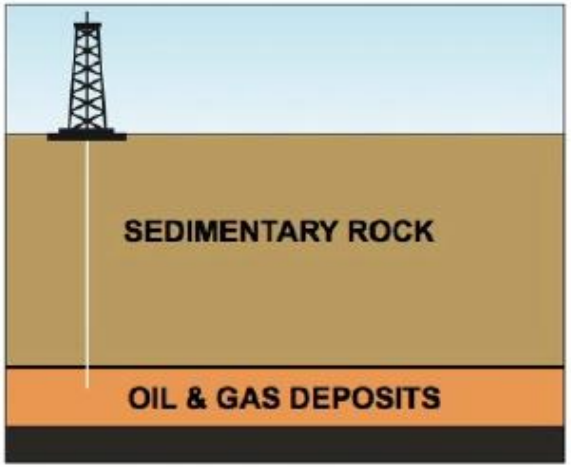
PART 3



Tiny sea plant and animals died and were buried on the ocean floor. Over time, they were covered by layers of sand and sediment, which turned into sedimentary rock.



Over millions of years, the remains were buried deeper and deeper. The emormous heat and pressure from inside the earth and the rock above turned them into oil and gas.



Today, we drill down thousands of feet through layers of sand and sedimentary rock to reach the rock formations that contain oil and gas deposits.

Please read the following descriptions of non-renewable energy, and answer the following questions for each box:

1. What type of products can be created from each fossil fuel?
2. Of these products, which do you and your family use on a day to day scale?
3. On a global scale, how much of each fossil fuel do we use?
4. When do you think the global availability of each fossil fuel will run out?

Oil

Oil, or Petroleum is used to create products, including: transportation fuels and fuel oils for heating and generating electricity, asphalt and road oil. Petroleum is also used as feedstocks, which is used to make chemicals, plastics, and synthetic materials. Think about how much plastic we use, meaning that this feedstock is found in nearly everything we use today.
Other, more unexpected, uses include the creation of soap panels, aspirin and chewing gum as well as lipstick!
About 74% of the 6.89 billion barrels of petroleum that we used in 2013 were gasoline, heating oil/diesel fuel, and jet fuel.
For more information on this please see link: http://www.livescience.com/24752-surprising-oil-uses.html.

Natural Gas

Today, natural gas is used in countless ways for industrial, commercial, residential, and transportation purposes.
In residential homes, the most popular use for natural gas is heating and cooking. It is used to power home appliances such as stoves, air conditioners, space heaters, outdoor lights, garage heaters, and clothes dryers.

Natural gas is also used on a larger scale. In commercial settings, such as restaurants and shopping malls, it is an extremely efficient and economical way to power water heaters, space heaters, dryers, and stoves.
Natural gas is used to heat, cool, and cook in industrial settings, as well. However, it is also used in a variety of processes such as waste treatment, food processing, and refining metals, stone, clay, and petroleum.
Natural gas can also be used as an alternative fuel for cars, buses, trucks, and other vehicles. Currently, there are more than 5 million natural gas vehicles (NGV) worldwide.
Source : http://education.nationalgeographic.co.uk/encyclopedia/natural-gas/

Coal

Coal has many important uses worldwide. The most significant uses of coal are in electricity generation, steel production, cement manufacturing and as a liquid fuel. Around 6.6 billion tonnes of hard coal and 1 billion tonnes of brown coal are used each year.

Since 2000, global coal consumption has grown faster than any other fuel. The five largest coal users - China, USA, India, Russia and Japan - account for 76% of total global coal use.

Different types of coal have different uses. Steam coal - also known as thermal coal - is mainly used in power generation. Coking coal - also known as metallurgical coal - is mainly used in steel production.

The biggest market for coal is Asia, which currently accounts for over 67% of global coal consumption; although China is responsible for a significant proportion of this. Many countries do not have natural energy resources sufficient to cover their energy needs, and therefore need to import energy to help meet their requirements. Japan, Chinese Taipei and Korea, for example, import significant quantities of steam coal for electricity generation and coking coal for steel production.

Other important users of coal include alumina refineries, paper manufacturers, and the chemical and pharmaceutical industries. Several chemical products can be produced from the by-products of coal. Refined coal tar is used in the manufacture of chemicals, such as creosote oil, naphthalene, phenol, and benzene. Ammonia gas recovered from coke ovens is used to manufacture ammonia salts, nitric acid and agricultural fertilisers. Thousands of different products have coal or coal by-products as components: soap, aspirins, solvents, dyes, plastics and fibres, such as rayon and nylon.
Source: http://www.worldcoal.org/coal/uses-of-coal/

Part 2

Fossil Fuel burning and the formation of Air Pollution

Another problem with using fossil fuels is that when they are burned they release pollutants into the air. These tiny bits of fuel are so small that humans cannot see them, but in some places we can see where lots of tiny bits have grouped together. Like the black soot on some buildings in the city, or the smog hanging over the city. This pollution can also cause problems for people who already have difficulties breathing, like those who have asthma.

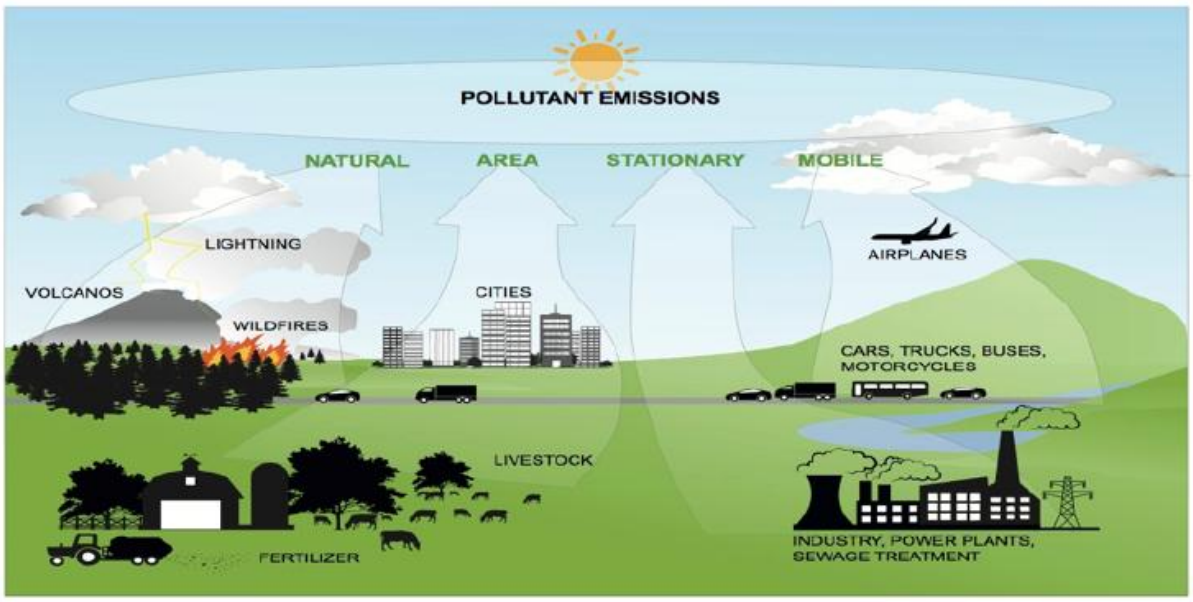
Has air pollution been persistent?

Air pollution has largely increased in the Earth's atmosphere due to human activity. We call these pollutants anthropogenic, meaning they are caused by man-made sources or activity.

However, the Earth has been around for far longer than human beings and long before we were here nature was pretty good at managing pollutants that were emitted from natural sources.

Nature was able to move particulate matter (the dust and dirt solids that pollute the air) through wind based dispersal and the water cycle was able to dissolve many substances, locking it away in the oceans or the ground. At the same time, nature also had plants at work, cleaning the air of carbon dioxide and replacing that with oxygen through the process of photosynthesis (more on that another time). Additionally, the wind caused the dispersal of gases to other areas of lower concentrations.

But it was the advancement of human society and the huge growth in urban living that lead to the exhaustion of nature's own methods of pollution handling. There was suddenly too much pollution in the air for nature to cope with.



Sources of air pollution

Q. Does anything surprise you about the diagram above? Are there any sources listed in the picture that you didn't expect? Can you think of any sources that are missing?

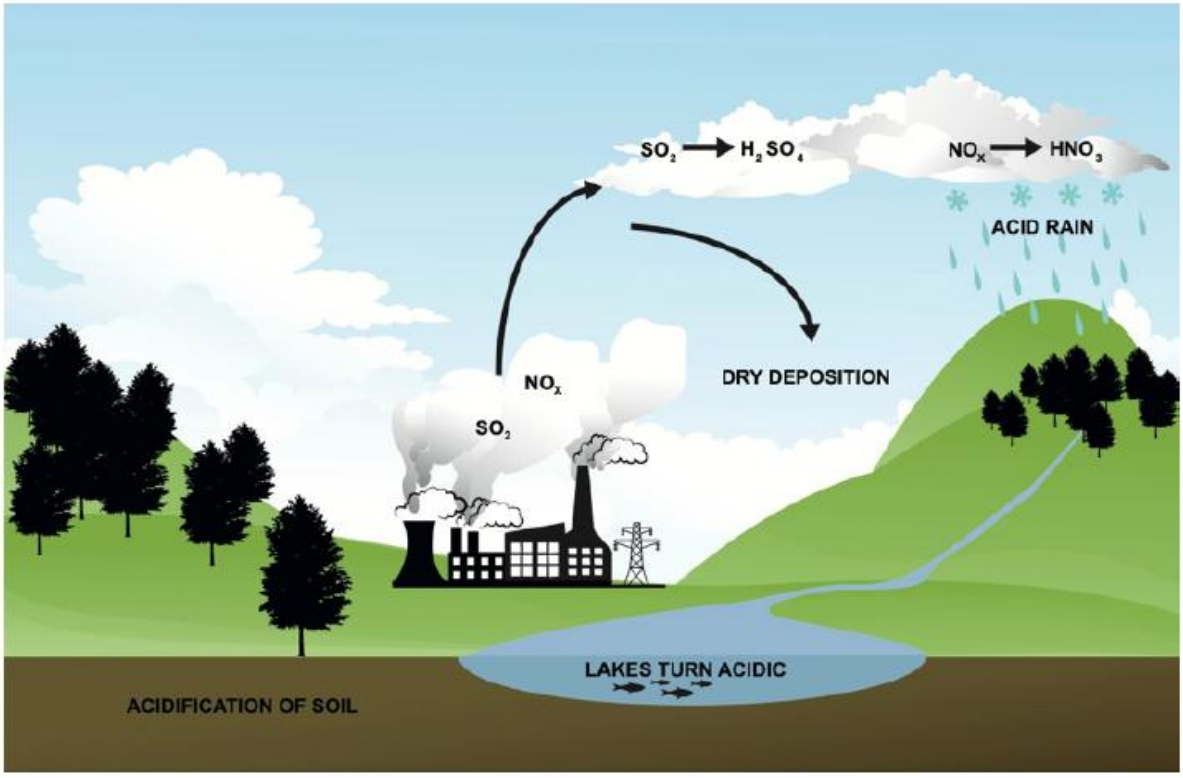
Watch this short video clip about the increasing production of air pollution from urban settlements around the world:

Video link here

Q1. Describe what happens to the plumes of pollution including their direction of travel.
Q2. In your own words, describe what has happened on a global scale since 1901.
Q3. What do you predict will happen in the next 100 years unless something changes?

As you have seen in the earlier video, some forms of air pollution are a global risk. Though pollutants may be caused by anthropogenic or natural sources in one area, their effects may be felt in other areas as a result of being wind-blown or by contaminating the environment. International cooperation is therefore essential for a resolution.

Some of the problem:



Part 3 – in class or as a homework activity

Primary and Secondary Sources of Air Pollution - Students to complete in class, or as a Homework task

You have a couple of minutes to think about and list the pollutants you can think of. If you know, try to write the *source* of each pollutant, i.e. where the pollutant comes from.

Compare your list with your neighbour, or if you worked on your lists together, compare them with someone else.

With your lists we are now going to talk about *primary* and *secondary* pollutants.

Primary pollutants are those that are pumped directly into our atmosphere, such as carbon monoxide from car exhausts. Another example is sulphur dioxide, which is released during the combustion of coal, in fires or factories for example.

Secondary pollutants are those that are formed as a result of chemical reactions in the atmosphere. One example of this is ozone, which is formed when various pollutants, namely hydrocarbons (HC) and nitrogen oxides combine in the presence of sunlight. Another example is nitrogen dioxide, which is formed as nitrogen combines with oxygen in the air. Acid rain is a third example, which is formed when sulphur dioxide or nitrogen oxides react with water.

Lesson 3: "Local & community-based solutions to air pollution"

(PHYSICS, GEOGRAPHY)

Length of Lesson: 1 hour 15 minutes
National Curriculum in England, for teaching from September 2015

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf Science Introduction page 59, Physics page 64, Geography page 92

CURRICULUM

Science: General
Experimental skills and investigations:
- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience

CURRICULUM

Physics
Energy, Calculation of fuel uses and costs in the domestic context:
Domestic fuel bills, fuel use and costs
Fuels and energy resources.

CURRICULUM

Geography:
Human and Physical Geography:
- Understand how human and physical processes interact to influence, and change landscapes, environments and the climate; and how human activity relies on effective functioning of natural systems.

LESSON PLAN

Part 1. Students will receive the Part 1 handout, available, and are asked to answer three questions. After 10 minutes, start a class discussion where students are asked to present in class what they do during their day to day routine that may be helping to deplete fossil fuel resources.

Next, group the class into teams of three or four and hand out poster paper and pens. Ask the teams to think of ways in which populations on a global scale can do things differently in order to reduce the use and reliability of fossil fuels. This should take approximately 15 minutes. One to two answers will then be presented to the rest of the class.

Part 2. Keep the groups as there will be more group work to come! Fist, the class as a whole will learn about 'air pollution' on a more local level, with some ideas provided in the 'Action Tips'. In the 'Student Group Activity' each group will think of ideas in which people could reduce air pollution on a more local and community based level, including at home, at school and when they are travelling. There is some written information about this available for teachers.

After about 10 minutes, ask each group to come up with a local community project around improving air quality in the area.

Each team will be asked to answer three questions, which they will write down on the poster paper before presenting in front of the class.

End the class by asking which project they think would work best. Maybe the class can even present it to the principal and get the project brought into action!

There is a homework activity for students to complete where they are asked to complete one of two tasks.

LEARNING OBJECTIVES

- Pupils will come up with ideas for how to reduce the usage of fossil fuels, from a global to local level.
- Students will work as a team, and create a presentation to present in front of the class.
- Students will learn to ask question and engage in class; before agreeing on which project they believe would work best
- Students will understand what it takes to set up a project on both a local and global scale

LESSON REQUIREMENTS

- White board
- Poster paper
- Pens

Part 1
Discussion

1. How dependent are you on:

- Plastic
- Metals
- Transportation: Cars, airplanes, buses, taxis
- Electricity in your home
- Heating.

2. Thinking about your own every day activities, how much do you rely on non-renewable fossil fuels?

3. Do you think many people on the planet also use fossil fuels for similar reasons?

Discuss options for reducing the level of pollution created by people.
Think of 5 ways in which the global consumption of fossil fuels and creation of air pollution can be reduced. Write down your thoughts on poster paper together with your group.

Part 2

Using what you know about air pollution and its sources, design a basic plan for London that helps reduce the level of pollutants that are emitted into the air.

As you are planning strategies for combating air pollution, think about the challenges you might face changing peoples' behaviours. For example, would it be easy to get everybody walking rather than driving? How likely is that to happen? You might start by thinking about how you could change your own behaviour.

Student Group Activity:
Think of a community project that would focus around improving the air quality in the local area.

Each group will need to answer the following question:
- Who the project would benefit
- How the project would best be advertised and would the project cost any money?
- whether the project is short or long term, and what would need to be changed or added in terms of policies, transport facilities, community development etc. for the project to be put into place for a more long term time scale.

Ask each group to write their idea on the poster, which they will then present briefly in front of the rest of the class. Each team should be prepared to answer questions from the rest of the class.

End the class by asking which project they think would work best. Maybe the class can even present it to the principal and get the project brought into action!

Local Action Tips!

CONSERVE ENERGY — Your home energy consumption translates into air pollution, therefore any energy conservation or efficiency improvements you make will help.

MODIFY YOUR TRANSPORTATION — share a ride to work or use electric vehicles. Bicycle or walk to errands when possible. Most of the journeys in London are fast by foot than taking a car!

ELIMINATE TOXIC CHEMICAL USE AT HOME — A surprising number of household or home shop chemicals are toxic and volatile. Many release vapours into the air, inside the home and out. This can be serious health threat to your family, and contributes to community-wide levels of air pollutants.

PLANT LEAFY TREES AND SHRUBS — Deciduous trees and shrubs (the kinds that drop leaves in the fall) are excellent air filters to help reduce smog and cool the air on hot summer days.

GET INVOLVED AND TALK TO YOUR LEGISLATORS — Many of our current governmental regulations are not strong enough to address our air pollution problems. You need to work with your legislators and ask for better policies. If you want advice on how to do this, visit ChangeLondon.org and go to the pupil page.

Homework Activity. Please complete the following task:

1.
Article "Journeys in London are no longer and no different to anywhere else" with questions provided.

Access the following link to reach an article about transport in London:

Journeys that could be done without a car / http://www.aviewfromthecyclepath.com/ 2013/08/journeys-in-london-are-no-longer-and-no.html

Student activity:
Read the article and digest the data that is presented in the pie charts and the comparative bar chart.

- What are the major differences between the usage of cars between London and the Netherlands?
- Consider your daily activities from the moment you wake up to when you fall asleep. Is there anything you could do to cut down on the amount of waste you produce?
- Discuss your thoughts with those around you and see what similarities there are in your daily habits.
- Appoint a spokesperson for your group and report back to the class about how you might be able to change your behaviour and make a difference to the environment.

Lesson 4: "Diffusion and pollutants"

(BIOLOGY, CHEMISTRY)

Length of Lesson: 1 hour 15 minutes
National Curriculum in England, for teaching from September 2015

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf Biology page 60, Chemistry page 62 & 63

CURRICULUM

Biology
The structure and function of living organisms:
- Role of diffusion in the movement of materials in and between cells.

Gas exchange systems
- Structure and function of the gas change system humans

CURRICULUM

Chemistry
Pure and Impure Substances:
- Diffusion in terms of the Particle Model

Earth and Atmosphere
- The composition of the atmosphere.

LESSON PLAN

Before starting this lesson, it would be helpful if the class has already learnt about the mechanisms of breathing, and the movement of gases from the alveoli in the lungs into the blood system to feed the cells.

Part 1: Students will be briefly explained about diffusion in animal cells and the way that oxygen and carbon dioxide move around the body.

Next, students will do a short pop quiz around what they have just learnt about diffusion. This should take about 10 minutes. After the pop quiz, the teacher will read out the answers, and explain the "Diffusion of Anthropogenic pollutants in the air" to the class.

Students should be informed that there are many pollutants in the air in London, and that we inhale these as well, and that this makes us ill and alters our ability to fully develop.

Part 2: In this part, students will be introduced to the Deliver Change AirSensa data. Teachers can either retrieve the data from their school's own individual device, if applicable, or use a prepared data set provided by Deliver Change. This data will be able to show the type of air pollutants in the area, their abundance and their levels at various times of day. Students are asked to take a look at the data and answer some questions.
After about 10 minutes, ask each group to come up with a local community project around improving air quality in the area.

Each team will be asked to answer three questions, which they will write down on the poster paper before presenting in front of the class.

End the class by asking which project they think would work best. Maybe the class can even present it to the principal and get the project brought into action!

There is a homework activity for students to complete where they are asked to complete one of two tasks.

LEARNING OBJECTIVES

1. Students will learn that diffusion happens in the air around us.
2. Students will understand that human made pollutants are harmful to our bodies and move around the air.
3. Students will learn that pollutant concentration varies at different times of day.

LESSON REQUIREMENTS:

- Paper for pop quiz and producing drawings
- Pencils,
- Ruler,
- Eraser
- AirSensa data

Part 1

Diffusion - Catch up

Diffusion in Animal Cells:

The cells in our body need glucose and oxygen for respiration. Both of these are carried in the blood. When blood reaches the cells the molecules of glucose and oxygen diffuse out of the blood and into the cells.

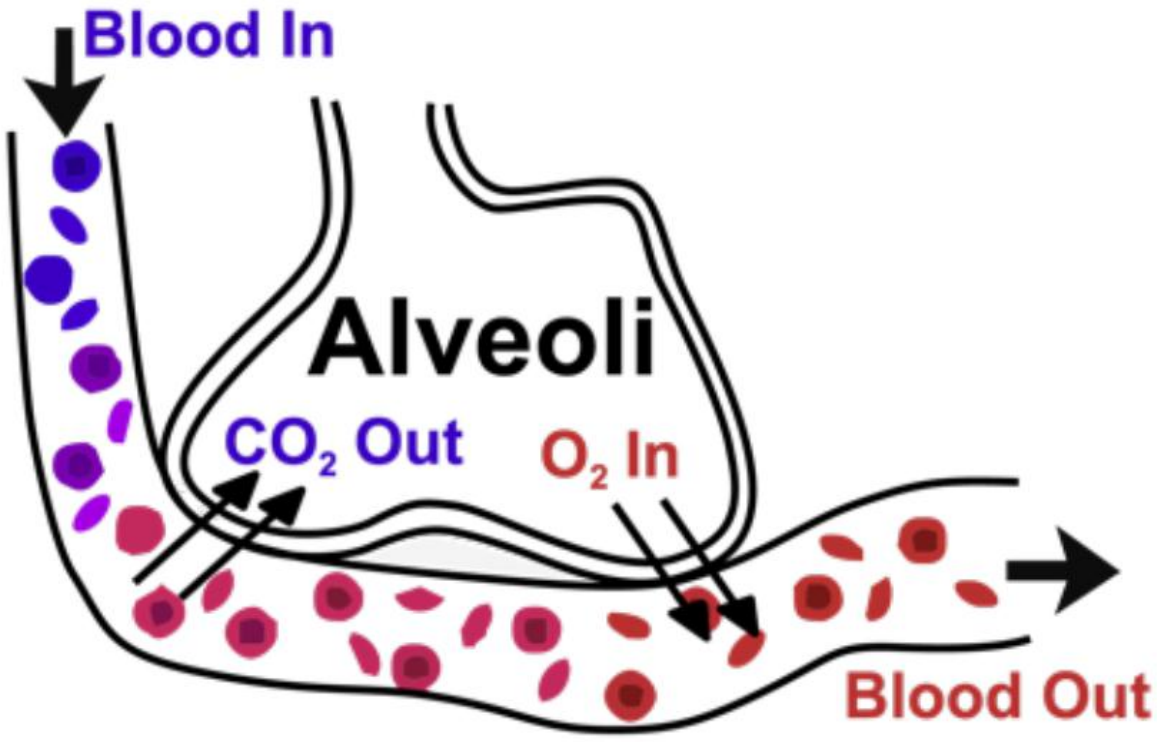
As cells use up the glucose and oxygen they produce waste chemicals and carbon dioxide. If these were to build up in the cells they would poison them, therefore they diffuse out of the cells into the blood.

The body is in a continual process of particle delivery and exchange, enabled by the transportation system of the blood.

Cells require Oxygen for respiration and in doing so produce Carbon Dioxide as a waste product. It is important to understand that O_2 is exhaled into the lungs, and gets transported into the blood to our cells, so our bodies and function properly. Carbon dioxide leaves the cells to go into the blood stream to enter the lungs, and it is this that we exhale.

In the diagram below we see how the deoxygenated blood (which is high in CO_2) sees the CO_2 diffuse into the alveoli that is temporarily a site of low CO_2 and high O_2 concentration. At the very same time, the O_2 in the alveoli diffuses out of the alveoli and into the cells in the blood where there is low O_2 concentration. This exchange is happening continually whilst we are alive!

Deoxygenated and Oxygenated Blood



Diffusion

Pop Quiz!
Questions:
- When does diffusion occur?
- From which area of concentration do particles spread to (low to high, or high to low?)
- Can you name an example of when particles diffuse?

Answers:
- Diffusion occurs when particles spread. They move from a region where they are in high concentration to a region where they are in low concentration. Diffusion happens when the particles are free to move. This is true in gases and for particles dissolved in solutions.
- Particles diffuse down a concentration gradient, from an area of high concentration to an area of low concentration.
- For example:

    ▪ Oxygen Particles diffuse out of the alveoli (lungs) and into the blood, and carbon dioxide diffuses out of the blood and back into the alveoli (lungs) which we breathe out.
    ▪ When the smell of cooking travels around the house from the kitchen, this is also particle diffusion.

Diffusion of Anthropogenic pollutants in the air

In the case of anthropogenic pollutants, diffusion is still the process by which gases travel around the nearby area. Thus gaseous pollution produced in one area can affect the environment and organisms in other areas.

Remember, particles continue to move from a high to a low concentration while there is a concentration gradient. When the particles are equally diffused the process of diffusion stops.

The composition of the atmosphere

In certain parts of the world, where it is very urban or where there is a lot of industry, we often inhale other gases such as nitrogen oxides, carbon monoxide and sulphur dioxide. Some of these substances (called pollutants) are directly harmful to humans.

For example, carbon monoxide reduces the amount of oxygen that blood can carry. Sulphur dioxide, for instance, is particularly harmful to the environment by causing harm to humans indirectly through producing acid rain.

Key Words:
Particles; Concentration gradient; Diffuse;

Part 2

Accessing the AirSensa data

If a school has its own *AirSensa*, the individual *AirSensa* data can be accessed by adding in the school specific log-in code, which is shared with the head teacher or head of faculty. If you (the teacher) have not yet received access to the log-in code and data please contact the individual who is responsible for the *AirSensa* and its data.

Once you have typed in the log-in code you will see a dashboard page which contains graphs of key air pollutants, with their level of pollution against a time gradient. Teachers can alter the time average by adding in the time-frame of pollutant measurements in the task bar at the top of the page. The data can also be downloadable as an Excel CVC file, allowing students to draw their own graph, if applicable.

If the school does not have its own individual *AirSensa*, Deliver Change will be able to supply a prepared data set for students to work with. In this case, please contact info@deliverchange.org to receive this information.

Questions for students:

Using the graphs available, please write down for each pollutant, the time of day when the most pollution is recorded.

Please state a season why you think this may be the case (think about the type and amount of activity that goes on the road).

Lesson 5: "Health Effects of Air Pollution"

(BIOLOGY)

Length of Lesson: 45 minutes
National Curriculum in England, for teaching from September 2015

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf Biology page 60 & 61

CURRICULUM

Biology:
Gas exchange systems
- The mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume.
- The impact of exercise, asthma and smoking on the human gas exchange system.

CURRICULUM

Biology:
Interactions and interdependencies.
- How organisms affect, and are affected by, their environment, including the accumulation of toxic materials.

LESSON PLAN

Part 1: Begin the class by handing out the two diagrams of the respiratory system and alveoli exchange, as well as the 'Health effects of air pollution' text, provided.

This lesson will best be taught as a follow up class to 'Lesson 4' on diffusion and air pollution. If not all students have been taught Lesson 4, i may be useful for the teacher to tell the class briefly about how air moves in and out of the lungs and alveoli. Explain to the class that pollutants that are found in much of the air around cities, such as carbon monoxide and nitrogen oxides, are a similar size to oxygen and carbon dioxide. This means that we can inhale them and they will follow a similar route that oxygen will take when it enters our lungs. If the air is polluted, pollutants can be transported in the blood and sent to our cells, which should usually only receive oxygen. This harms our cell system and can cause us to become ill.

Next, write on the board: "Do you think that air pollution levels could be high enough to affect people's health? Do you think these levels can be reached in our local environment?"

Ask the students to state why or why not.

Next, ask the class to indicate how air flows into our system and where it goes once being transported by the blood (here the pictures will be useful).

Part 2: Students will be asked to read through the document 'Health impacts of air pollution'. After reading the text students will be asked to answer a set of questions provided. This activity can be completed in pairs.

Part 3: The teacher will ask the class to conduct a research activity, which can take place either during the class, or at home, as long as the students can research the web. Students are asked to find out *which* other areas of the body might be affected when exposed to air pollutants. The students must then write brief notes about *how* these areas are affected.

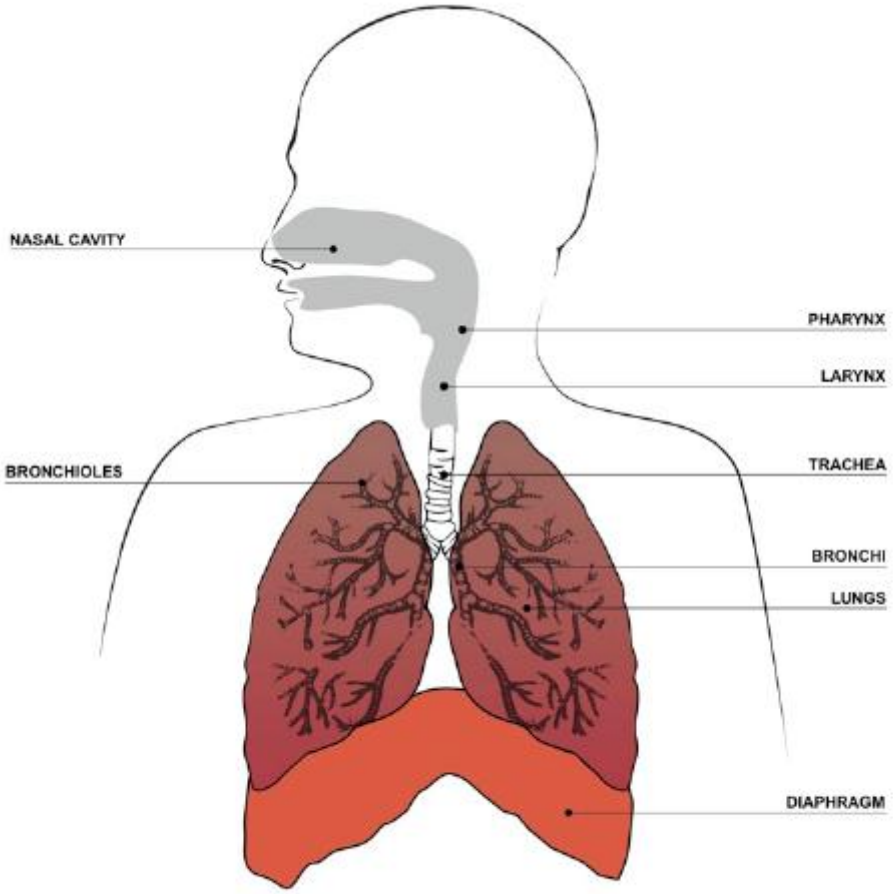
LEARNING OBJECTIVES

- Students will understand that poor air quality can have an impact on other areas of the body besides the lungs.
- Students will gain an understanding of the pollution levels in and around their local environment.

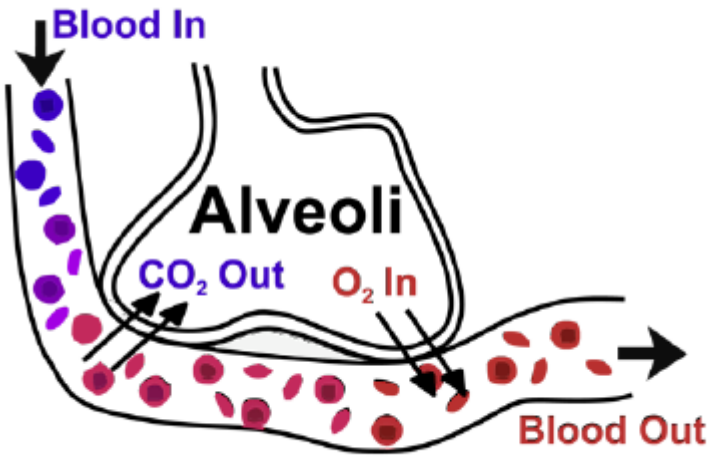
LESSON REQUIREMENTS:

- Health Impacts handout
- Question sheet handout
- Gas exchange diagrams handout
- Pencils and Erasers
- Web access if applicable

Part 1



Diagrams of the Human respiratory and circulatory systems: Gas exchange.



Part 2

Health effects of air pollution

Please read the text below

Air Pollution and its impact on everyone

Air pollution is something we can't escape. We breathe it every day. In fact, every minute of every day, we breathe six to ten litres of air. If the air around us carries pollutants, those pollutants enter our bodies and can affect us in many ways.

The air pollution is such a health risk that it is said to have caused almost 9,500 premature deaths in London in 2010, and this is from only two key pollutants: particulate matter 2.5 and nitrogen dioxide. Enough people are affected, and affected badly enough, that just in London, the health impacts of air pollution costs us millions of pounds every year.

Air pollution is especially harmful to the very young and old. Infants and young children are at risk because their lungs are not fully developed and because they breathe faster. The elderly are at risk because their bodies are no longer as effective at dealing with environmental stress. Of course, since the respiratory system comes in direct contact with the air we breathe, it is the body system most likely to be affected by air pollutants. So people, who already have asthma, emphysema, or other respiratory conditions, people with heart or circulatory problems, and cigarette smokers are especially susceptible to the effects of air pollution.

People who are young and healthy can be affected by pollution too. Air pollution can affect anyone. Even healthy teenagers, young adults, and strong athletes can suffer negative effects from high pollution levels, especially when exercising outdoors.

A Tricky Question

It's a real challenge for scientists to study the health effects of different air pollutants. It wouldn't be ethical for researchers to just put people in a lab and expose them to high levels of a pollutant. Outside the lab, people who live in heavily polluted areas are exposed to not just one pollutant but to many pollutants. Also, the concentration of each pollutant is changing all the time, in some cases independently of other pollutants. All of this makes it difficult to separate out the effects of each pollutant.

In addition, how susceptible people are to the effects of air pollutants can vary widely. Think about a roomful of healthy people who are all exposed to the same cold virus. Some will develop a bad cold, others a mild cold, and others no cold at all. In a similar way, susceptibility to pollutants can vary greatly even among a group of healthy individuals.

Finally, there are always many influences on our health. If you develop symptoms that might be caused by air pollution, it's often difficult to be sure that pollution was "the" cause. Just as with other health problems, there are likely to be several factors affecting your health.

How Much Do We Know?

One way to study the relationship between air pollution and health is to compare hospital records and death records to pollutant levels. Researchers have found that during extreme air pollution events, hospital admittances for respiratory problems increase. Death rates also increase, especially among the elderly and those who already have respiratory problems.

Another type of research involves evaluating the effects of long-term exposure to pollutant levels that are high but not extreme. In one study, scientists analysed medical records of several thousand people who lived in an area where pollutant levels went above the National Ambient Air Quality Standards for 42 days or more. These people were 33 per cent more likely to have bronchitis, 74 per cent more likely to have asthma, and 37 per cent more likely to have lung cancer than people who lived in an area with clean air. Other studies have found these kinds of results as well.

Finally, being affected by air pollutants is not just an "either/or" question. People can suffer from pollution to varying degrees. Although they may not be diagnosed with a specific disease, their health may be affected on a long-term basis in a way that reduces their quality of life.

In general, we know that long-term exposure to irritants in the air can cause swelling and constriction of the airways, increased production of mucous, and paralysis of bacterial destroying cells. Normally, the cilia of the epithelial cells that line the airways make sweeping movements to keep the airways clean. The cilia move mucous, along with germs and dirt caught in the mucous, out of the respiratory tract. Air pollutants can irritate the cilia, so that their protective action slows down or even stops. This leaves sensitive tissues unprotected.

The microorganisms and bits of foreign matter in the air are more likely to remain in the lungs. Here they can cause infections, lead to the development of lung diseases like chronic bronchitis and emphysema, and increase the chances of lung cancer.

Although the part of our bodies most affected by air pollutants is the respiratory system, the circulatory system works in close relationship with the respiratory system, so it can be affected too. If the respiratory system is damaged or diseased, then it will not be as effective at exchanging gases with the blood. With less oxygen in the blood, the heart must work harder, pumping more blood to deliver the same amount of oxygen to the body. In this way, the heart and arteries can be stressed.

When we inhale particulate matter (PM_{10} and $PM_{2.5}$), these tiny bits of foreign matter travel deep into the lungs where they become lodged in the alveoli. These small, balloon like sacs are the point in our bodies at which oxygen exchange occurs. This is where the lung removes carbon dioxide from the blood and replaces it with oxygen from the air. Very tiny particulates, those less than one micron, can stay trapped here for years.
They can irritate the alveoli, reducing their ability to work properly, and cause long-term

chemical and structural damage to the lungs.
In contrast, carbon monoxide is unusual in that it has no direct effect on the lungs but is absorbed by the blood. Carbon monoxide readily combines with haemoglobin in red blood cells, taking the place of some of the oxygen that should be entering the bloodstream. Every moment, we are interacting with the air around us. Our bodies are constantly exchanging molecules with the atmosphere. Just as breath is essential to life, so too is the quality of the air we breathe essential to good health and the quality of our lives.

Source: Students For Clean Air. Clean Air Program. Pima County Department of Environmental Quality. Tucson, Arizona

Section 6: Helpful links and further resources

Eye on Earth: Interactive tool to display and discover information about the environment, including air quality information from monitoring stations and user feedback.
www.watch.eyeonearth.org/

British Gas' Generation Green: Produces lessons plans and resources linking issues of sustainability into different areas of the curriculum.
www.generationgreen.co.uk/resources/type/activity

EDF's Energy Programme for Greener Schools: Resources and information on renewable energy schemes for schools, including example lesson plans.
www.jointhepod.org/activities/

DCSF's Energy Display Meters Programme (scheme now closed)
Lessons plans and resources for schools, broken down into different Key Stage groups.
www.energydisplaymeter.co.uk/lesson-plans/default.aspx

Suschool: Child-friendly explanations and ideas for action on themes such as climate change, transport and energy efficiency.
www.suschool.org.uk/

The Open Air Laboratories (OPAL) network: Lichen and air survey, guide and quiz
www.opalexplorenature.org/LichenGuide

www.oxford.gov.uk

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