AIR POLLUTION

Lesson plans for Years 5,6 & 7

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Cleaner AIR Better HEALTH

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

cleanerairbetterhealth.co.uk

The educational package ‘Air pollution’ was developed for primary schools in the UK and is the end result of the Joaquin project, led by the Flemish Environment Agency. The package was conceived by Imke van Moorselaar, working at the Environment & Health Department at GGD Amsterdam, one of the Joaquin project’s 16 partners and adapted by Dr Kirsty Smallbone and Maddie Chacha of the University of Brighton.

The Joaquin project has three main objectives: to measure health-related air pollution, to study possible measures and to inform the public about air pollution. This educational package serves to improve the knowledge about air quality amongst the target group children.

More information on the Joaquin project can be found on www.joaquin.eu.

Always be careful! Joaquin, nor the partners involved can be held responsible for any damage or accidents occurring during the lessons.

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INTRODUCTION

TARGET AGE GROUP

The ‘Air Pollution’ lesson package is designed for students aged 9 - 12. In the UK this corresponds to Year 5, 6 and 7, upper Key Stage 2 and lower Key Stage 3. In particular, content covered within the package links to the KS3 National Curriculum 2013 Science subject content. The eductaional package is built around four seperate interactive lessons.

DESIGN

1. In the first lesson, **What is air?,** students are introduced to the concept of air via a number of simple experiments, the results of which will give us a measure of their existing knowledge of the subject. This introduction will serve as a basis for the remainder of the lesson package.
2. In the second lesson, students’ **understanding of the atmosphere and air pollution** will be built upon. Sources of air pollution and different types of air pollution will be discussed.
3. In the third lesson, the **link between air pollution and health** is explored. As part of this lesson, the students will experience how air pollution affects their health via participation in a role-playing game.
4. In the fourth and final lesson, students are introduced to the steps or **‘measures’** that can be taken to improve air quality. They are challenged to think about how these measures can lead to improved air quality. Finally, students will be encouraged to reflect on their own role and that of their families; how they contribute to air pollution and the ways that they can reduce their impact. The students will be asked to think of any changes in behaviour that people could make in order to improve air quality. The starting point for this and a key concept of the teaching package, is that every little change helps.

The four lessons can also be taught individually, but for a complete overall picture it is recommended that the lesson package be taught in its entirety. The lessons can be spread over several days.

This teacher’s manual is organised into identically structured sections.

- At the top of each lesson plan is a box in which the learning objectives, National Curriculum links and lesson duration are specified. The introduction is followed by a background section, which can be used by the teacher to help him/her plug any potential knowledge gaps that they might have in the subject area.
- The required materials are specified for each lesson. In essence these are ‘DIY’ items, which may take a little preparation to collect and put together. The tasks and experiments can be downloaded together with the lesson package.
- The assessment questions are examples of questions which students should be able to answer after the lesson.
- The major concepts that will be discussed in the lesson are listed under the heading ‘concepts’.
- Finally, there is the lesson plan with a step-by-step description for the lesson. The lesson plans consist of four sections: preparation, lesson starter, tasks, and plenary.

The lesson materials for this lesson package consist of tasks, worksheets, videos, texts and DIY materials. The collection and preparation of the DIY materials may take some preparation time, however the other materials can be downloaded together with the lesson package. Some tasks require a laptop or computer to play videos. If this equipment is not available in the school, the teacher may choose to perform only those assignments for which no computer is required. PowerPoint slides can be used as supporting material. If no interactive whiteboard is available, these may be omitted.

OVERVIEW OF THE ‘AIR POLLUTION’ LESSON PACKAGE

LESSON 1 ‘WHAT IS AIR?’
- Introduction to the concept of the atmosphere and ‘air’
- 2 classroom experiments
- 30 minutes teaching time

LESSON 2 ‘WHAT IS AIR POLLUTION?’
- Discussion about the sources and different types of air pollution
- Text analysis task
- Practical task in which students create their own smog
- 1 - 2 hours teaching time

LESSON 3 ‘HEALTH AND AIR POLLUTION’
- Discussion about the relationships that exist between air pollution and health
- Classroom role-playing game during which students learn how particle pollution can cause health problems
- 50 minutes teaching time

LESSON 4 ‘MEASURES TO COMBAT AIR POLLUTION’
- Discussion about the types of measures that are taken to improve air quality
- Group and individual assignments during which students work on their own ideas for new measures to improve air quality as well as evaluating their own role in producing or mitigating air pollution during their daily lives
- 1 hour and 20 minutes teaching time

OBJECTIVES

Knowledge and insight

Students will evaluate and expand upon what they know in the subject area of air pollution. Students will be introduced to different types and different sources of air pollution; they will be taught about the relationships that exist between air pollution and health and they will be helped to identify how they contribute to air pollution and what they can do to reduce it. The specific learning objectives for each lesson are given in chapter 3.

Skills and differentation

Students complete a number of tasks and take part in experiments independently and in groups. The lesson package comprises various learning styles and caters for a wide spectrum of capability levels through the use of a variety of carefully planned and diverse tasks.

Students will be encouraged to explain in their own words the different types of air pollution, the various sources of air pollution, the relationship between air pollution and health and the measures that can be taken (and that they can take themselves) to reduce air pollution.

Perception and attitude

Through completing tasks both individually and in groups, students will develop a greater understanding of the subject of air pollution. Based on these experiences and the knowledge gained, students will hopefully go on to show greater commitment to the subject of air pollution.

LESSON 1.

What is AIR?

30 MIN.

LEARNING OBJECTIVES
- To understand what air is
- To understand why air is important

National Curriculum Links: KS3 BIoloogy

This first lesson aims to introduce students to the concept of air and to investigate what prior knowledge they have on the subject. Two experiments are carried out to help students visualise the presence of the air around them.

OBJECTIVES
- Students learn that air is everywhere around them
- Students experience that there is air in their lungs (via a simple experiment)
- Students are able to explain why they breathe

CONCEPTS
- Air (additional info see:www.bbc.co.uk/education/clips/zwy2hyc)
- Air pressure (additional info see: www.bbc.co.uk/education/clips/z2bmyrd)
- Oxygen (www.youtube.com/watch?v=b4wveY2-lCo)
- Wind

To illustrate these key concepts, the teacher may choose to show the video material during the lesson.

MATERIALS
- Drinking glass filled with water
- Picture postcard
- Bowl
- 5 litre jerry can
- Water
- Flexible hose (e.g. garden hose)
- Marker pen
- Adhesive tape
- Transparent vessel (where appropriate)
- Worksheet lesson 1

PREPARATION
Lay out the lesson materials on a table in the classroom. This may help engage the students and build excitement and curiosity.

BACKGROUND INFORMATION FOR TEACHER
Extra information can be found in Appendix 1.

LESSON STARTER
(5 MINUTES)

Tell students what is going to happen in Lesson 1:
- You are going to experience that air is all around you.
- You are going to perform an experiment where you discover that there is air in your lungs.
- You will afterwards be able to explain why you breathe in air.

EXPERIMENT 1: 'AIR IS STRONG'

(10 MINUTES)

MATERIALS
- Drinking glass filled with water
- Picture postcard
- Bowl

STEPS
1. Fill the glass with water all the way up to the rim (without overflowing)
2. Place the postcard (with the smooth side down) on top of the glass
3. Gently press down on the postcard so that there is no air under it
4. Say that you are going to turn the glass upside down:
   - *-Ask the students what they think will happen (Question 1)? Let them think up an explanation for their answer. Students can discuss their answers in pairs. They have 2 minutes for this. During these 2 minutes walk through the classroom (to listen to the students' expectations).*
5. Ask two or three pairs of students what they think will happen and why.
6. Perform the experiment by turning the glass upside down (quickly):
   - Holding the cardboard tightly in place, turn the glass upside down while holding the cardboard in place (do this over a bowl just in case!). Keeping the glass straight, take your hand away from the cardboard (the water should stay in the glass).

QUESTIONS:
1. What do you think will happen when the glass is turned upside down?
2. What has happened?
3. Why do you think that this has happened?
4. Would this also work with a bigger glass?

ANSWERS
Question 1
If you have written down what you thought would happen, then that is OK, even if something different has actually happened.

Question 2
During and after turning the glass over, the postcard remained stuck to the water-filled glass. That is why, when the glass is held upside down, the water stays in the glass.

Question 3
All answers are 'good' provided you have written down why you think this is so.

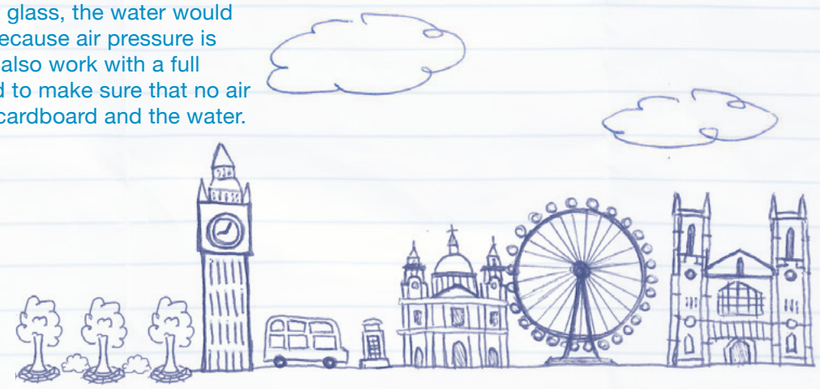
Question 4
Yes, even with a large glass, the water would not pour out; this is because air pressure is very strong. It should also work with a full bucket! You only need to make sure that no air can get between the cardboard and the water.

EXPLANATION
You do not notice it, but the air around us presses on everything. Air is everywhere, and therefore it also presses from everywhere. When you hold the glass upside down, the water presses down with its weight upon the cardboard, however, the air presses up on the cardboard from underneath. You have seen that the water does not fall out of the glass; this is because of the interaction of these forces, i.e. the air presses harder upon the cardboard from underneath than the water does from above.

Facts: Air presses with 1 kilogram per square centimetre (1 kg/cm^2) on everything, also including on the cardboard in our experiment. One litre of water weighs approximately one kilogram. This means that you can hold about one litre of water upside down per square centimetre. The opening of the glass has a surface area of at least 15 square centimetres, so you can easily hold the water in a glass upside down with a piece of cardboard placed upon it.

The cardboard is necessary because the water is thin and liquid. Crème fraîche, for example, is not as thin and liquid and a tray of crème fraîche can easily be held upside down without cardboard.

EVALUATIVE QUESTIONS
- **What is air?**
  Answer: Air is made up of nitrogen, oxygen and other gases.
- **Why is air important to humans?**
  Answer: Humans need air to survive. When we breathe in air, oxygen enters the lungs and from the lungs the oxygen is transported through the rest of the body where it is used to help us live and grow.



EXPERIMENT 2: 'AIR IN THE BODY'

(10 MINUTES)

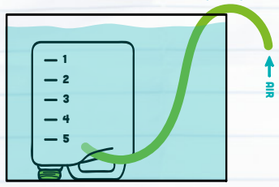
MATERIALS
- 5 litre jerry can
- Flexible hose (e.g. piece of garden hose)
- Marker pen
- Water
- Fish tank/aquarium (or transparent plastic box)

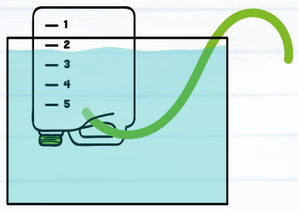
PREPARATION
Pour one litre of water (possibly coloured with food colouring) into the jerry can and mark the water level with a marker pen. Write '1 l' next to the water level. Add another litre. Again mark the level with the marker pen, but this time write '2 l'. Add another litre, mark '3 l', etc. The jerry can is now ready for use. Empty the jerry can.

Fill the fish tank/plastic box completely with water. Fully immerse the jerry can in the fish tank/aquarium; making sure that there is no more air inside it. Now, insert the hose through the opening of the jerry can, making sure that a piece of the hose is left projecting out from the fish tank/aquarium, in order to blow air into the jerry can later on.

STEPS
1. Fill the jerry can completely with water and fully immerse it in the fish tank/aquarium, which has also been filled with water. Ensure that there is no residual air left inside the jerry can.
   Question 1) *What do you think will happen when you blow into the hose?*
2. Take a deep breath and then blow as much air as possible into the hose (get students to do this.
   Question 2) *What has happened?*
   Question 3) *How do you think this has happened?*
3. Repeat the experiment with other students.

   Question 4) *What could be the reasons for the differences in lung capacity? (Lung capacity can be read from the amount of air breathed into the jerry can)*





ANSWERS
Question 1
If you have written down what you thought would happen than that is OK, even if something different has actually happened.
Question 2
Air has passed from the lungs into the jerry can. This air has taken the place of some of the water in the jerry can. It seems as if the jerry can is partially empty, but this part is actually filled with air.
Question 3
All answers are 'good' provided you have written down how you think this has happened.
Question 4
For example, sex, age, height. The taller you are, the greater your lung capacity. Smokers generally have a smaller lung capacity than non-smokers.

EXPLANATION
The lungs are filled with air. By blowing into the hose, air is transferred from your lungs into the jerry can. The air takes up the space of the water in the jerry can. In this way, you can see how much air there is in your lungs.

Not everyone has the same lung capacity. The lung capacity depends on a number of factors such as, for example, the size of your chest, but also factors such as height, age, sex, weight, etc; these all play a role. Smokers generally have a smaller lung capacity than non-smokers.

LESSON 1 PLENARY
Repeat the objectives of Lesson 1 and evaluate whether they have been met. The following questions can help with this:

- **What is air?**
  Answer: air is a composite of oxygen and other gasses.

- **Why is air important to humans?**
  Answer: Humans need oxygen to survive. Air is a mixture of several different gasses. \as fifth ($^1/_5$) of air is oxygen. People can last days without drinking and weeks without food, but without oxygen they will die within minutes. Breathing air brings oxygen to the lungs. Through the lungs it enters the bloodstream, transporting it through the whole body.

- **Is it possible to feel air?**
  Answer: You can feel the air almost every day, at least when there's a breeze. Wind is nothing more than moving air.

LESSON 2.

What is AIR POLLUTION?

Clean and dirty air.

1 - 1.5 HOURS

LEARNING OUTCOMES
- Identify different sources of air pollution
- Be able to identify types of air pollution

National Curriculum Links: KS3 Chemistry

In this lesson, students will learn about different sources of air pollution and the different types of air pollution we have today.

OBJECTIVES
- Students should be able to name examples of sources of air pollution.
- Students should be able to differentiate between man-made and natural sources of air pollution.
- Students should be able to name different types of air pollution (e.g. particle pollution, smog).
- During the lesson students will be able to make 'smog' themselves.

CONCEPTS
- Sources (anthropogenic and natural sources)
- Particulate matter (extra info: http://www.airnow.gov/index.cfm?action=particle_health.index)
- Soot
- Smog (extra info: http://kidsenvirohealth.nlm.nih.gov/subtopic/001/air-pollution/025/outdoor-air-pollution/)

MATERIALS
- Appendix 4 worksheet and experiment, 'Making smog' (number of students in classroom)
- Worksheet lesson 2
- Glass jar (1 per 2 students)
- Aluminium foil (1 roll)
- Ruler (1 per 2 students)
- Scissors (1 per 2 students)
- Matches or cigarette lighter
- Ice cubes (1 - 2 per 2 students)
- Ice cube/tray holder
- Freezer
- Newspaper sheets
- White cloth
- Size A2 poster
- Stickers

PREPARATION
Lay out the lesson materials on a table in the classroom. This may help engage the students and build excitement and curiosity.

BACKGROUND INFORMATION
Extra information can be found in Appendix 1.

START OF THE LESSON

(10 MINUTES)

Repeat the learning objectives of Lesson 1 and lead into those for Lesson 2.

Say to the class that in the first lesson we learnt through our experiments that air is all around us, that we constantly breathe in air and that air is important because it contains oxygen, which we need to live and grow.

Tell students what the objectives of Lesson 2 are: *"We are now going to learn that air can be clean or dirty and that certain activities/ processes are responsible for dirty/polluted air (i.e. they are pollution sources). Later during the lesson you will do some independent reading about air pollution and then you will work in groups on an experiment where you will try to make your own 'smog'".*

During the introduction, you may like to show the students the 'What is air pollution' video (~ 3 minutes in duration.) *"To start with let's make a list of anything you can think of that can make the air dirty or 'polluted'. We call these things 'pollution sources'. Write down 5 sources of air pollution" (or maybe do this as a class exercise and ask the students to write their thoughts on a white board).*

EXTRA ACTIVITY: After collecting the answers, the PowerPoint slide 'sources' with the 5 major sources of air pollution, can be shown. Tell the students about natural and man-made sources of air pollution.

TASK 'AIR POLLUTION YES/NO'

(10 MINUTES)

Hand out Appendix 4A-B-D.

Explain the tasks to the students and extra activity.

After about 10 minutes, discuss their answers in the class (see answers Appendix 4C).

THE DUST CLOTH EXPERIMENT

(5 MINUTES)

Ask the students to look out of the window and ask them whether or not they can see any air pollution. No?: Does this mean that the air is very clean?

If the window is open, you can wipe a white cloth or tissue along the window or windowsill. The cloth should normally turn black (test before the lesson, if necessary find another source of dust in the classroom).

- **Explanation:** The dust/dirt on the white cloth comes from, among other things, particulate matter. Particulate matter comprises very tiny particles that cannot be separated apart from one another with the naked eye. Traffic is the main source of particle pollution in the city. Particulate matter is a type of air pollution. Inhaling particulate matter is unhealthy.

Say that air pollution is often invisible.

Ask students how you can find out if the air is polluted. Do you think that the air pollution outside can also enter the classroom?

- **Explanation:** You can make measurements to determine whether the air is polluted. If the outside air is polluted, that air will also enter the classroom, e.g. through the window or ventilation grille. In the Netherlands, the National Institute for Public Health and the Environment performs air quality measurements. In the UK, the Department for Environment, Food and Rural Affairs (DEFRA) and your local council will monitor air quality. The DEFRA data is available online from http://uk-air.defra.gov.uk/

READING EXERCISE: 'SMOKE + FOG = SMOG'

(15 MINUTES)

Tell the students that there are different types of air pollution and that we have already seen one (show the white cloth with particulate matter on it), but that there are many more. Tell them that another type of air pollution is smog and that smog can actually be seen. Smog and particulate matter are one of the main types of air pollution for human health.

Say to the students: *"You are first going to read about smog and then try to make your own smog in an experiment."*

Hand out the text 'SMoke + fOG = SMOG' (Appendix 4E) and tell the students that they have 5 minutes to thoroughly read the text on their own.

After they have read the text, ask if they have any questions (e.g. why is smog bad for our health or how smog is formed?).

SLIDES 'SMOG'

(10 MINUTES)

Go through the slides with the children and discuss the images. talk about where smog comes from and discuss the impact that it has on people.

http//:www.slideshare.net/LisaGardiner2/air-pollution-images

EXPERIMENT 3 'MAKING SMOG'

(15-20 MINUTES)

Tell the students that they have just read about smog and seen some pictures on the subject. Say you are now going to try to make your own smog in a little experiment.

Tell the students that they are *"going to perform the experiment 'Making smog' in groups of 2".* (Teacher selects groups or the students themselves select the groups)

Tell the students that they are *"going to do an experiment where they will make their own smog in a jar".*

Everyone in the group is given a different task. The worksheet (Appendix 4F-G) specifies exactly what should be done -> READ THIS CAREFULLY.

Say to the student designated as the 'collector' that *"when you have reached the step 'ignite fuse', you must call the teacher".* This last step should preferably be performed outdoors because of the smell and smoke involved. If the last step is performed outdoors, instruct students to wait calmly until everyone has finished and then go outside together.

During the experiment, the teacher should walk through the classroom and try to engage the students on the subject and try to answer all questions raised and provide guidance.

Be sure to tidy up the materials when everyone has finished the experiment.

Instruct those students who have not yet started the questions to do so now. After the experiment the teacher should instruct the students to continue with the questions that go with the experiment.

CONCLUSION: EVALUATE LESSON 2

(10 MINUTES)

What is smog? How is smog formed?

Repeat the objectives of lesson 2 and evaluate whether they have been met.

Discuss the questions and answers belonging to the 'Making Smog' experiment (see answers). These questions are used to help evaluate whether the objectives of Lesson 2 have been achieved.

Extra questions that can be asked for evaluation purposes include:

- **What sources of air pollution are there?**
  Answer: There are natural and man-made sources of air pollution. Natural sources are, for example, forest fires, volcanic eruptions and sandstorms. Man-made sources include traffic, transport, industry, agriculture and households activities.
- **What are the most important types of air pollution?**
  Answer: smog and particulate matter.
- **What is particulate matter and what are the major sources of particulate matter?**
  Answer: Particulate matter is airborne particles of less than 10 microns. Major man-made sources of particulate matter are traffic, transport and industry. Natural sources include volcanic eruptions, sandstorms and forest fires.
- **How is smog formed?**
  Answer: Smog is formed when a large amount of pollutants (including particulate matter) from traffic and power stations remains trapped in a city.

LESSON 3.

Health and AIR POLLUTION

1 HOUR

LEARNING OUTCOMES

- To understand what particulate matter is
- To understand the impact that particulate matter can have on our health

National Curriculum Links: KS3 Chemistry, KS3 Biology.

In this lesson students will learn through a role playing activity (the 'Cilia Game') how air pollution (particle pollution) can lead to health problems.

OBJECTIVES

- Students should be able to explain what particle pollution is.
- Students should be able to name sources of particle pollution.
- Students should understand how particle pollution affects health.
- Students will observe through role playing activities how our bodies (cilia in particular) help protect us from particle pollution.

CONCEPTS

- Particulate matter (extra info see: http://www.epa.gov/airnow/pm/pm.html)
- Cilia/vibrating hairs (extra info see: www.youtube.com/watch?v=F0RuU2QHghM)
- Sources of air pollution

MATERIALS

- Flour
- Flashlight
- Appendix 3 'Cilia Game Set-Up'
- 4 objects to set up the boundaries of the game (e.g. large marker cones from the gym)
- 75 (3 to 4 per student) balls of newspaper (approximately the size of tennis balls), wrapped in masking tape.
- Name tags ('Cilia or vibrating hair', 'Particulate matter' and 'Lungs')

EVALUATIVE QUESTIONS

- **What are particulate matter?**
  Answer: particulate matter is a type of air pollution; particulate matter includes airborne particles with a size of around 10 microns or less.
- **Where does particulate matter come from?**
  Answer: Sources of particulate matter include traffic, factories, fireplaces and wood-burning stoves, volcanoes, forest fires, sandstorms and sea salt.
- **How does particulate matter affect our health?**
  Answer: Breathing in particulate matter can make people cough or cause respiratory problems; particulate matter can make asthma and heart disease worse.
- **How does our body protect itself from particulate matter?**
  Answer: the body protects itself with cilia (microscopic vibrating hairs).

PREPARATION

Make sure that the required materials have been collected, constructed and are ready to use.

BACKGROUND INFORMATION

Extra information can be found in Appendix 1.

START OF THE LESSON

(5 MINUTES)

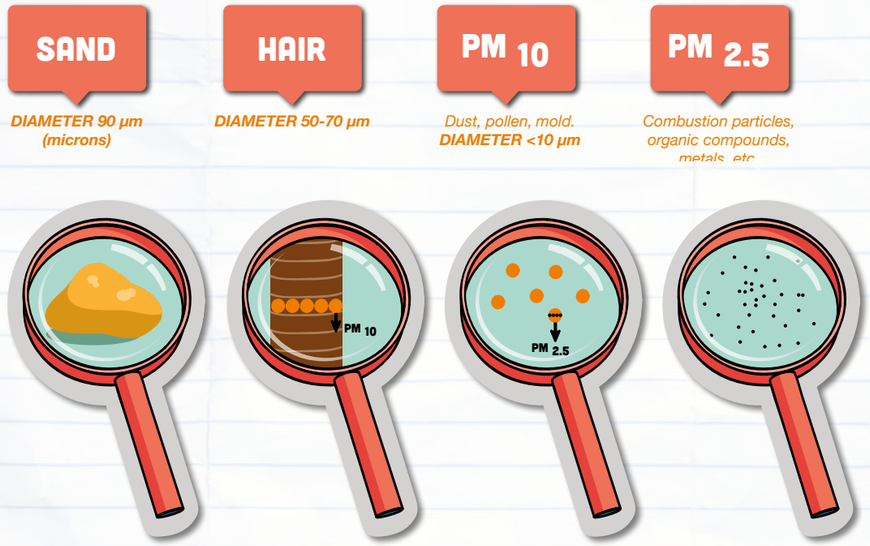
Establishing prior knowledge

Repeat the objectives of Lessons 1 and 2 and look ahead to Lesson 3.

- Repeat what has been learnt thus far: air is all around us, air is present in human lungs, air is polluted by different sources and there are different types of air pollution.
- In Lesson 2 we talked about smog and particulate matter. This lesson deals with particulate matter and how it is harmful to our health.
- Tell students (in their own language) about the learning objectives of lesson 3.
- Later on we will play a game (with you, the students, in the leading roles) where you will see and experience how particulate matter adversely affects our health.

EXPERIMENT 4 'DUST IN THE AIR'

(10 MINUTES)



*PM: particulate matter

Darken the classroom by turning out the light and shutting the curtains. Gently throw a handful of flour into the air (keeping it away from students).

Shine a flashlight on the flour as it is falling. Ask the students to describe what they see.

Discuss how the flour floats in the air, separating into tiny pieces, like dust. Tell the students that *"these tiny pieces are called 'particles'"* Explain that *"some particles floating in the air cannot be seen with the naked eye, but that they are inhaled into our lungs. This will sometimes make you cough".*

Turn on the light again.

Ask the students if they can name any sources of particulate matter. Point to a number of students and supplement their answers if necessary. Tell the students that *"where there is a lot of particulate matter in the air, people can get sick from breathing it into their lungs. Particulate matter can make it hard for people to breathe and can aggravate heart or lung disease".*

DRAWING PARTICULATE MATTER

(5 MINUTES)

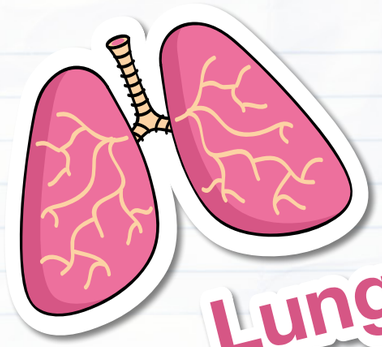
Draw yourself or have one student come up to the blackboard and draw, a large circle. Tell students to *"pretend that the circle represents the cross-section of a strand of hair".* Label the diameter '70 microns' (or 0.07 millimetres or 0.000007 metres).

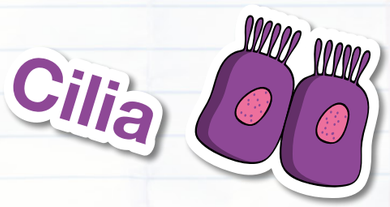
Draw yourself or have a student draw, two tiny circles inside the large circle. Label their diameters '10 microns' (or 0.01 millimetres or 0.000001 metres).

The large circle represents the cross-section of a strand of hair and the small circles represent particulate matter. Tell students that *"particulate matter comprises very tiny particles that cannot be seen with the naked eye. We may not be able to see them, we know they are exist".*

Explain what cilia/fibrils are and the role they play in our health and in relation to particulate matter. (You could draw a diagram of the human respiratory system).

(Background information: cilia are microscopically small hairs in our respiratory system. Their purpose is to stop foreign particles, like particulate matter, from entering our lungs. While breathing air, the cilia move back and forth, stopping the particulate matter and removing it in the process. (Watch this clip for more information: www.youtube.com/watch?v=miEEluVlemQ and www.youtube.com/watch?v=xQG3QHMxoTA





INTRODUCING THE CILIA GAME

(10 MINUTES)

Tell the students that they are going to play the 'Cilia Game'.

This game will show how particulate matter is harmful to human health.

Ask for student volunteers for the following roles (or select students yourself):

- Half the class, plus a few more, as 'particulate matter'
- Two students as the 'lungs'
- The remaining students as 'cilia'

Pass out the nametags as you allocate the roles. Refer to the info sheet 'Cilia Game set-up' and set up the boundaries of the game. Read the game rules to the class:

- The 'lungs' students stand on the short side of the trapezoid.
- The 'particulate matter' students line up along the longer edge of the game area.
- The 'cilia' students stand in a line between the 'lungs' and the 'particulate matter'. Tell the Cilia students that they can wave their arms like cilia to keep particulate matter from entering the lungs. They must, however, stand still with their feet on the ground. When moving their arms they must not hit other students. Have the 'cilia' students practise this movement.
- Pass the newspaper balls to the 'particulate matter' students. Explain that the 'particulate matter' students will throw the balls towards the 'lungs' students, and the 'cilia' students will try to defend the lungs by waving their hands and stopping the balls.

  EMPHASIZE THAT THE BALLS SHOULD NOT BE THROWN TOO HARD AND NOT ANYWHERE NEAR ANYONE'S FACE.
- Demonstrate by having a 'particulate matter' student throw one of the balls at you.
- Tell students to take a deep breath and feel the air moving in their own lungs.

PLAY THE GAME

(10 MINUTES)

- Begin the game by declaring that 'the is day bright and clear, and its early in the morning so there is only a limited amount of small particles', and tell two 'particulate matter' students to throw two balls each towards the lungs. The 'cilia' students should try to stop the balls by waving their arms.
- Explain that now it is later in the day and there is lots of particulate matter in the air. Tell the students that when you say *"GO"*, all of the 'particulate matter' students should throw all of their balls, one at a time, towards the lungs. The 'cilia' students should try to stop the balls.
- Shout out *"GO!"*
- When all of the balls have been thrown, stop the game. Allow time for students to calm down.
- Ask the 'lungs' how it felt to have all of that 'particulate matter' thrown at them. Tell the 'lungs' to count how many balls reached them.
- Ask the 'cilia' how they felt.

EVALUATE LESSON 3

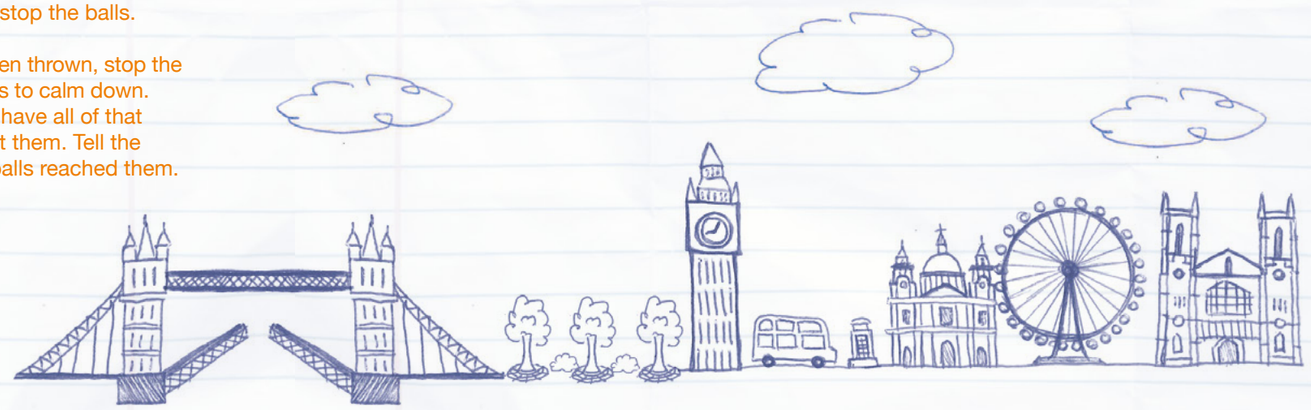
(10 MINUTES)

Review with the students what happened in the Cilia Game: Tell them that *"When there was just a limited amount of particulate matter, it was easier for the cilia to keep the particulate matter away from the lungs. When there were lots of particulate matter, it was much harder. The lungs may have felt 'attacked' by the 'particulate matter'"*.

Explain that at high concentrations, particulate matter can affect everyone. Some groups of people are more sensitive, including children, the elderly and people with lung and heart problems. Breathing in particulate matter may make people cough, make it harder to breathe and can make asthma and heart disease worse. People visit hospitals more often when there is a lot of particle pollution.

Repeat the objectives of Lesson 3 and evaluate whether they have been met. You can ask the following questions:

- **What is particulate matter?**
  Answer: particulate matter is a form of air pollution. It consists of floating particles smaller than 10 micrometres.
- **Where does particulate matter come from?**
  Answer: sources of particulate matter are traffic, industry, fires, bonfires, volcanoes, forest fires, sandstorms and sea salt.
- **How does particulate matter affect our health?**
  Answer: while breathing, particulate matter can make people cough or cause respiratory problems, particulate matter can worsen asthma or heart conditions.
- **How does our body protect itself from particulate matter?**
  Answer: the body protects itself with cilia (microscopic hairs).



LESSON 4.

Measures to combat

AIR POLLUTION

What can you do yourself?

1,5 HOUR

LEARNING OUTCOMES

- To identify measures that can be taken to improve air quality

National Curriculum Links: KS3 Chemistry

Luckily there are ways to limit air pollution: technical solutions (particulate filters, catalitic converters), planning solutions (changing traffic routes through city streets, LEZ's), and behavioural change (reducing car usage). In this lesson we will discuss a number of measures (technical, planning and changes in behaviour) that could be taken to improve air quality. Students will be given information about a measure to reduce air pollution and must reason how that measure can lead to improved air quality. In addition, students must reflect on how they and their families contribute to air pollution. They will also be asked to reflect on changes that they could make to their own behaviour in order to reduce their (or their families') contribution to air pollution.

OBJECTIVES

- Students should be able to name measures that can improve air quality (technical, planning and change in behaviour).
- Students should be able to explain how air-quality measures can lead to improved air quality.
- Students will have an insight into how they (and their families) contribute to air pollution.
- Students should be able to name examples of changes that can be made in behaviour to reduce their contribution to air pollution.

MATERIALS

- Red and green Post-Its (100)
- Work sheets 'Air-Quality Measures' (Appendix 5 and 6)
- Computer/laptop (2 to 4 depending on group size)
- Scissors (8)
- Marker pens
- Glue (8)
- Poster (format A2 ...)
- Loose A4 sheets
- 'Post-It task' 6H

CONCEPTS

- Low Emission Zone
- Green transport
- Green energy
- Energy power stations
- Saving energy

PREPARATION

Make sure that the required materials are already in place.

BACKGROUND INFORMATION

Extra information can be found in Appendix 1.

START OF THE LESSON

(5 MINUTES)

Tell students what the objectives of Lesson 4 are. Repeat what has been learnt thus far: air is all around us, air is present in human lungs, air is polluted by different sources and there are different types of air pollution, particulate matter penetrate the lungs and is therefore harmful to health. (You can also/alternatively ask the students what they have learnt thus far)

Ask students if they know of any measures that can be used to help combat air pollution.

Tell the students that, *"In this lesson we will see what is being done to combat air pollution. You will learn about this by working on a task in groups. Later on you will also be asked to think of how you contribute to air pollution".*

Tell the students that by the end of the lesson they will:

- *"Be able to name measures that improve air quality (technical, planning and changes in behaviour)*
- *Be able to explain in your own words how the measures help to improve air quality*
- *Have an insight into how you (and your family) contribute to air pollution*
- *Be able to name changes that you can make in behaviour to reduce your or your family's contribution to air pollution."*

POSTER

(40 MINUTES)

- The students will be working in groups of 4. (Teacher selects groups or the students themselves select the groups).
- Each group will be given a different task. Each group will receive information about a measure that has been taken to improve air quality.
- Ask the students to read what exactly this measure is about and then think about how this measure will lead to improved air quality.
- Using pictures, the students should write down or explain how the measure contributes to improved air quality.
- Ask the students to write down their explanations on the worksheet for lesson 4, which will then be posted in the classroom combined with the other tasks.
- After half an hour or so, ask the students to explain to each other how the measure that they have examined contributes to improved air quality.
- Hand out a task to each group. There are 4 tasks, so there will be several groups working on the same task. While students are working on the task, the teacher should walk through the classroom to provide guidance.
- When a group has finished, they can post their result on the wall.

DISCUSSION

(10 MINUTES)

All tasks should have been stuck up on the wall after half an hour. Each group briefly explains which measure they have worked on, what exactly it is and how it contributes to improved air quality. The teacher makes sure that students explain how the measure contributes to cleaner air and will explicitly ask them if they don't.

TASK 'PERSONAL CONTRIBUTION TO AIR QUALITY'

(10 MINUTES)

Tell the students that they have just learnt about different measures and ways to improve air quality. It is important for students to realise that they can also contribute to making the air cleaner. To prevent air pollution being considered exclusively as a problem for the government, it is important to point out peoples' personal contributions to the problem and even more important to stress what they can do themselves to reduce the problem. Finally, reflect with the students on how they and their families contribute to air pollution and on solutions to the problem.

Hand out the green and red Post-Its (2 per student).

Hang an empty poster in the classroom and explain the task.

Introduce the task 'Personal Contribution to Air Quality' (write the task on the whiteboard or show the 'Post-It task' of appendix 6H):

1. Think of how you (or your family) contribute(s) to air pollution in your town or city.
2. Write this down on the red Post-It.
3. Think of how you (or your family) can change your (or their) behaviour to reduce your (or their) contribution to air pollution.
4. Write down this change in behaviour on the green Post-It.
5. Paste both Post-Its on the poster in the classroom (red at the top, green at the bottom).

EVALUATE LESSON 4

(15 MINUTES)

The teacher reads a number of examples from the poster and discusses them with the class. Examples of questions that could be asked include:

- who else pollutes the air in this way?
- who else will adapt their behaviour?

Repeat the objectives of Lesson 4.

The following questions can be asked for evaluation purposes:

- **What measures are, or could be taken to improve air quality?**
  Answer: (examples of worksheets) low emission zones, cyclones in a factory chimney, public transport, bicycle instead of car, saving energy etc.
- **How can saving energy lead to improved air quality?**
  Answer: when saving energy, less coal needs to be burnt in a power station in order to meet the energy demand.
- **How can a filter or cyclone in a factory pipe or chimney lead to improved air quality?**
  Answer: the filter in a factory pipe or chimney can result in a significant reduction in the emission of particulate matter, heavy metals and dioxins into the atmosphere.
- **How can public transport contribute to improved air quality?**
  Answer: if people use public transport instead of their own car, this results in reduced emissions of pollutants. A train for example, can hold a large number of people, for which hundreds of cars would be required.
- **How can a low emission zone lead to improved air quality?**
  Answer: a low emission zone leads to air-quality improvement by imposing requirements on lorries that are allowed to enter the city. As a result, highly polluting lorries are discouraged from entering the city.
- **What can you do yourself to reduce your contribution to air pollution?**

The poster with the Post-Its can be left in the classroom to remind students of the solutions that they have come up with to change the air quality in their town or city. In the future you can also ask students whether these lessons and what they learnt managed to change their (or their families') behaviour.

University of Brighton

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Cleaner AIR Better HEALTH

APPENDIX 1

GLOSSARY (DICTIONARY OF TRICKY WORDS)

AIR

Air is one of the four classical elements: earth, water, fire and air. Air is something you cannot see; you hardly ever notice it (except when the wind blows), yet it is all around us. In principle, air is present everywhere at the Earth's surface where there is no water (air is also present in soil).

AIR PRESSURE

Air presses on everything and everyone with a force of 1 kilogram per square centimetre (1 kg/cm^2).

CILIA

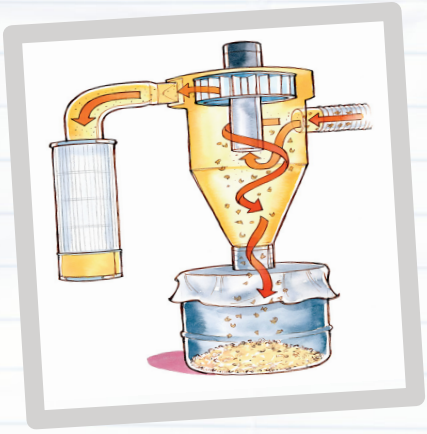
Particulate matter are tiny bits of dust in the air that you cannot see. They can adversely affect human health. The human body provides protection against particulate matter by means of tiny vibrating 'hairs' within the respiratory system, known as cilia.
Cilia are microscopic vibrating 'hairs' that line the walls of our respiratory system. Cilia try to keep foreign substances such as particulate matter out of our bodies. Cilia do this by moving back and forth trying to interact with and capture particles that enter our respiratory system with the air we breathe. As air is inhaled, the cilia wave around, capturing and pushing any foreign matter away from the lungs. However, particulate matter can still by-pas these defences and enter our lungs, if this happens we might feel poorly or get ill.

CLOTH FILTER

A cloth filter is a system to purify air. They are primarily used in factories to filter particulate matter and heavy metals from the air. The polluted air is led through the cloth, which separates the dust particles from the clean air. These particles will later be removed and collected from the cloth. This process makes the air emitted by for example factory chimneys cleaner.

CYCLONE FILTER

A cyclone filter is another system to purify air. Its like a giant Dyson vacumn cleaner. They are primarily used in factories to filter particulate matter and heavy metals from the air. The polluted air is led through the cyclone where the air spins around very fast. Dust particles are thrown into the centre of the spinning air mass where the air is still and they fall down to the bottom where they are collected in a 'hopper' (like a big skip).These particles will later be removed and disposed of safetly. This process makes the air emitted by for example factory chimneys cleaner.



Source: woodworking.com

ENERGY/POWER PLANT

An energy or power plant is a structure whose purpose is to generate energy. Energy plants include power stations which burn fossil fuel (e.g. gas or coal fired power stations), but there are also various natural resources that can be used to produce energy. These include water, wind, and solar power, for example. See also: www.bbc.co.uk/education/clips/zyt6n39

GREEN ENERGY

Green energy is electricity generated from sustainable energy sources. The term 'green energy' is used to distinguish it from regular electricity, called 'grey energy'. There is no difference between green energy and grey (standard) energy in the national grid, just the way its produced makes it different. A range of techniques can be used to generate green energy: for example hydroelectric power, wind power and solar power.

HUMAN SOURCES OF AIR POLLUTION

Human sources of air pollution include traffic, factories, fireplaces and woodstoves. When petrol or diesel is burnt in an engine, different types of exhaust gases, particulate matter and soot are formed. The most important exhaust gases are carbon dioxide (CO_2) and nitrogen oxides (NO_x). Other examples of human sources of air pollution are:

- **Agriculture and horticulture.** Agriculture is responsible for the emissions of some greenhouse gases into the air as well as nitrogen dioxide (NO_2) and particulate matter. Particulate matter is formed from the use of equipment and vehicles and in stables (e.g. manure/feed particles).
- **Households** contribute to air pollution via, amongst other things, central heating, gas or solid fuel cookers and boilers. The use of these appliances often involves the burning (combustion) of fossil fuels, which leads to air pollution. Barbecues and fireplaces release gasses, soot and other types of particulate matter into the air. Paint, spray cans and some cleaning agents are sources of volatile organic compounds (VOCs), but traffic and the chemical industry are also sources of VOS.
- In **industry,** factories that burn coal or fuel oil (power stations and oil refineries) for example, discharge large amounts of pollutants into the air, including particulate matter and soot.

MEASURES TO IMPROVE AIR QUALITY

(Source: Defra.gov.uk)

There are all sorts of ways in which you can reduce your own contribution to air pollution. Even though it sounds clichéd, every little bit helps. If everyone were to make sustainable choices in their day-to-day life, e.g. walking instead of taking the car, switching off gadgets and lights when we don't use them, air quality would improve much more rapidly. All of these measures involve a change in behaviour. Changes in behaviour are often difficult to accomplish. Actions to combat air pollution also include technical measures such as the installing a cloth filter in a factory or a Low Emission Zone in a city.

- **Consuming:** When buying products check how they were manufactured or grown and transported. It is for example more energy-efficient to buy local seasonal vegetables and fruit, because they usually do not need to be transported from far-away countries and less or no extra energy has to be used to grow them. When buying cleaning products and paint you can opt for the environmentally friendly type.

- **Heating:** Heating homes and buildings is (often indirectly) a major source of air pollution. Heat is generated in different ways: by fossil fuels (coal, diesel, petrol and gas), biomass (wood), natural sources (sun, geothermal energy), electricity or by residual heat from industry (district heating). Its contribution to air pollution depends on the energy source used and the applied technology. Heat generation by natural sources makes the lowest contribution to air pollution and fossil fuel use account for the highest contribution.

- **Reducing car use:** Road traffic is one of the main sources of air pollution. Car use should therefore be restricted as much as possible. For short distances (less than 5 km) it is better to go by bicycle or walk rather than use a car.

  For longer distances, public transport or car sharing (car pooling) are good alternatives. If you share a car with other people, you will probably use it more consciously and less frequently. If you do need a car, choose to purchase an economical car. Also try to drive as economically as possible.

- **Saving energy:** Do not waste energy. Coal and gas are still commonly used to generate electricity. At home and at work, do not leave appliances and lamps on longer than necessary. You can also opt for energy-saving light bulbs and energy-efficient appliances. Make sure your home is properly insulated so that you need less energy to heat it.

See www.cleanerairbetterhealth/eu/en/ for more information on what air pollution does and how you can prevent it.

NATURAL SOURCES OF AIR POLLUTION

Air pollution can have natural and human causes. Natural sources of air pollution are, for example, volcanic eruptions, forest fires or sandstorms. During these events a large amount of dust and soot enters the air. These substances belong to the group of pollutants known as particulate matter.

OXYGEN

Air is a mixture of many different gases, but is made up mainly of nitrogen (N_2 = 78%) and oxygen (O_2 = 21%). The remaining 1% consists of traces of noble gases and highly varying quantities of water vapour, carbon dioxide (CO_2) and various reactive trace gases (which includes pollutants, e.g. NO_2, CO, volatile organic compounds etc).

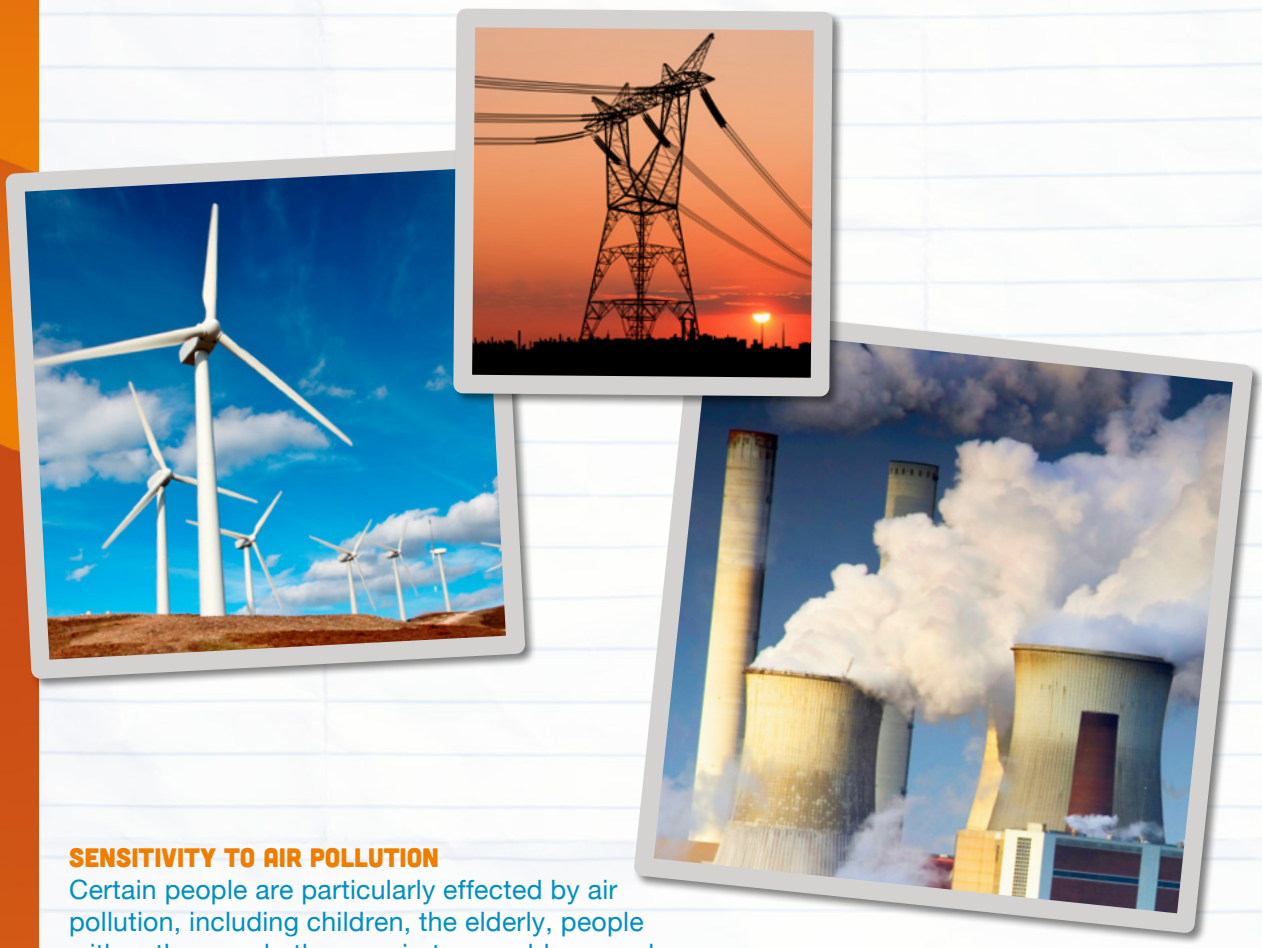
See: www.youtube.com/watch?v=b4wveY2-ICo
www.bbc.co.uk/education/clips/zwy2hyc

PARTICULATE MATTER

Particulate matter includes all airborne particles with a diameter of 10 microns or less (by comparison, a human hair has an average diameter of 70 microns). It is an important form of air pollution. Soot is a part of particulate matter that comes mainly from traffic and has a big impact on health.

Particulate matter is formed in the combustion process, for example, in cars (especially diesel engines), power stations and industry. It can also be formed in the storage or shipment of materials such as coal, ore and wheat, and wear of car tyres and road materials.

See: www.youtube.com/watch?v=nzHpcryefOE



SENSITIVITY TO AIR POLLUTION
Certain people are particularly effected by air pollution, including children, the elderly, people with asthma and other respiratory problems and people with heart conditions. Air pollution including particulate matter may make you cough or have difficulty breathing. It can also make asthma and heart disease worse.

SMOG
Smog is a type of air pollution. The word 'smog' is a combination of the English words 'smoke' and 'fog'. Smog is smoke that is polluted with smoke and exhaust gases. Particulate matter is one of the components of smog. Air that is inhaled during a period of smog may cause health problems. Examples are temporary respiratory complaints such as dry throat, chest pain, coughing, tightness and pain when taking a deep breath. Other symptoms include headache, discomfort, nausea and dizziness.

SOOT
Soot is a type of particulate matter and is produced by the incomplete combustion of carbon-containing fuels such as wood, coal, petrol or diesel. Soot particles are very small and one of the most harmful components of fine particulate matter.

WIND
Wind is moving air. Air moves as a result of the different kinds of air pressure in the Earth's atmosphere (high and low pressure). Air travels (blows) from an area of high air pressure to an area of low air pressure. Air pressure differences are the result of uneven heating of the Earth, e.g. between the tropics and moderate climate areas/ poles or between land and sea.

An example of how wind is formed: On sunny summer days, a sea breeze may develop later in the day, which will cause a sudden significant drop in temperature on the beach.

Why is this? Air above land warms considerably, whereas the temperature above the sea stays more or less the same. Warm air above land rises. The air above the sea then travels inland to compensate for the difference, thereby creating wind. Because the air above the sea was still cool, there will be an accompanying drop in temperature close to the sea.

APPENDIX 2

Lessons' LEARNING OBJECTIVES

This teaching back is designed to link in to the national curriculum. Each lessons learning objectives and where it fits in to the national curriculum are specified below.

LESSON 1

Learning Objectives:

- To understand what air is.
- To understand why air is important to human beings.

National Curriculum Links:

- KS3 Biology; Gas Exchange Systems.
- The mechanism of breathing to move air in and out of the lungs.

LESSON 2

Learning Objectives:

- To identify different sources of air pollution.
- To be able to identify types of air pollution.

National Curriculum Links:

- KS3 Chemistry - the production of carbon dioxide by human activity and the impact on climate.

LESSON 3

Learning Objectives:

- To understand what particulate matter is.
- To understand the impact that particulate matter has on our health.

National Curriculum Links:

- KS3 Chemistry - the nature of particualte matter.
- KS3 Biology - the mechanism of breathing to move air in and out of the lungs; the **impact** of asthma on the human gas exchange system.

LESSON 4

Learning Objectives:

e To identify measures that can be taken to improve air quality.

National Curriculum Links:

- KS3 Chemistry - the production of carbon dioxide by human activity and the impact on climate.

APPENDIX 3
Materials

THIS EDUCATION PACKAGE CONTAINS:

1	Package (box)
1	Ring binder
1	Manual
6	Appendices
4	Worksheets
10	Postcards
1	Poster A2
15	Stickers
30	Name tags

LESSON 1

Quantity	Materials
1	Drinking glass filled with water
1	Picture postcard ✓
1	5 litre jerry can
1	Flexible hose (e.g. garden hose)
1	Marker pen
1	Transparent vessel, where appropriate

LESSON 2

Quantity	Materials
15	Glass jar (1 per 2 students)
1	Aluminium foil (1 roll)
15	Ruler (1 per 2 students)
15	Scissors (1 per 2 students)
15	Ice cubes
1	Ice cube holder
1	Freezer
1	Matches or cigarette lighter
1	Newspaper sheets
1	White cloth
1	Poster A2 ✓
1	Stickers

LESSON 3

Quantity	Materials
1	Flour
1	Flashlight
4	4 objects to set up the boundaries of the game (e.g. large marker cones from the gym)
75	Balls of newspaper (size of tennis balls) wrapped in masking tape (3 to 4 per student)
30	Name tags ('Cilia or vibrating hair', 'Particulate matter' and 'Lungs') ✓

LESSON 4

Quantity	Materials
100	Red & green Post-Its
4	Computer/laptop (2 to 4 depending on group size)
8	Scissors
8	Glue pots
8	Marker pens
4	Poster (format A2)

✓ Part of the education package

APPENDIX 4.A

Air pollution YES OR NO?

- You will complete this exercise together with your neighbour.
- You will need scissors.
- You will have 10 MINUTES to complete the exercise.
- After 10 minutes the answers will be discussed in the class.

WHAT SHOULD YOU DO?

1. Is it the first time you have completed this excercise? If so, neatly cut out all of the pictures. from the end of this booklet. You can use the table in appendix 4B to put them on.
2. Cut out the pictures from appendix 4D. (They are repoduced at the end of this booklet). Put them in a line on the table.
3. Place the pictures that cause air pollution under the heading: 'Air pollution YES'. Discuss with each other why you placed the picture there.
4. Place the pictures that do not cause air pollution under the heading: 'Air pollution **NO'.** Discuss with each other why you placed the picture there.
5. Look at all of the pictures and decide if you agree on their allocated places.
6. After the task you can put the stickers back on the appropriate pictures in appendix 4.D.

EXTRA TASK

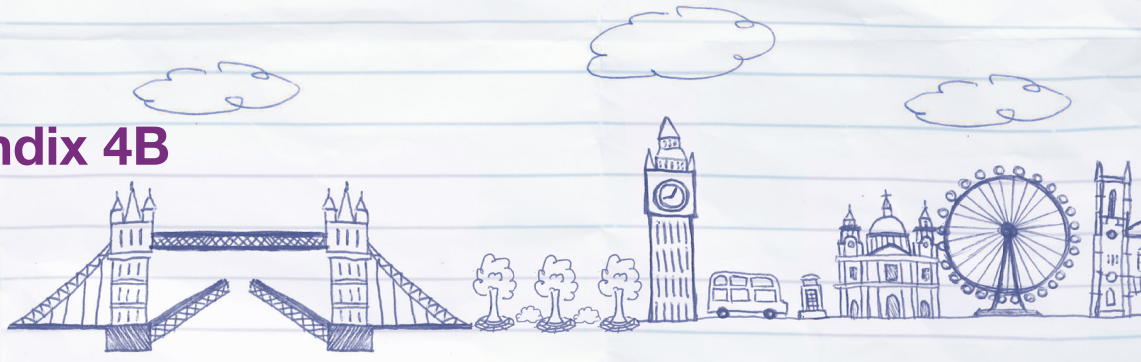
1. Look at the pictures that cause air pollution.
2. For each of these pictures think whether the air pollution is caused by humans or by nature. Write down which of the pictures show examples of natural air pollution .
3. For the remaining pictures (pollution caused by humans), can you think of something that works in the same way but causes less air pollution? Example: You can ride a bike instead of taking a motorcycle.
4. Write down what you have thought of on the worksheet.

AIR POLLUTION

YES

AIR POLLUTION

NO



Appendix 4B

APPENDIX 4.C

Answers for Air pollution YES/NO

TASK

AIR POLLUTION YES

- Human sources: Coal-fired power plant, engine, truck, car.
- Natural sources: Forest fires, volcanic eruptions, sandstorms.

AIR POLLUTION NO

Bicycle, wind turbine, solar panel, rain cloud, tram*, underground/metro*, electric car*, electric bus*.

*CONSOLIDATION:

A discussion can be held as to whether trams, trains, the metro/underground, electric cars and electric buses cause air pollution or not.

If these vehicles drive on green energy (generated from natural sources), they do not cause air pollution.

If however, they drive on grey energy (generated from fossil fuels), they indirectly cause air pollution. If students follow this reasoning, it is OK if they place electric vehicles under the block 'Air pollution YES'.

EXTRA TASK:

→ Alternative with less air pollution.

- Car → e.g. bicycle, walking, electric car.
- Lorry → e.g. electric car, freight train.
- Motorcycle → e.g. bicycle, walking, electric scooter.
- Coal-fired power plant → e.g. sustainable energy (hydroelectricity plant, wind turbine, solar energy).

APPENDIX 4.D

Take the pictures and put them on the poster of appendix 4B (or the later A3 poster at the end of this pack).

After the exercise you can put the pictures back in an envalope.

This page is just for reference, the pictures for cutting out are at the end of this pack.


03


ELECTRIC

APPENDIX 4E

SMoke + fOG = SMOG

Look at the picture to the right. It seems as if it is very foggy in the city. However, what you can see is not fog but SMOG. Smog is a type of air pollution. The word 'smog' is derived from the words 'smoke' and 'fog'. You are now first going to read this text to learn more about smog and then you will try to make your own!

HOW IS SMOG FORMED?

You have learnt that the majority of air pollution comes directly from cars, lorries and factories. **Smog** does not come directly from exhausts or chimneys. **Smog** usually occurs under specific weather conditions (sunny, little wind and no rain) and when many pollutants remain trapped in the city air.

Smog mainly occurs during bright and sunny weather. Because there is little wind and no rain, pollutants from, for example, traffic and factories remain trapped in a city and react with one another to form **smog** pollution. This is illustrated in the picture below.

This combination of dirty substances is called **SMOG.**

WHY IS SMOG BAD?

We are not too happy with smog, because smog is bad for our health.

Smog can cause breathing problems and itchy eyes. You may also develop chest tightness, start coughing or have an asthma attack. That is not so good.

The elderly, children and people with breating or heart conditions suffer most from smog. This does not mean that smog effects all elderly, young and sick people in the same way.

WHAT CAN YOU DO IF YOU SUFFER FROM SMOG?

Not everyone suffers to the same degree from smog. If you do suffer from smog, it is advisable to stay indoors and not to play outdoors when it is a smoggy day. It is also better to keep windows and doors shut when smog levels are high.

RECIPE FOR SMOG:
nice weather + no wind + no rain + lots of dirty and polluting substances = **SMOG**

You are now going to try to make your own SMOG. How this should be done is explained on the back of this sheet (appendix 4F).

APPENDIX 4F

Experiment: ‘MAKE YOUR OWN SMOG’

REQUIRED MATERIALS

- Glass jar
- Piece of aluminium foil
- Strip of newspaper
- Ruler and scissors
- 1 or 2 ice cubes

This experiment is carried out in pairs.
You have just read about smog. You are now going to try to make your own smog. To perform this experiment, you must collect and prepare a few things. You will do this in pairs.

TASK ALLOCATION

Everyone is allocated a task, these are:

- 1st person: ‘Collector’ and ‘Lid Maker’
- 2nd person: ‘Cutter’ and ‘Wetter’

STEPS

1. The ‘collector’ goes to fetch the required materials and lays them out on your table. The ‘collector’ carefully checks if everything is present and also whether the following steps are carried out correctly.
2. The ‘cutter’ cuts a strip of paper about 15 cm long and 5 cm wide from the newspaper sheet. The ‘cutter’ rolls up the strip so as to form a long ‘fuse’.
3. The ‘lid maker’ makes a lid for the glass jar from the aluminium foil. Make sure there is a small depression (or dip) in the lid to keep the ice cubes from sliding off. Also make sure the lid can easily be removed from the jar. Carefully remove the lid from the jar and put it aside.
4. The ‘wetter’ picks up the glass jar, puts it on the sink and wets it on the inside with water. Do this by putting a little water in the jar and cause the water to run down the sides of the jar. Pour the water that remains in the jar into the sink.
5. The ‘collector’ now calls the teacher or supervisor. (Go outside).
6. The teacher or supervisor lights the strip of paper with the match. Throw the burning paper into the wet glass jar and quickly place the aluminium lid on the jar. Make sure the lid properly seals the jar. Now place the ice cubes on the lid. ATTENTION!! Thiu step must be carried out quickly.
7. Look at the result of your experiment. Observe
   - what is happening
8. Answer the questions in appendix 4G. The ‘wetter’ notes down your answers.
9. Working together, tidy everything up.

APPENDIX 4G

NAMES:

GROUP:

Results: ‘MAKE YOUR OWN SMOG’

Answer the following questions in groups of two:
The ‘wetter’ writes down the answers.

1. Write down what you saw happening during the experiment.

2. How do you think this has happened?

3. When is smog formed in a city?

4. a) What are the effects of smog on people?

b) What types of people are most sensitive to smog?

5. There are different sources of air pollution. A source is a place where air pollution comes from, such as for example, a diesel vehicle. Name three other sources of air pollution.

APPENDIX 4H

Explanation of 'MAKE YOUR OWN SMOG'

ANSWER 2: 'Smog' is formed in the jar. As the paper burns, soot particles/smoke are produced and get into the jar (soot is a form of particulate matter). The jar is quite moist on the inside (which means that the water vapour concentration inside the jar is high). The ice cubes on the lid produce a strong cooling effect near the lid. This cooling causes the water vapour on the soot particles and smoke to condense (i.e. it becomes fog), thereby forming 'smog' (or smoky fog). Fog is made up of a large amount of water droplets that are light enough to keep floating.

(Condensation is the transition phase from gaseous or vapour form to liquid. Condensation is the opposite of boiling. Well-known examples of condensation are the formation of clouds and the white condensation trails that are formed when aeroplanes emit the water vapour that is released during the combustion of kerosene. At the height where they are flying, the air is cold, so that the water vapour condenses directly in the exhaust gas).

ANSWER 3: Smog is formed in a city when there is a lot of (local) air pollution caused by exhaust gases and particulate matter from traffic and pollution from industry. Smog usually occurs when it is sunny, when there is little wind and no rain, allowing the substances to accumulate in the city. The glass jar can be compared with a city and its atmosphere. Because there is no wind the smog remains trapped in the city, comparable with the smog that remains in the jar because of the lid. It is not hard to imagine that living in a glass jar is not much fun. Just as it is not much fun to live in a city where there is a lot of smog.

ANSWER 4A: Smog affects the respiratory and cardiovasular (heart) system. Smog can cause irritation of the mucous membranes in the throat, nose and eyes it can cause chest tightness, coughing and chest pain. It can lead to heart attacks and strokes.

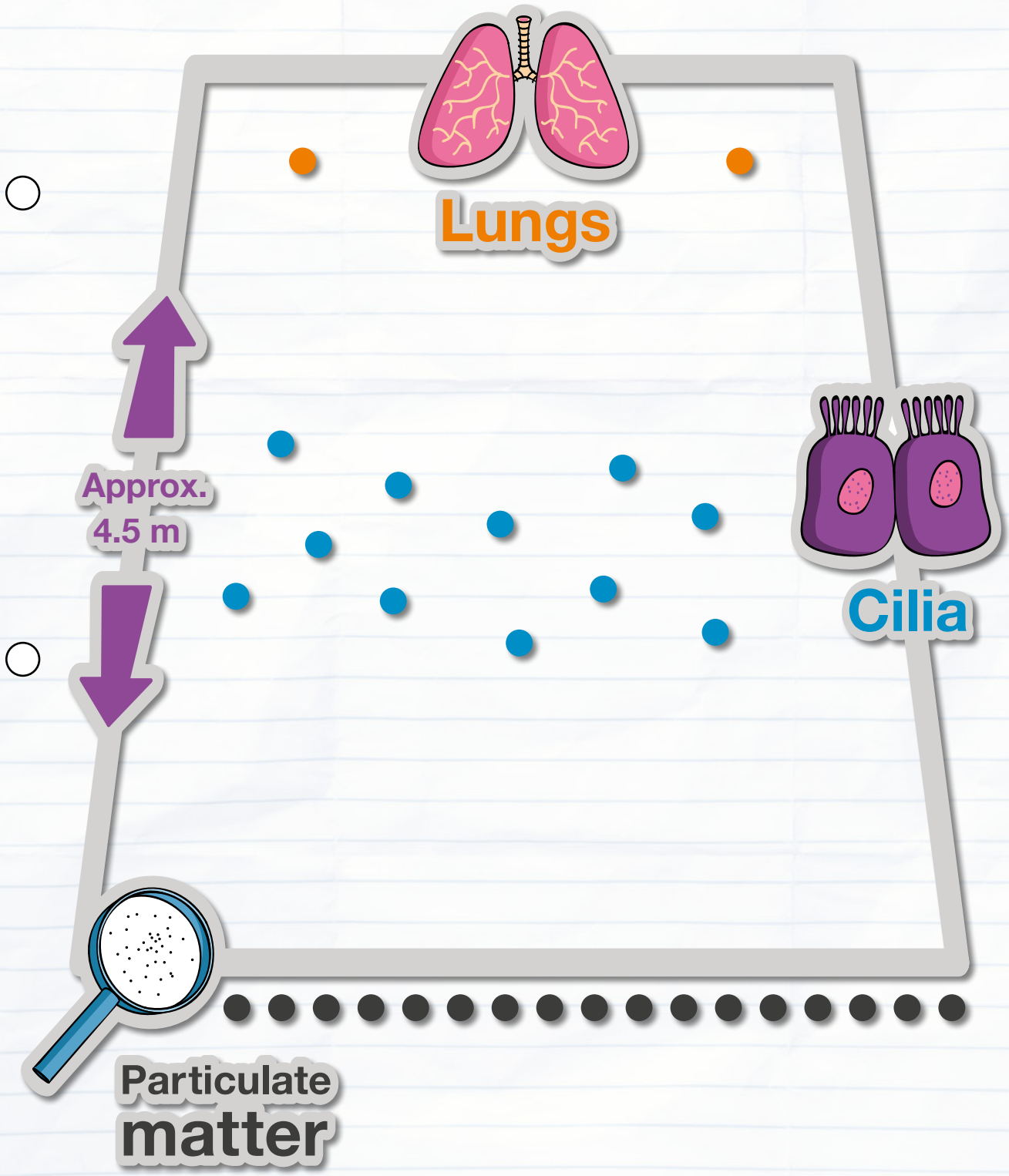
ANSWER 4B: As the duration and concentration of smog increase, more and more people will experience health problems. The most sensitive groups are children, the elderly and people who already have respiratory and cardiovascular complaints.

ANSWER 5: Road traffic, industry, coal power plants, agriculture, forest fires, volcanic eruptions, sea salt etc.

APPENDIX 5.

Cilia
GAME SET-UP

(lesson 3.)



APPENDIX 6A

Saving ENERGY

Particulate matter

1. Watch one of these videos: www.youtube.com/watch?v=81Vsabx2svk or www.bbc.co.uk/education/clips/zsdyb9q. The video shows a whole series of examples of energy waste as well as tips to prevent such waste.

2. Explain how wasting energy leads to air pollution and how economical energy use leads to improved air quality. In making your explanation you can use the pictures below or make a drawing yourself.

3. The other groups have also been given an task. In about half an hour you will explain your results to each other. Prepare a nice poster, explaining how saving energy helps improve air quality.

Coal

Coal-fired power plant

YOUR EXPLANATION SHOULD CLEARLY MENTION:

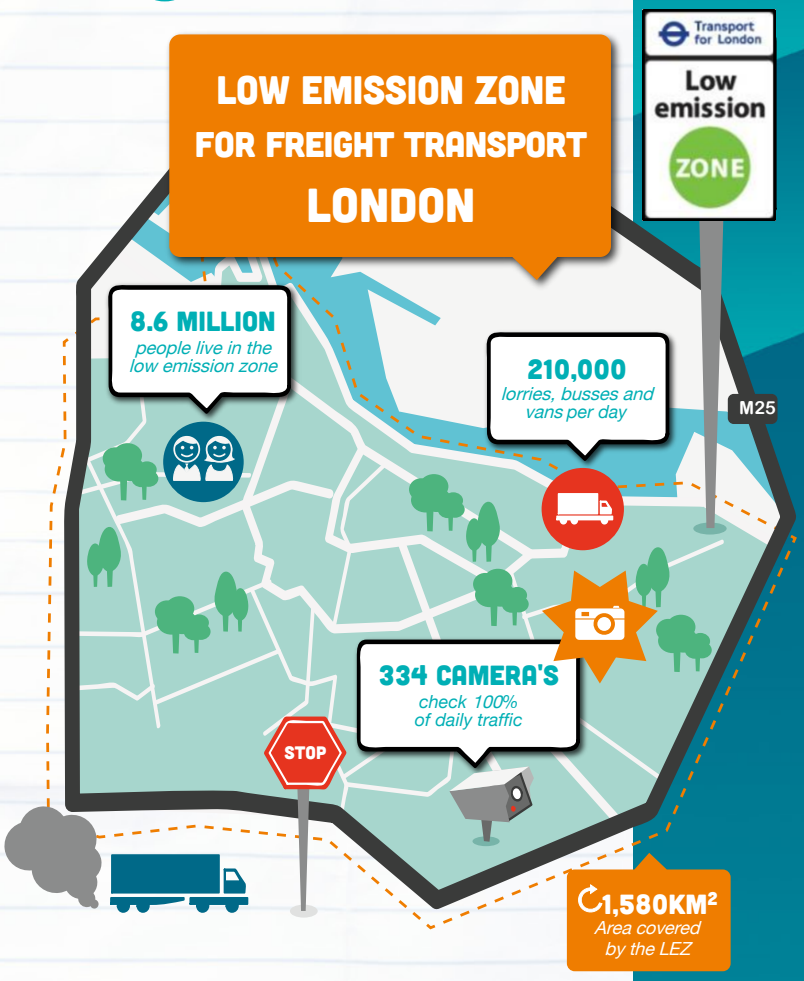
1) What is the problem?
2) What might be done to solve the problem?
3) How does saving energy help improve air quality?

In a coal-fired power plant, coal is burnt to generate energy. During this combustion, particulate matter and other harmful substances that cause air pollution are released into the air.

APPENDIX 6B

LOW EMISSION ZONE
Information

On 4th February 2008, the Greater London Authority introduced a low emission zone. A *Low Emission Z*one (LEZ) is a city area with restricted access for vehicles that emit large amounts of particulate matter and exhaust gases. An example of an exhaust gas is nitrogen dioxide, also called NO_2. A *Low Emission Zone* aims to improve air quality in the city.



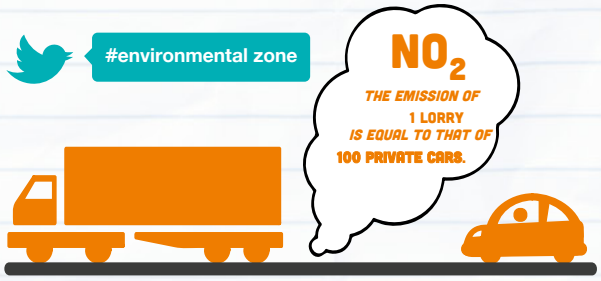
The London Low Emission Zone covers all roads in Greater London, those at Healthrow airport and parts of the M1 and M4 motorways. Generally it covers the area within the M25 motorway with a few exceptions.

The Greater London Council seeks to improve air quality in the city, for example, by taking measures aimed at reducing the number of (polluting) vehicles in the city. The nitrogen dioxide (NO_2) emissions from one lorry equal those from about 100 passenger cars. With the introduction of the low emission zone London is working towards cleaner air.

REQUIREMENTS FOR LORRIES

When is a lorry allowed to drive into the city and when is it not?

Lorries, busses, vans, pickup trucks and 4x4s with diesel engines that emit a lot of particulate matter and exhaust gases are not allowed to drive into the city. Vehicles with a 'clean' engine (e.g. a new engine, a gas vehicle or one with approved 'filter' fitted to the exhaust pipe) are allowed to drive into the city without paying a daily charge (£100 for vans and £200 for Lorries and buses).



VEHICLE REQUIREMENTS

REQUIREMENTS

Since January 2012, 98% of vans and minibusses and 90% of lorries and busses in the LEZ now meet the new emission standards.

POLLUTION

Since being introduced in 2008, the LEZ has reduced emission of particulate matter by 28 tonnes (equivilant of 160 return trips to the moon.

Source: www.cleanairforlondon.or.uk/sites/default/files/measures.

LOW EMISSION ZONE

Task

1. Read the information on the low emission zone first. London has air-quality problems and is trying to improve the quality of its air by introducing the low emission zone.
2. Explain how the measure taken by the Greater London Authority helps improve air quality. For your explanation you can use the worksheet and the pictures below or make a drawing yourself.
3. The other groups have also been given a task. In about half an hour you will explain your results to each other. Prepare a nice poster, explaining how the environmental zone helps improve air quality.

YOUR EXPLANATION SHOULD CLEARLY MENTION:

1) What is the problem?
2) What is the measure taken?
3) How does the environmental zone help improve air quality?

APPENDIX 6D

TATA STEEL Information

The information below relate to the company TATA STEEL. TATA STEEL is located near Port Talbort in Wales, and is the second-biggest steel producer in Europe. This steel is used in the automotive industry, in the railways, in construction and in the packaging sector (e.g. drink cans, spray cans). Steel is produced at very high temperatures (up to 1300-1400 °C). It involves the combustion of materials and produces a lot of air pollution. You are now going to read about a measure taken by TATA STEEL to improve air quality.

TATA STEEL STARTS UP NEW BLAST FURNACE NO 4

Welsh First Minister, Carwyn Jones called the project to rebuild No 4 furnace at Tata Steel, Port Talbort "a significant long term investment" **Early tests on the new furnace which cost £185 million to rebuild have been good and it should be fully working by the end of the year. The old furnace was decommissioned in July 2012 before being completely rebuilt incorporating the patest technology to improve energy efficency, environmental performance and safety standards. The new covered conveyer belt should also help to reduce dust emissions from the site.**

TATA STEEL ACHIEVES SIGNIFICANT ENVIRONMENTAL GAINS WITH NEW FURNACE

Blast furnace No 4 was orgionally built in 1956 and rebuilt in 1992. It has worked continuously 24 hours a day, 7 days a week, 365 days a year. The only exception to this was when scheduled maintance took place. Planning for the new rebuild of blast Furnace No4 started in 2007, and building it cost £185 million and took around four months to complete. It was part of a £240 million investment in the site to improve environmental performance, health and safety and production.

Making steel does create environmental impacts, but the new blast furnace should reduce these impacts as it uses the latest technology to control emissions. Tata Steel works with the Environment Agency and the local Council to monitor air quality, especially partiulate matter less than 10 microns (PM_{10}). Measures that have been taken to reduce levels of PM_{10} from the steel works include enclosing the storage bays for raw materials, improving lorry wheel washing and load covering and building a distribution road on site to remove HGV traffic from residential areas. The rebuilt blast furnace No4 has lots of technology to make the production of steel more efficent (and thus produce less pollution in the first place) and to reduce PM_{10} emissions. A cyclone (like a big dyson vacumn cleaner) which is 80-85% efficent has been installed to remove the dust and collect it for safe disposal. Following the rebuild of blast furnace No4 there PM10 pollution did not exceed its allowed limits in 2013.

Source: 'Neath Port Talbort air quality progress report 2014, Siemens industry report., BBC.co.uk

APPENDIX 6E

TATA STEEL
Task

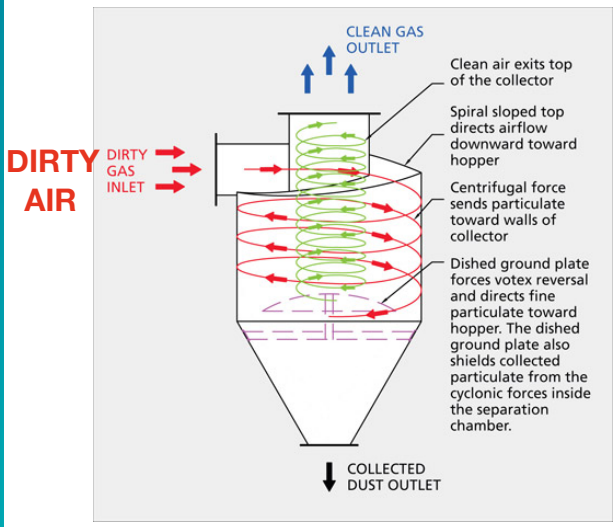
1. First read the above information. Steel manufacturer TATA STEEL has rebuilt a blast furnace to improve air quality.

2. Explain how the measure taken by TATA STEEL help to improve air quality. For your explanation you can use the worksheet, the pictures below or make a drawing yourself.

3. The other groups have also been given a task. In about half an hour you will explain your results to each other. Prepare a nice poster, explaining how TATA STEEL contributes to improving air quality. Your poster will be pasted on another larger poster in the classroom when you have finished, together with the assignments of the other groups.

Your explanation should clearly answer the following questions:

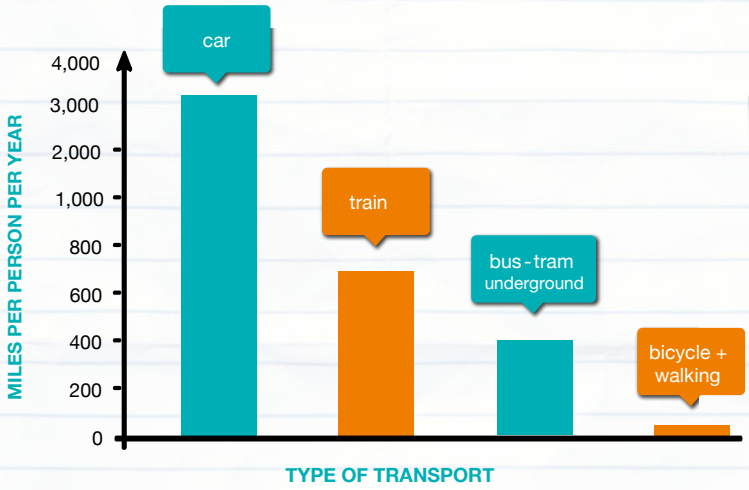
1) What is the problem?
2) What is the measure taken?
3) How does the measure help to improve air quality?



APPENDIX 6F

ENVIRONMENTALLY FRIENDLY TRANSPORT Information

A main cause of air pollution is traffic. Every day people travel from home to work and back. If they use the car for this it is not good for air quality. Bicycles or public transport, by contrast, are environmentally friendly modes of transport .



USE OF PUBLIC TRANSPORT AND MOTOR CARS

The public transport network in a big city may consist of a mixture of trams, buses, the underground, ferries, and trains. Do you ever use one of these means of transport?

The graph above shows the number of miles each person travels each year by type of transport. The figures date from 2014 (for whole of Great Britian). It is clear that most people do most of their journeys by car (3,223 miles per person per year). As you can see in the graph above, far fewer miles per person per year are travelled by public transport and bicycle. Added together, they do not come even near the distance travelled by car:

Train + Bus/Tram/underground + Bicycle = 1,194 miles per person per year, which is just over a third of the distance travelled by car.

ENVIRONMENTALLY FRIENDLY TRANSPORT

Travelling by car isn't very good for air quality. Taking the train is a more environmentally friendly option. Electric transport such as trains, trams and subway systems are better for air quality than the average car. Even buses are not that good for air quality. Most buses drive with diesel engines. Diesel engines cause air pollution. It is nevertheless better for air quality if lots of people travel by one bus instead of using lots of their own cars. Many cars added together will cause more air pollution than a single bus.

What if it's absolutely necessary to travel by car?

There are ways to lower the emission of your vehicle. Buy a new, more economic car, or opt for an electric one. You could also travel with several people together (car-pooling) or share your car with others (car clubs).

APPENDIX 6G

ENVIRONMENTALLY FRIENDLY TRANSPORT

Task

1. First read the information on environmentally friendly transport. Most big cities in the UK have air-quality problems. Use of environmentally friendly transport helps improve air quality.
2. Explain how the use of environmentally friendly transport helps improve air quality? For your explanation you can use the worksheet, the pictures below or make a drawing yourself.
3. The other groups have also been given a task. In about half an hour you will explain your results to each other. Prepare a nice poster, explaining how the use of environmentally friendly transport helps improve air quality. Your poster will be posted in the classroom when you have finished, together with the assignments of the other groups.

YOUR EXPLANATION SHOULD CLEARLY MENTION:

1) What is the problem?
2) What might be done to solve the problem?
3) How does the use of environmentally friendly transport help improve air quality?

APPENDIX 6H

Post-it
TASK

1. Think of the ways you (or your family) cause air pollution in the city.

2. Write these on the red post-it.

3. Try to think of ways for you (or your family) to cause less air pollution.

4. Write these on the green post-it.

5. Put the red and green post-its on the poster.

LESSON 1.

Worksheet

LESSON 2.

Worksheet

LESSON 3.

Worksheet

LESSON 4.

Worksheet

○

○

4D EXTRA

Neatly cut out all of the stickers and put them on the poster of appendix 4A.

After the task you can put the stickers on the appropriate pictures of appendix 4D.


03


ELECTRIC