Deliver Change

Key Stage 4 AQA BIOLOGY 4401
GCSE

Lesson 5: "Effects of air pollution on the environment and the effect this has on plants and animals"

Divided into two Parts:
Length of Part 1 can take 1 hr 15 minutes
Length of Part 2 can take 45 minutes

Version 2, May 2012
For Exams June 2014 onwards
Lesson Topics:
B1.4 Interdependence and adaptation
B2.4 Organisms and their environment
B3.4 Humans and their environment
http://filestore.aqa.org.uk/subjects/AQA-BIOL-W-SP-14.PDF *page 20, 34 and 54*

CURRICULUM

3.3 Unit 1: Biology 1
B1.4 Interdependence and adaptation
Evaluate data concerned with the effect of environmental changes on the distribution and behaviour of living organisms

CURRICULUM

3.3 Unit 1: Biology 1
B2.4 Organisms and their environment
Evaluate methods used to collect environmental data, and consider the validity of the method and the reproducibility of the

CURRICULUM

3.5 Unit 3: Biology 3
B3.4.1 Waste from human activity
P*art a.* Rapid growth in the human population and an increase in the standard of living means that increasingly more waste is produced. Unless waste is properly handled, more pollution will be caused
P*art b.* Waste may pollute: Air, with smoke and gases such as sulphur dioxide, which contributes to acid rain

LESSON PLAN

Part 1: Students will be reminded of key outdoor air pollutants, how they are formed and their environmental effects. This understanding allows students to be taught about the impact that some of these pollutants can have when they react in the air, to form acid rain.

This is followed by a student activity based around investigating the pH scale. Students will brainstorm and share their beliefs and opinions as to what constitutes acid rain. Students will investigate the pH scale and determine the pH of substances to gain a better understanding of what constitutes as acidic, basic, and neutral. This class includes a student activity based around investigating the pH scale. Each student will receive a lab sheet which they will complete in class.

Part 2. (This can also be set as homework.) In this part there is a focus around the impact of environmental change on animals and plants.

Students are asked to watch a video, as well as access the LAQN website. Students in their next task are asked to understand these two external sources of data information, plot graphs and use variables.

LEARNING OBJECTIVES

Students will:

- Be able to list a number of anthropogenic pollutants that pose problems to human and environmental health.
- Describe the processes of Acid Rain and suggest problems caused by acidic rainfall.
- Test the pH levels of various substances to learn about the pH scale: acids, bases, and neutrals.
- Gain practice and familiarity with the concept and measurement of pH, the use of Universal Indicator solution, and the Universal Indicator colour chart.
- Develop the scientific background and terminology necessary for understanding the range of acidity of acid rain
- Watch a short video about how environmental change influences the population of plant and animal life
- Develop their previous practical observations of natural pollution indicators and be confident to use data from the London Air Quality Network to judge areas of highest air pollution.

LESSON REQUIREMENTS:

- AirSensa data from school and London average
- Paper and pens
- Web access
- PH testing materials (see part 1, class activity)

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Part 1

Outdoor Air Pollution

Introduction
As the human population grows, so does the amount of waste we produce. This waste comes in many forms, one of which is outdoor air pollution, most notably caused through industrial processes and transport methods that utilise combustion engines.

Many pollutants are released as a byproduct of the combustion of fossil fuels to find their way into the atmosphere and impact the air that we breathe. These pollutants include carbon monoxide, oxides of nitrogen and sulphur dioxide and are primarily found in the air around its combustion source. Their environmental effects are described in the table below.

Pollutant	Environmental effects
carbon monoxide	poisonous gas formed by incomplete combustion of petrol- or diesel-powered motor vehicles
oxides of nitrogen	photochemical smog acid rain formed by reaction of nitrogen and oxygen at very high temperatures such as in an internal combustion engine
sulfur dioxide	acid rain formed from sulfur impurities when fossil fuels burn

Impact on the environment: Acid Rain

Though outdoor air pollution can have direct impacts upon human health through exposure to pollutants, it can also have environmental impact that later leads to implications for humans, but also for other animals and plants in the environment. Today we will learn about the formation of acid rain, the impact and the effect on the living environment. Understanding whether common solutions are acidic or alkaline as a result of their composition will help us understand the impact that the tiny particles that make up such solutions can have.

The Acid Rain Problem
Carbon dioxide in the air can dissolve in rain water to form carbonic acid, H_2CO_3.

$CO_2 + H_2O \rightarrow H_2CO_3$
Carbonic acid gives natural rain water a slightly acidic pH value of 5.6. Anything under pH 7 is acidic, anything above pH 7 is alkaline, and pH 7 is neutral.

Image from Lab Monsters: http://www.labmonsters.com/cross-disciplinary-labs/natural-ph-indicators/

Over millions of years this very dilute acidic solution has been responsible for the formation of caves in areas of limestone rocks. Limestone is made of calcium carbonate, which reacts with acids.

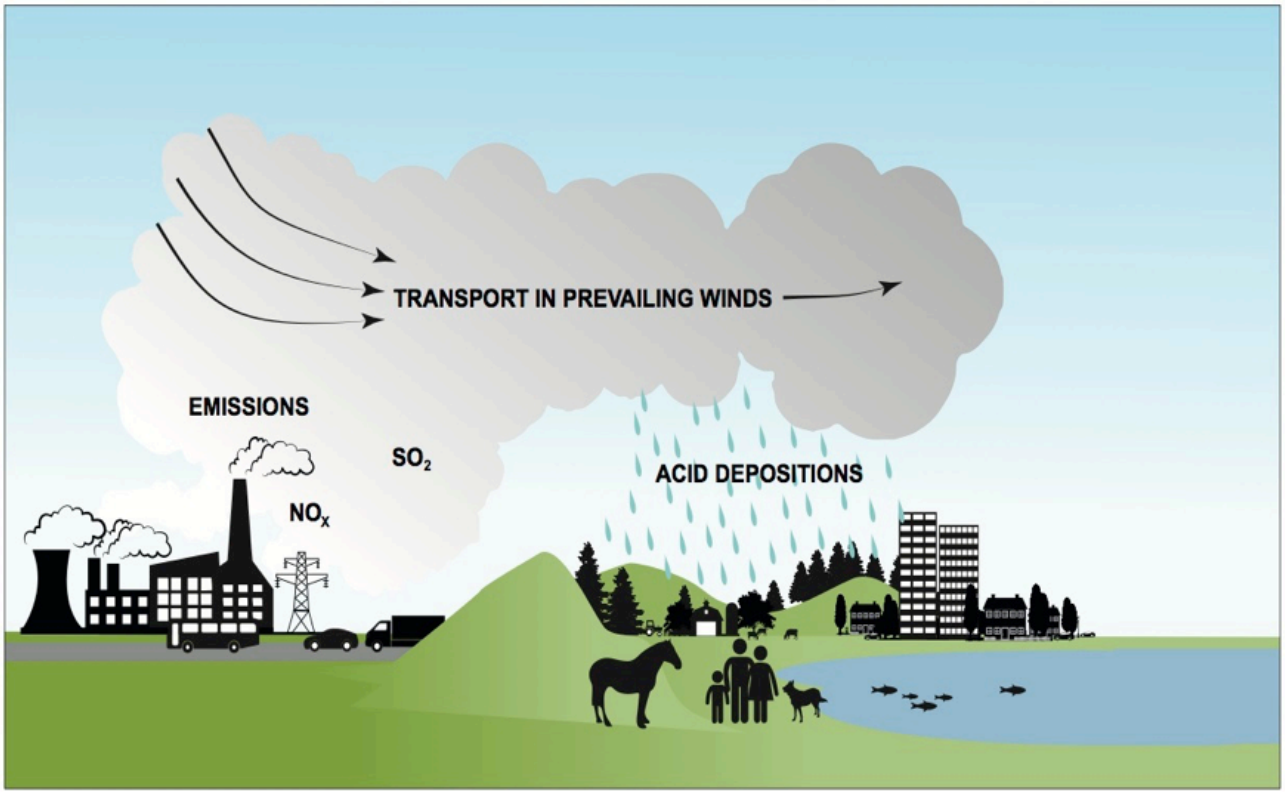
calcium carbonate + acid calcium salt + water + carbon dioxide

During the last century the rain water in some parts of the world has become far more acidic. This acid rain has been caused by the emission of pollutant gases such as sulphur dioxide. When coal is burned in electricity power stations, sulphur impurities form sulphur dioxide.
$S + O_2 = SO_2$

The gas is also produced when fuels obtained from crude oil are burned. When sulphur dioxide is released into the air it reacts with water and oxygen to form sulphuric acid, H_2SO_4.

Sulphuric acid gives rain water a pH below 5.0, making it more acidic than carbonic acid. Rain water with higher level of acidity can cause damage to buildings and statues, particularly those made of limestone. It can also reduce the growth of, or even kill, trees and crops. Acid rain may even lower the pH of water in lakes, killing fish.

The image below may be helpful in explaining the basics of acid ran.



Class activity

Investigation Overview:
Students will investigate the pH scale and determine the pH of substances to gain a better understanding of what constitutes as acidic, basic, and neutral.

Activity:
Overview: First, students will observe a teacher demonstration to learn how to test solutions for pH levels. Second, they will participate in an activity to test the pH of various substances.

Materials Required

- pH data sheets
- Safety goggles
- Approximately 1 Litre of distilled water
- Approximately 1 Litre of tap water
- rain water
- Baking soda and one litre of container for making the baking soda solution
- Access to a sink for washing and rinsing
- Lemon juice
- 1 Universal Indicator colour chart

Advance Preparation:
Prepare in advance for each group a tray with a set of labeled plastic cups containing: Tap water, normal rain (*distilled water that has been exposed to the environment for at least a week*), lemon juice, vinegar, and baking soda solution (4 tablespoons /500 ml tap water). Additionally, each group will need a squeezed bottle labelled "Universal Indicator", the Universal Indicator colour chart and safety goggles.

Teacher Discussion:
First draw out and discuss the pH scale. Point out on the 1-14 pH scales that scientist classify chemical into three groups according to how they react: *acids, bases (alkaline),* and chemicals that are neither of these are called *neutral*.

Discuss some of the shared properties of "acids": sour-taste, breaks-up proteins, dissolves metals, conduct electricity. Discuss some of "bases": baking soda, soap, toothpaste, ammonia, drain-cleaner, and milk of magnesia. You may also mention other substances with weaker acidity and alkalinity strength to show substances can be all along the scale.

Explain they will be testing a variety of substances to see where the substances belong on the pH scale, but first you (the teacher) will model for the class the testing of normal rain (distilled water) to see where it belongs on the pH scale. Explain and show how to use the Universal Indicator solution and plot the pH of the normal rainwater.

Student Activity:

Have students make predictions about the substances they will test and record those predictions on their lab sheet before they conduct the pH level for each substance. After they have made their predictions, have the students conduct the pH test on the various substances. If the students find the colour of the test too faint, too dark or cloudy have them enter more Indicator Solution. Have them read and complete the lab sheet.

Teacher Activity:
Pool from the class groups the measured pH data from the tap water, baking soda solution, lemon juice, normal rain, and vinegar from groups as they finish their testing.

When all the results are posted, ask general questions about the results:
1. Which substances were the most acidic, basic, etc*/*
2. What substances if any varied extremely in the measured pH level?

You may also inquire if they have any questions and other personal observations. Finally, poll the class for their predicted pH values of given substances. Ask students to justify their thoughts and findings.

Students will each receive a copy of the Lab Sheet.

Homework activity

Students can either team up in groups, pairs or conduct this activity on their own:
The class will be asked to develop a list of what they recall about acid-rain, what they may have heard about acid-rain and*/*or any questions about acid-rain. From group reports, the teacher will compile a classroom-generated list of statements and questions about acid rain. Post this list in the classroom to serve as a useful tool for students to sort out the scientific validity of hearsay information, and, as the unit progresses, to factual information from statements more related to social values and global change. An optional extension of the posting could be to post another classroom-generated list titled*: What We Don't Know About Acid Rain*.

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Lab Sheet

A. Testing pH of Substances

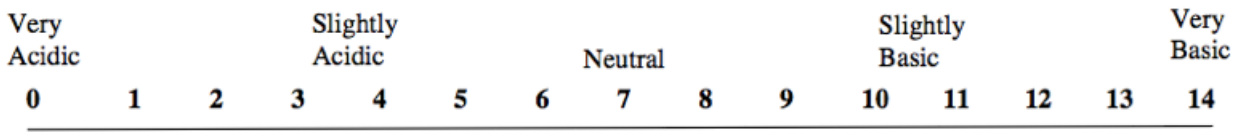
1. Choose a test solution.
2. Record your prediction of that solution's pH on this sheet.
3. Squirt a small amount of test solution into a compartment in test tray.
4. Carefully add 2 drops of Universal Indicator to the liquid in the tray and gently swirl the mixture.

Test Solutions	My Prediction	My Result
1. Tap water		
2. Baking soda solution		
3. Normal rain		
4. Lemon juice		
5. Vinegar		

5. Match each colour of the mixture to the pH chart and decide what pH the test solution is.
6. Record your test result (pH number) on this sheet.
7. Repeat this procedure until you have tested all five solutions.

Recording the pH of Substances

Write the name of each solution *you tested* where it belongs on the pH scale below.



name .....

Part 2 / Homework

Task 1
Ask the class to watch the following video, and take notes.
https://www.youtube.com/watch?v=PTCWjI6txKE

It will be important to understand the impact that environmental change can have on the population of certain animal and plant life forms.

Students should pay particular attention to the graphs drawn to represent the relationships between pollution increase / decrease and the plant or animal population increase / decrease in response.

Task 2
Students are asked to:
2.1 Access the London Air Quality Network (LAQN) website and find the section at the bottom called TOOLS.

2.2 Click on GRAPH DRAWING and it will take you to a series of options.
Use these to (a) Select a Site in London, and (b) Select a Pollutant. Then plot the graph.

2.3 In a new window, repeat this process for the *same location* but *different pollutant.*

2.4 Compare the two graphs.
Do you notice any relationships between the two graphs? Do the pollutants increase proportionately? Do they have

2.5 Now use those graphs and add in another *variable*, such as temperature, wind direction, or something you prefer to consider.

Using words such as 'relationship', 'influence', and 'correlation', try describe what your investigation reveals about the pollutants and the selected variable.