Deliver Change

Key Stage 4 EdExcel BIOLOGY 2BIO1
GCSE

Lesson 1: "Outdoor air pollution, acid rain and the pH scale"

Divided into two parts
Length of Part 1: 30 minutes
Length of Part 2: 45 minutes

For First Certification 2014
Lesson Topics:
Unit B1: Influences on Life
Unit B2: The Components of Life
http://www1.edexcel.org.uk/science2011/GCSE_Biology.pdf page 24 & 29

CURRICULUM

B1: Influences on Life
3.21
Explain how the increase in human population contributes to an increase in the production of pollutants, including phosphates, nitrates and sulphur dioxide (acid rain)

CURRICULUM

B2: The components of life
2.23

LESSON PLAN

This class is divided into two parts.

- Part 1: students will be reminded of key outdoor air pollutants (separate resource available for more information), how they are formed and their environmental effects. This understanding allows students to learn about acid rain, including its composition and effects.
- Part 2: 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 that they will complete in class.

Students are given a short homework activity, which will be looked over by the teacher.

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.

LESSON REQUIREMENTS:

- Lab sheet
- 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

ADDITIONAL: 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*.

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 use 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

Outdoor air pollution can directly impact human health when we are exposed to them, and can also have other environmental implications on plants, animals, waterways, trees and buildings. Today we will learn about the formation of acid rain and it's impact on the living environment.

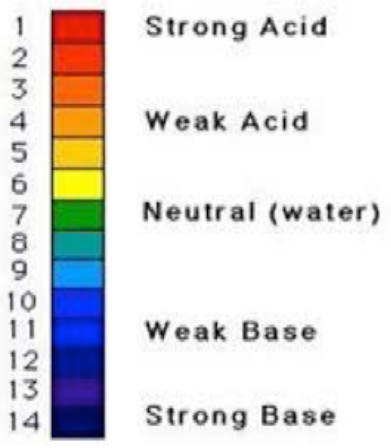
The Acid Rain Problem

Carbon dioxide in the air can dissolve in rainwater 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

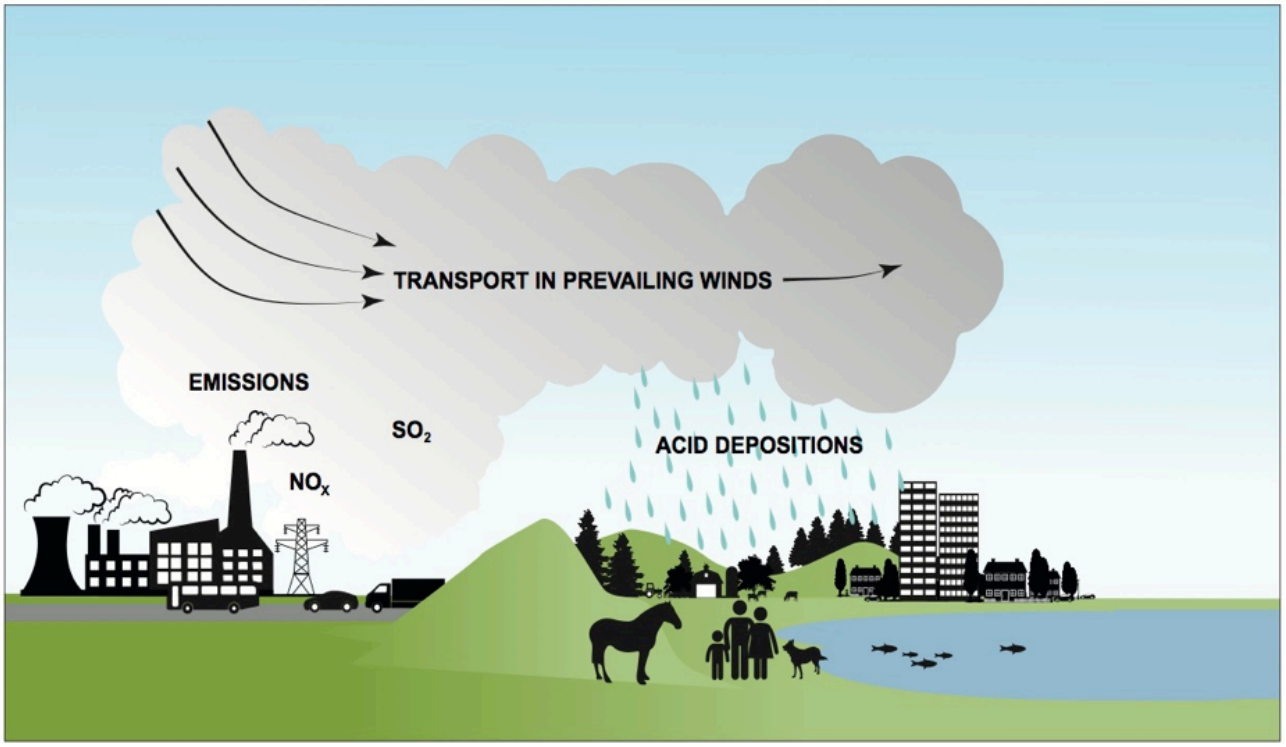
During the last century the rain water in some parts of the world has become far more acidic. This acid rain has been caused by the emission of pollutant gases such as sulphur dioxide. When coal is burned in electricity power stations, sulphur impurities form sulphur dioxide.

$$S + O_2 = SO_2$$

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.



Part 2

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 labelled 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.

name .....

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.
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.

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

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