Name:

ACID RAIN ASSIGNMENT

1. Define acid. Provide examples of acids.
2. Define base. Provide examples of bases.
3. Define pH scale (in a way you can understand).
4. Define acid rain.
5. Explain the pH difference between acid rain, normal rainfall, and pure water.
6. Describe the major causes of acid rain.
7. What are the main chemicals in the air that create acid rain?
8. What are the impacts of acid rain?
9. Which region of the Continental United States is most affected by acid rain, and why?
10. Which region is least affected by acid rain, and why?
11. * What did the U.S. government do at first to reduce acid rain, and did it work?
12. Which animal species is the most sensitive to acidity (low pH), and what has been the result?
13. * What is the difference between granite, sandstone, limestone, and marble (remember we are talking about acids and bases today)?
14. Which type of the rocks above is most sensitive to acids?

* may need to use internet

WHAT IS ACID RAIN

Lesson 6 Activity 1

Reading 1

Since the beginning of time, humans have learned to make use of many things in nature such as fire and electricity. From the early times through the Industrial Revolution to the Space Age, humans have produced inventions that use many of the earth's varied energy resources to make living easier. In many cases the energy comes from burning fossil fuels—coal, oil and natural gas.

Some of the inventions that make our lives easier are also causing pollution. Pollution is the release of harmful substances into the environment. One form of pollution is acid rain. Acid rain is any form of rain that is more acidic than normal (with a pH lower then 5.6). Pure water has a pH of 7, normal rainfall has a pH of a bit less than 7, but acid rain can have a pH of about 5.0-5.5, and even in the 4 range in the northeastern United States.

Acid rain can damage plants, animals, soil, water, building materials, and people. Scientists have discovered that air pollution from the burning of fossil fuels is the major cause of acid rain. People burn fossil fuels such as coal and oil to make electricity. Electricity heats and lights buildings and runs appliances such as televisions and video recorders. Fossil fuels power our cars, buses, and airplanes. The air pollution created when these fuels burn does not stay in the air forever. It can return to the earth as acid rain. And when it does, it may weaken the plant and animal life it contacts. Acid rain is only one form of pollution that results from burning fossil fuels. It is one of particular interest, however, because it can be transported over long distances. Scientists, engineers, and researchers are learning how to measure the amount and effects of pollution in the air, forests, water, and soil. They are inventing ways to reduce the amount of pollution that enters the environment and prevent new damage in the future.

The smoke and fumes from burning fossil fuels rise into the atmosphere and combine with the moisture in the air to form acid rain. The main chemicals in air pollution that create acid rain are sulfur dioxide (SO_2) and nitrogen oxide (NO_x). Acid rain usually forms high in the clouds where sulfur dioxide and nitrogen oxides react with water, oxygen, and oxidants. This mixture forms a mild solution of sulfuric acid and nitric acid. Sunlight increases the rate of most of these reactions. Rainwater, snow, fog, and other forms of precipitation containing those mild solutions of sulfuric and nitric acids fall to earth as acid rain.

The chemical reactions that change air pollution to acid rain can take from several hours to several days. Years ago, when smokestacks were only a few stories high, pollution from smokestacks usually stayed near the ground and settled on land nearby. This caused unhealthy conditions for plants and animals near the smokestacks. To reduce this pollution, the government passed a law permitting the construction of very tall smokestacks. At that time, people thought that if the pollution were sent high into the air it would no longer be a problem. Scientists now know that this is incorrect. Sending pollution high into the sky increases the time that the pollution stays in the air. The longer the pollution is in the air, the greater are the chances that the pollutants will form acid rain. In addition, the wind can carry these pollutants for hundreds of miles before they become joined with water droplets to form acid rain. For that reason, acid rain can also be a problem in areas far from the polluting smokestacks.

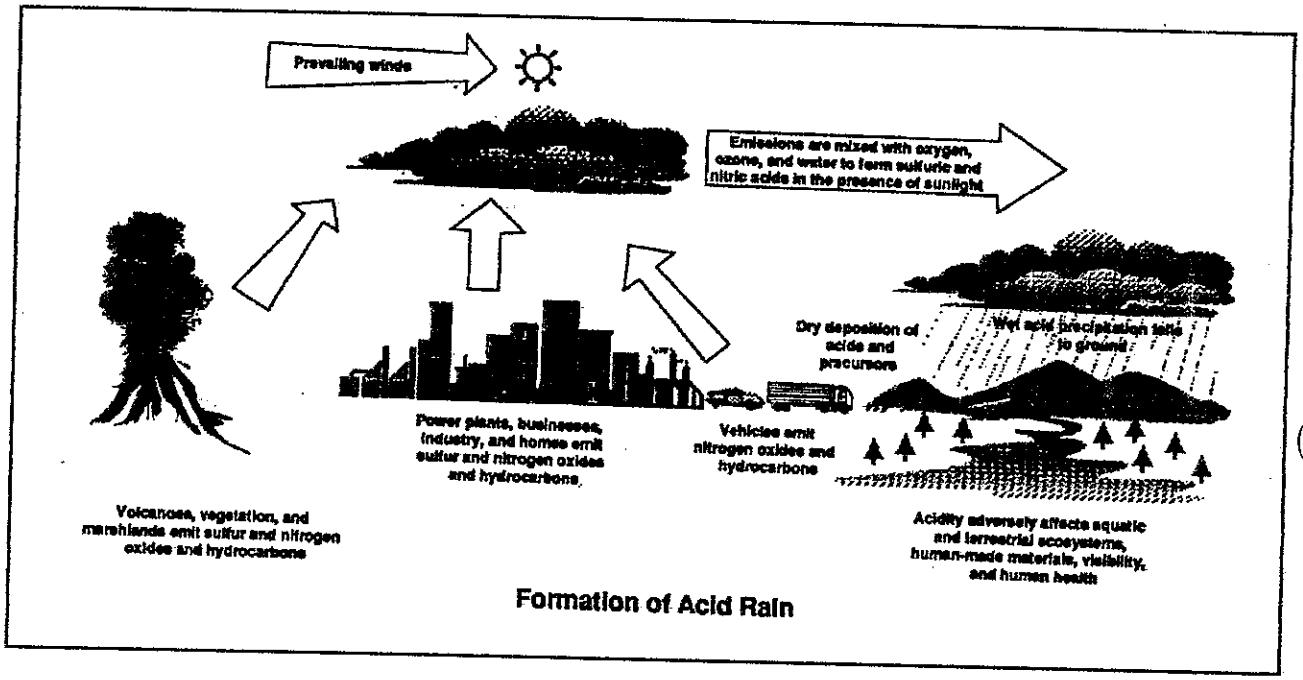
The region of the Continental United States most affected by acid rain is the Northeast, where pH levels of between 4.0 and 4.5 are commonplace. Notably, the most rapid increase in acid precipitation in the U.S. seems to be in the Southeast, an increase paralleling the expansion of Southeastern urban and industrial activities that result in sulfur and nitrogen emissions.

West of the Mississippi, rain is generally neutral or even alkaline. Colorado, the Los Angeles Basin, the San Francisco Bay Area, Spokane, Tucson, and Portland are the known exceptions. In these locations, as in the Northeast, precipitation ranges from between pH 4.0 to 5.0.

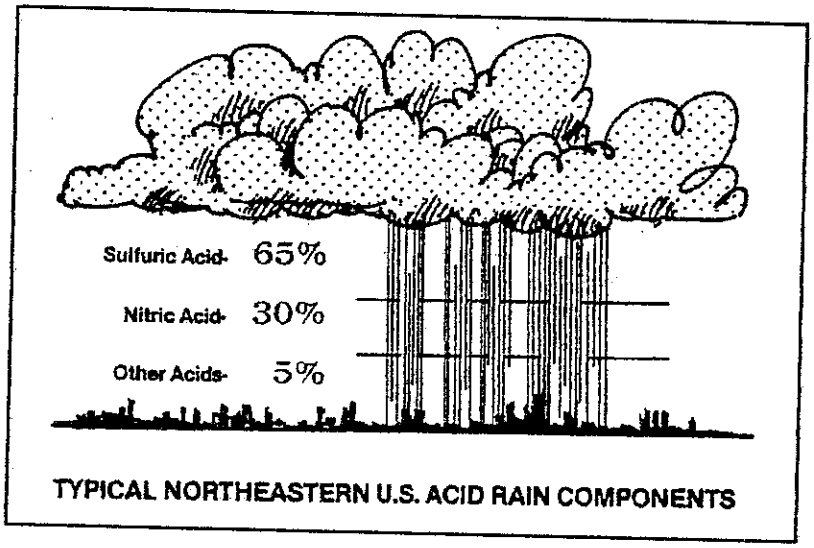
Source: *Acid Rain. A Student's First Sourcebook.* EPA, Washington, DC

EFFECTS OF ACID RAIN

Lesson 6 Activity 2
Handout 4



Formation of Acid Rain



TYPICAL NORTHEASTERN U.S. ACID RAIN COMPONENTS

Source: *Acid Rain. A Students' First Sourcebook.* EPA, Washington, DC

FACTSHEET

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Acid Rain

What is Acid Rain?

Acid rain is a result of air pollution. When any type of fuel is burnt, lots of different chemicals are produced. The smoke that comes from a fire or the fumes that come out of a car exhaust don't just contain the sooty grey particles that you can see - they also contains lots of invisible gases that can be even more harmful to our environment.

Power stations, factories and cars all burn fuels and therefore they all produce polluting gases. Some of these gases (especially nitrogen oxides and sulphur dioxide) react with the tiny droplets of water in clouds to form sulphuric and nitric acids. The rain from these clouds then falls as very weak acid - which is why it is known as "acid rain".

How acidic is acid rain?

Acidity is measured using a scale called the pH scale. This scale goes from 0 to 14. 0 is the most acidic and 14 is the most alkaline (opposite of acidic). Something with a pH value of 7, we call neutral, this means that it is neither acidic nor alkaline.

Very strong acids will burn if they touch your skin and can even destroy metals. Acid rain is much, much weaker than this, never acidic enough to burn your skin.

Rain is always slightly acidic because it mixes with naturally occurring oxides in the air. Unpolluted rain would have a pH value of between 5 and 6. When the air becomes more polluted with nitrogen oxides and sulphur dioxide the acidity can increase to a pH value of 4. Some rain has even been recorded as being pH2.

Vinegar has a pH value of 2.2 and lemon juice has a value of pH2.3. Even the strongest recorded acid rain is only about as acidic as lemon juice or vinegar and we know that these don't harm us - so why do we worry about acid rain?

The Effects of Acid Rain

Acid rain can be carried great distances in the atmosphere, not just between countries but also from continent to continent. The acid can also take the form of snow, mists and dry dusts. The rain sometimes falls many miles from the source of pollution but wherever it falls it can have a serious effect on soil, trees, buildings and water.

Forests all over the world are dying, fish are dying. In Scandinavia there are dead lakes, which are crystal clear and contain no living creatures or plant life. Many of Britain's freshwater fish are threatened, there have been reports of deformed fish being hatched. This leads to fish-eating birds and animals being affected also. Is acid rain responsible for all this? Scientists have been doing a lot of research into how acid rain affects the environment.

Forests

It is thought that acid rain can cause trees to grow more slowly or even to die but scientists have found that it is not the only cause. The same amount of acid rain seems to have more effect in some areas than it does in others.

As acid rain falls on a forest it trickles through the leaves of the trees and runs down into the soil below. Some of it finds its way into streams and then on into rivers and lakes. Some types of soil can help to neutralise the acid - they have what is called a "buffering capacity".

Other soils are already slightly acidic and these are particularly susceptible to the effects of acid rain.

Acid rain can effect trees in several different ways, it may:

- dissolve and wash away the nutrients and minerals in the soil which help the trees to grow.
- cause the release of harmful substances such as aluminium into the soil.
- wear away the waxy protective coating of leaves, damaging them and preventing them from being able to photosynthesise properly.

A combination of these effects weakens the trees which means that they can be more easily attacked by diseases and insects or injured by bad weather. It is not just trees that are affected by acid rain, other plants may also suffer.

Lakes and Rivers

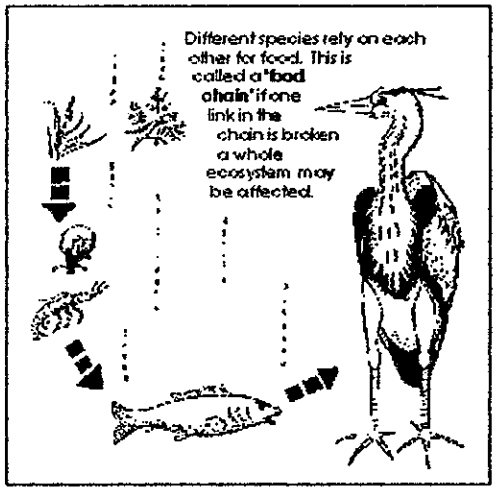
It is in aquatic habitats that the effects of acid rain are most obvious. Acid rain runs off the land and ends up in streams, lakes and marshes - the rain also falls directly on these areas.

As the acidity of a lake increases, the water becomes clearer and the numbers of fish and other water animals decline. Some species of plant and animal are better able to survive in acidic water than others. Freshwater shrimps, snails, mussels are the most quickly affected by acidification followed by fish such as minnows, salmon and roach. The roe and fry (eggs and young) of the fish are the worst affected, the acidity of the water can cause deformity in young fish and can prevent eggs from hatching properly.

The acidity of the water does not just affect species directly, it also causes toxic substances like aluminium to be released into the water from the soil, harming fish and other aquatic animals.

Lakes, rivers and marshes each have their own fragile ecosystem with many different species of plants and animals all depending on one another to survive. If a species of fish disappears, the animals which feed on it will gradually disappear too. If the extinct fish used to feed on a

particular species of large insect, that insect population will start to grow, this in turn will affect the smaller insects or plankton on which the larger insect feeds.



Buildings

Every type of material will become eroded sooner or later by the effects of the climate. Water, wind, ice and snow all help in the erosion process but unfortunately, acid rain can help to make this natural process even quicker. Statues, buildings, vehicles, pipes and cables can all suffer. The worst affected are things made from limestone or sandstone as these types of rock are particularly susceptible and can be affected by air pollution in gaseous form as well as by acid rain.

Where is it coming from?

Until relatively recently air pollution has been seen as a local issue. It was in southern Scandinavia in the late 1950's that the problems of acid rain were first observed and it was then that people began to realise that the origins of this pollution were far away in Britain and Northern Europe. One early answer to industrial air pollution was to build very tall chimneys. Unfortunately all this does is push the polluting gases up into the clouds allowing emissions to float away on the wind. The wind carries the pollution many hundreds of miles away where it eventually falls as acid rain. In this way Britain has contributed at least 16% of the acid deposition in Norway. Over ninety percent of Norway's acid pollution comes from other countries. The worst European polluters are Germany, UK, Poland and Spain, each of them producing over a million tons of sulphur emissions in 1994. Governments are now beginning to admit that acid rain is a serious environmental problem and many countries are now taking steps to reduce the amount of sulphur and nitrogen emissions.

What can be done?

Reduce emissions:

• Burning fossil fuels is still one of the cheapest ways to produce electricity so people are now researching new ways to burn fuel which don't produce so much pollution.

• Governments need to spend more money on pollution control even if it does mean an increase in the price of electricity.

• Sulphur can also be 'washed' out of smoke by spraying a mixture of water and powdered limestone into the smokestack.

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• Cars are now fitted with catalytic converters which remove three dangerous chemicals