Air Quality

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Academic Setting

This unit will be used at Rio Grande High School (RGHS). I am designing this unit to be used for tenth to twelfth grade students. The typical class size will be twenty five to thirty students. RGHS serves a predominately low-income, Hispanic, semi-rural population (about 2000 to 2500 students).

Goals of this unit

The goal of this unit is to introduce to students a general knowledge and awareness of air pollution. Many of my students suffer from asthma and allergies. I would like to teach my students that the quality of the air they breath is very important. Polluted air triggers asthma and allergies. This unit describes earth's atmosphere, the sources and effects of pollutants, and the national agencies and laws [Environmental Protection Agency (EPA), local and state environmental resources and agencies, Clean Air Act and National Ambient Air Quality Standards (NAAQ)] that are working to make air cleaner. Also this unit includes information on the existing air quality of the South Valley and the community involvement in solving the problems with air pollution.

Introduction

The atmosphere that surrounds the planet Earth is one of the factors that make our planet hospitable toward life. The average human makes use of about 30 pounds of air each day, using it to oxidize food for energy and warmth. This life- sustaining atmosphere is a mixture of gasses (Table-1-1) that is held around the surface of the earth by gravitational attraction of the planet's mass. Because it surrounds us so intimately, we've used it without thought to burn not only the food in our bodies, but also the coal in our furnaces and the gasoline in our cars. Almost equally without thought, we've used it to carry away our wastes-not only the carbon dioxide we exhale, but also the wastes from the furnaces and the cars and from our thousands of other activities. The atmosphere is, however, limited; although it seems essentially infinite from our individual human perspective, only a relatively thin layer (a few miles thick) is accessible to us our use in sustaining life and diluting wastes.

It's my purpose in this unit to consider the relationship between these two uses-how we use air for dumping wastes and how that might interfere with our use of it for sustaining life in the broadest sense.

Narrative

According to the dictionary, pollution is a synonym for contamination. Therefore air pollutants are things that contaminate the air in some manner. The federal government, as well as each state, has incorporated into law a more precise definition of air pollution. The legal definition is as follows:

> Air pollution is the presence in the outdoor atmosphere…. of any one or more substances or pollutants in quantities which are or may be harmful or injurious to human health or welfare, animal

or plant life, or property, including outdoor recreation.

By the preceding definition, any solid, liquid, or gas that is present in the air in a concentration that causes some deleterious effect is considered an air pollutant. However, there are several substances that, by virtue of their massive rates of emission and harmful effects, are considered the most significant pollutants.

Historical Perspective

The history of air pollution as we know it today begins with the Industrial Revolution, or more accurately, with the entire broad spectrum of economic and social change that began slowly in the eleventh century, produced by the steam engine and factories of the 1800s. The growth of industrialization spurred coal production, while the availability of coal sped the growth of industrialization. The overall effect, however, was an increasing burning of coal and a growing concern with the smoke and sulfurous odors that resulted. By 1820 there were regulations controlling the nature of burning (coal) in industrial furnaces. In the United States, the late 1800s brought the first smoke control laws, beginning with Chicago in 1881. By 1912 such laws had been passed by most of the largest American cities (Commoner).

Before World War I, London was affected by "smog" due to the mixture of smoke and fog. The world saw the smog problem in England largely as an unequally British phenomena (Wise). But in winter of 1930, in Belgium in the deep, narrow, highly industrialized valley of the Meuse River, a period of five days of abnormally high pollution killed 63 people and made several hundred others ill with pulmonary attacks. It was due to the tremendous accumulation of smoke and other pollutants (Lynn).

By the 1930s, St. Louis (along with Pittsburgh and many other cities) found itself increasingly burdened with the unpleasant effects of massive coal burning. By the late 1930s communities demanded an end to the darkness created in St. Louis by smoke, and by 1940 the law became effective which regulated the quality of fuel permitted to be used.

In 1945, the Los Angeles Basin of southern California faced the serious problem of "smog," soon resulting in legislation creating the Los Angeles County Air Pollution Control District. In October 1948, the killer smog struck Donora, Pennsylvania, a small industrial town of 12,000 in the valley of Monongehela River about 30 miles south of Pittsburgh. Between October 27th-31st pollutants from the town’s homes, a zinc smeller, a steel mill, and a sulfuric acid plant accumulated in the windless valley. Within two days 40 % of the people were sick, and by the third day, 20 had died.

In many ways "the Donora episode" marked the beginning of modern air pollution control in the United States and drew the federal government into the air pollution field. The Public Health Service of the United States made a retrospective medical study of Donora, and from this ultimately developed the present program of the Environmental Protection Agency (EPA).

Causes and Sources of pollutants

In this section we will briefly discuss some of the major pollutants with respect to their causes and sources. The cause explains why or how a pollutant is formed, whereas a source identifies what type of process, industry, or device discharges particular pollutants. For example, Table 1-2 presents data on emission rates from the major sources of the five major pollutants in the United States in 1981.

1. Particulate Matter

Particulates are very small diameter solids or liquids that remain suspended in exhaust gases and can be discharged into the atmosphere. They are caused by one of two fundamental types of processes. Material handling processes such as crushing or grinding ores or loading dry materials in bulk can emit small particles of noncombustible ash or incompletely burned soot. The particles are divided into two categories—those that settle out rapidly and those that remain suspended in the air for long periods—and the size ranges are labeled "dustfall" and "suspended particulate matter" respectively as shown in Table 1-3 (Lynn).

Dustfall

Dustfall is made by the particulate larger than about ten microns, which tend to settle to the ground rapidly. These are a problem only in the vicinity of the source of the dust as the particles settle before the wind can carry them very far.

Suspended Particulate Matter

Unlike dustfall, particles smaller than about ten microns in size remain suspended in the air for long periods of time. The turbulent motion of the air is able to keep them afloat more or less permanently, and these comprise the biggest part of air pollution. Both dustfall and suspended particulates are measured by weight (micro gram/meter cube).

Black Smoke

Black smoke is not really another type of particulate but rather a different way of looking at particulate pollution. It is visible and measured not by weight, amount or the chemical nature of the pollutant, but by a smoke inspector who observes the plumes from a smokestack and compares it with the Ringelmann chart.

2. Sulfur Oxides

Sulfur oxides (SO_2) are produced whenever sulfur or a material that contains sulfur is burned. As can be seen in Table 1-4, the main source is fossil-fuel combustion, although nonferrous metal smelting is also a major source. The primary sulfur oxide is SO_2, but SO_3 is also formed in furnaces. Most SO_2 is oxidized to SO_3 in the atmosphere.

3. Nitrogen Oxides

Nitrogen Oxides (NO_2) are formed whenever any fuel is burned in air. Nitrogen and oxygen in the air combine to form NO and NO_2 . Also, organically bounded nitrogen atoms present in some fuels can contribute substantially to NO_x emissions. Total U.S. emissions of NO_x are almost equally distributed between stationary sources and mobile sources (automobiles, trucks, planes, and so forth). As can be seen from Table 1-5 all other sources of NO_x are unimportant compared with the three primary sources—large electric utilities, industrial furnaces and transportation vehicles.

4. Carbon Monoxide

Carbon Monoxide (CO) is a colorless, odorless, tasteless gas that results from the incomplete combustion of any carbonaceous fuel. Power plants and other large furnaces are usually designed and operated carefully enough to ensure nearly complete combustion, and do not emit much CO. Thus the major source is the transportation sector. As shown in Table 1-6 automobiles, trucks, buses, airplanes and other vehicles produced about 70 millions metric tons of CO in 1981.

5. Volatile Organic Compounds

Volatile organic compounds (VOCs) include any organic with an appreciable vapor pressure such that they vaporize when exposed to air. VOC emissions are caused by incomplete combustion or by evaporation of organic liquids. As a group, automobiles and other vehicles from which small amounts of unburned fuel are released to the air, are the major source of VOCs. Surface coating operations (using solvent-based paints) are another major source. Petroleum production, refining, and marketing also account for substantial VOC emissions.

6. Photochemical Oxidants

Photochemical oxidants are caused by complex chemical reaction involving VOC and NO_x that are initiated by absorbing ultraviolet energy from sunlight. One of the main products of these reaction is ozone, a reactive oxidizer (ozone is not directly emitted from a source). Since VOCs and NO_x are emitted in a large quantities by motor vehicles, oxidants usually are a greater problem in large, warm-climate urban areas with heavy traffic.

Because the oxidants are secondary pollutants and because of the varying intensity of sunlight and other complicating factors, we can't relate the subsequent oxidant levels to the quantity of hydrocarbon and NO_x emissions very accurately. Table 1-7 shows an annual emission of hydrocarbons, estimates for 1970.

Effects of Pollutants

1. Effects of Particulate Materials

Particles in polluted urban air have been shown to increase fog formation and persistence (Robinson). On a larger scale, increased particulate concentration results in increased scattering and outright reflection of solar energy before it can reach the earth's surface. Increased rain and snow are also likely effects of particulates.

Deposition of particles can reduce the aesthetic appeal of structures and monuments. Structures and materials may need more frequent cleaning and/or painting. Particulates can intensify the chemicals effects of other pollutants, especially corrosion due to acid gases. Deposition of cement kiln dust on plants has been shown to cause leaf damage, especially in moist environments (National Research Council).

Airborne particles can effect human health in many ways. Certain pollutants may be toxic or carcinogenic (such as pesticides, lead, or arsenic). Particles may adsorb certain chemicals, and intensify their effects when held in the lungs for longer periods of time. Of special interest are the physical effects of particles on the normal functioning of the respiratory system

To cause lung damage, particles must penetrate the human respiratory system. Particles larger than about 2 to 5 microns generally do not penetrate deep into the lungs. They are intercepted by nasal hairs or settle onto the mucous membranes in the nasal or oral passages or trachea. Once captured on these membranes, insoluble particles are rapidly carried to the larynx through the normal combined action of ciliated and mucus-secreting cells. From there, particles can be swallowed or expectorated.

Very small particles (less than 0.1 microns) tend to be deposited in the tracheobronchial tree by diffusion. These are removed in the same manner as the large particles. Particles in the range 0.1 to 3 microns can penetrate deep into the lungs where they are then deposited in the respiratory bronchioles or alveolar sacs.

Ultimately effects of particles on human health are very difficult to quantify. Many epidemiological studies have been performed, but in all of the studies other pollutants were present with particulates. In the presence of the high SO_2 concentrations, there is a direct relationship between total suspended particles (TSP) concentrations and hospital visits for bronchitis, asthma, emphysema, pneumonia and cardiac disease (National Research Council). Also, elderly persons who suffer from a respiratory or cardiac disease have a significantly higher-than average risk of death when particulate concentrations are high for several days.

2. Effects of Sulfur Dioxide

In the atmosphere, sulfur dioxide is slowly oxidized to sulfur trioxide. Furthermore, NO_x and SO_3 can form acids when they hydrolyze with water, and the acids can then have detrimental effects on the environment. In addition, SO_2 has been associated with human health problems, damage to plants and animals, smog and haze through the formation of acid mists, and corrosion of materials.

The early history of sulfur dioxide pollution is associated with extensive damage to vegetation (Brandt and Heck). One of the major effects on green plants is chlorosis, or the loss of chlorophyll. Another is plasmolysis, or tissue collapse of the leaf cells. With SO_2 , both effects can occur with either short exposures to high concentrations or long exposures to lower concentrations.

The effects of short term intermittent exposures to SO_2 on animals are similar to those on humans except that animals are much less sensitive. SO_2 is soluble and is readily absorbed in the upper respiratory tract. In humans, the threshold levels for taste and odor are 0.3 ppm and 0.5 ppm, respectively (Stokinger and Coffin 1968). At concentrations above 1 ppm, some bronchoconstriction occurs; above 10 ppm, eye, nose and throat irritation is observed. SO_2 also simulates mucus secretion, a characteristic of chronic bronchitis (Goldsmith). The National Research Council in 1979 showed health effects due to SO_2.

3. Effects of Photochemical Oxidants and VOCs

Ozone (O_3) and peroxyacetyl nitrate (PAN) are two of the principal oxidizing agents formed as a result of atmospheric reaction involving NO_x and reactive VOCs . These oxidants are severe eye, nose, and throat irritants. Ozone attacks synthetic rubber (causing severe cracking) textiles, paints, and other materials. Oxidants cause extensive damage to plants by leaf discoloration and cell collapse (Brandt and Heck). Vegetation damage can occur at concentrations as low as 0.05 ppm and eye irritation begins at 0.10 ppm. Severe coughing occurs at 2.0 ppm.

Few VOCs have any known adverse effects on plants, animals, or materials. An exception is ethylene, which causes chlorosis and necrosis in broad-leaved plants (Brandt and Heck). General retardation of growth for several kinds of plants has also been reported. In addition to the displeasure experienced when exposed to certain odoriferous VOCs, they are carcinogenic, and many VOCs are reactive in the atmosphere (forming oxidants).

4. Effect of Carbon Monoxide

Carbon monoxide is essentially inert to plants or materials but can have significant effects on human health. CO is a colorless, odorless, tasteless gas that reacts with the hemoglobin in blood. The time of exposure effects human reaction from slight headaches to nausea to death.

The toxic effects of CO on humans are due solely to interactions of CO with blood hemoglobin (Stokinger and Coffin). When a mixture of air and CO is inhaled both oxygen and CO are transferred through the lungs to the blood. Both adsorb onto hemoglobin, but the equilibrium coefficient for CO is approximately 210 times as great as that for oxygen.

The most serious effects of atmosphere CO are expected for individuals already vulnerable to oxygen deficiency. People with anemia, those with chronic heart or lung disease, and those living at high altitudes are more at risk than others. Levels of HbCO in the blood as low as 2% to 5% have been shown to induce some effects.

Cigarette smokers knowingly and voluntarily pollute their lungs with the particulates VOCs and CO. Cigarette smoke typically contains 400 to 450 ppm CO (Wark and Warner). The blood of most smokers averages between 5% and 10% HbCO, whereas nonsmokers typically have 2% or so (Goldsmith). A heavy smoker caught in a traffic jam in a high-altitude city such as Denver could easily exceed 10% to 20% HbCO, which could result in headaches, fatigue, and impaired driving ability.

Greenhouse Effect

Different parts of the air pollution cycle are given different names—smog, urban pollution, acid rain, ground level ozone and the greenhouse effect, etc. In this unit we will be describing the greenhouse effect which is one of the major issues related to global warming.

The greenhouse effect is a naturally occurring process that aids in heating the earth’s surface and atmosphere. It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapor, and methane, are able to change the energy balance of the planet by absorbing long-wave radiation from the earth’s surface. Without the greenhouse effect, life on this planet would probably not exist, as the average temperature of the earth would be a chilly -18 degrees Celsius, rather than the present 15 degrees Celsius.

The Process

As energy from the sun passes through the atmosphere a number of things take place. A portion of the energy (26 % globally) is reflected back to space by clouds and particles. About 19 % of the energy available is absorbed by clouds, gases (like ozone), and particles in the atmosphere. Of the remaining 55 % of the solar energy passing through the earth’s atmosphere, 4 % is reflected from the surface back to space. On average about 51 % of the sun’s radiation reaches the surface. This energy is then used in a number of processes including the heating of the ground surface, the melting of ice and snow and the evaporation of water, and plant photosynthesis.

The heating of the ground by sunlight causes the earth’s surface to become a radiator of energy in the long-wave band (sometimes called infrared radiation). This emission of energy is generally directed to space. However, only a small portion of this energy actually makes it back to space. The majority of the outgoing infrared radiation is absorbed by a few naturally occurring atmospheric gases known as the greenhouse gases. Absorption of this energy causes additional heat energy to be added to the earth’s atmospheric system.

The now warmer atmospheric greenhouse gas molecules begin radiating long-wave energy in all directions. Over 90 % of this emission of long-wave energy is directed back to the earth's surface where it once again is absorbed by the surface. The heating of the ground by the long-wave radiation causes the ground surface to once again radiate, repeating the cycle described above again and again, until no more long-wave energy is available for absorption.

Enhanced Greenhouse Effect

The amount of heat energy added to the atmosphere by the greenhouse effect is controlled by the concentration of greenhouse gases in Earth's atmosphere. All of the major greenhouse gases have increased in concentration since the beginning of the Industrial Revolution (about 1700 A.D.). As a result of these higher concentrations, scientists predict that the greenhouse effect will be enhanced and Earth's climate will become warmer. Predicting the amount of warming is accomplished through computer modeling. Computer models suggest that a doubling of the concentration of the main greenhouse gas, carbon dioxide, may raise the average global temperature between 1 and 3 degrees Celsius.

However, the numeric equations of computer models do not accurately simulate the effects of a number of possible negative reactions. For example, many of the models cannot properly simulate the negative effects that increased cloud cover would have on the radiation balance of a warmer Earth. Increasing Earth's temperature would cause the oceans to evaporate greater amounts of water, causing the atmosphere to become more cloudy. These extra clouds would then reflect a greater proportion of the sun's energy back to space reducing the amount of solar radiation absorbed by the atmosphere and Earth's surface. With less solar energy being absorbed at the surface, the effects of an enhanced greenhouse effect may be counteracted.

Gases Involved

A number of gases are involved in the greenhouse effect. These gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFxClx), and tropospheric ozone (O_3). Of these gases, the single most important gas is carbon dioxide which accounts for about 55 % of the change in the intensity of the earth's greenhouse effect. The contributions of the other gases are 25 % for chlorofluorocarbons, 15 % for methane, and 5 % for nitrous oxide. Ozone's contribution to the enhancement of the greenhouse effect is still yet to be quantified.

Concentrations of carbon dioxide in the atmosphere are now approaching 360 parts per million. Prior to 1700, levels of carbon dioxide were about 280 parts per million. This increase in carbon dioxide in the atmosphere is primarily due to the activities of humans. Beginning in 1700, societal changes brought about by the Industrial Revolution increased the amount of carbon dioxide entering the atmosphere. The major sources of this gas were fossil fuel combustion for industry; transportation; space heating; electricity generation and cooking; and vegetation changes in natural prairie, woodland and forested ecosystems.

Emissions from fossil fuel combustion account for about 65 % of the extra carbon dioxide now found in our atmosphere. The remaining 35 % comes from the conversion of prairie, woodland and forested ecosystems primarily into agricultural systems. Natural ecosystems can hold 20 to 100 times more carbon dioxide per unit area than agricultural systems. Artificially created chlorofluoro-carbons are the strongest greenhouse gas per molecule. However, low concentrations in the atmosphere reduce their overall importance in the enhancement of the greenhouse effect.

Current measurements in the atmosphere indicate that the concentration of these chemicals may soon begin declining because of reduced emissions. Reports of the development of ozone holes over the North and South Poles, and a general decline in global stratospheric ozone levels over the last two decades, has caused many nations to cutback on their production and use of these chemicals. In 1987, the signing of the Montreal Protocol agreement by 46 nations established an immediate timetable for the global reduction of chlorofluorocarbon production and use.

Since 1750, methane concentrations in the atmosphere have increased by more than 140 %. The primary sources for the additional methane added to the atmosphere (in order of importance) are rice cultivation, domestic grazing animals, termites, landfills, coal mining, and oil and gas extraction. Anaerobic conditions associated with rice paddy flooding results in the formation of methane gas. However, accurate estimates of how much methane is being produced from rice paddies is difficult to obtain. More than 60 % of all rice paddies are found in India and China where scientific data concerning emission rates are unavailable. Nevertheless, scientists believe that the contribution of rice paddies is large because this form of crop production has more than doubled since 1950.

Grazing animals release methane to the environment as a result of herbaceous digestion. Some researchers believe the addition of methane from this source has more than quadrupled over the last century. Termites also release methane through similar processes. Land-use change in the tropics, due to deforestation, ranching, and farming, may be causing termite numbers to expand. If this assumption is correct, the contribution from these insects may be important. Methane is also released from landfills, coal mines, and gas and oil drilling. Landfills produce methane as organic wastes decompose over time. Coal, oil and natural gas deposits release methane to the atmosphere when these deposits are excavated or drilled.

The average concentration of nitrous oxide in the atmosphere is now increasing at a rate of 0.2 to 0.3 % per year. Sources for this increase include: land-use conversion; fossil fuel combustion, biomass burning, and soil fertilization. Most of the nitrous oxide added to the atmosphere each year comes from deforestation and the conversion of forest, savanna and grassland ecosystems into agricultural fields and rangeland. Both of these processes reduce the amount of nitrogen stored in living vegetation and soil through the decomposition of organic matter.

Nitrous oxide is also released into the atmosphere when fossil fuels and biomass are burned. However, the combined contribution to the increase of this gas in the atmosphere is thought to be minor. The use of nitrate and ammonium fertilizers to enhance plant growth is another source of nitrous oxide. How much is released from this process has been difficult the quantify. Estimates suggest that the contribution from this source represents from 50 % to 0.2 % nitrous oxide added to the atmosphere annually.

Ozone's role in the enhancement of the greenhouse effect has been difficult to determine. Accurate measurements of past long-term (more than 25 years in the past) levels of this gas in the atmosphere are currently unavailable. Moreover, concentrations of ozone gas are found in two different regions of the earth's atmosphere. The majority of the ozone (about 97 %) found in the atmosphere is concentrated in the stratosphere at an altitude of 15 to 55 kilometers above Earth's surface. In recent years, the concentration of the stratospheric ozone has been decreasing because of the build-up of chlorofluorocarbons in the atmosphere.

Since the late 1970s, scientists have discovered that total column ozone amounts over Antarctica in the springtime have decreased by as much as 70 %. Satellite measurements have indicated that the zone from 65 degrees North to 65 degrees South latitude has had a 3 % decrease in stratospheric ozone since 1978. Ozone is also highly concentrated at the earth's surface. Most of this ozone is created as a by-product of photochemical smog.

In summary, the greenhouse effect causes the atmosphere to trap more heat energy at the earth's surface and within the atmosphere by absorbing and re-emitting long-wave energy. Of the long-wave energy emitted back to space, 90 % is intercepted and absorbed by greenhouse gases. Without the greenhouse effect the earth's average global temperature would be -18 degrees Celsius, rather than the present 15 degrees Celsius. In the last few centuries, the activities of humans have directly or indirectly caused the concentration of the major greenhouse gases to increase.

Scientists predict that this increase may enhance the greenhouse effect making the planet warmer. Some experts estimate that the Earth's average global temperature has already increased by 0.3 to 0.6 degrees Celsius since the beginning of this century, because of this enhancement. Predictions of future climates indicate that by the middle of the next century Earth's global temperature may be 1 to 3 degrees Celsius higher than today.

Governmental Air Pollution Control Programs

The first governmental air pollution programs in this country were developed to reinforce the relay smoke-control laws in the major cities. By 1912, 23 of the 28 American cities with populations over 200,000 had such laws, passed by city councils under their state-delegated authority to protect the public health and welfare. Typically, these smoke-control laws specified the type of fuel-burning equipment that was to be used, how such equipment should be operated, and sometimes specified the type of the fuel that could be burned.

In 1947 California passed the first state law specifically directed at air pollution control. Developed out of the post-war concern about photochemical smog pollution in the Los Angeles Basin, this law provided specific enabling authority for countrywide air pollution control districts. The Los Angeles County Air Pollution Control District was immediately formed under this law, with a mandate somewhat broader than that of the smoke –control departments in the eastern cities. In the following years, other states adopted specific air pollution control legislation, and by the end of the 1950s there were active and growing efforts in many areas (Landau and Rheingold).

As part of this trend, the federal government came under increasing pressure to play a role and the result was the establishment, in 1955, of a federal air pollution program devoted primarily to conducting research and providing technical assistance to the states. Since then, the federal role has expanded considerably; today, local, state, and federal agencies are all involved in a vigorous, if not always completely coordinated, national program of pollution control.

The 1963 Initial Clean Air Act, administered through the Department of Health Education and Welfare, provided an opportunity for state and local governments to join the federal government in a national attack on air pollution. In 1967, the Air Quality Act called for systematic, regional efforts to combat air pollution. In 1970 the newly formed U.S. Environmental Protection Agency (EPA) established National Ambient Air Quality Standards (NAAQS), as shown in Table 1-8, for criteria pollutants, enforcement authority through State Implementation Plans (SIPs), Air Quality Control Regions, New Source Performance Standards, National Emission Standards for Hazardous Air Pollutant, carbon monoxide and oxides of nitrogen, and hydrocarbon reduction goals for automobile manufacturers.

In 1977 amenments were established as EPA guidelines for state and local governments in standardizing procedures and methods for ambient air monitoring for criteria pollutants with NAAQS. Quality assurance requirements were addressed, attainments and nonattainments were designationed, as were prevention of significant deterioration criteria, new source reviews, new source performance standards, best available control technology programs, and transportation control measures.

1990 Amendments reclassified nonattainment areas according to the severity of air pollution problems, further addressed mobile sources, and addressed air toxicities, acid rain, alternative fuels, stratospheric ozone depletion, and stationary source permitting (EPA Timeline: 1970-2000) as shown in Table 1-9.

Regions (EPA/GOV)

Each regional office is responsible within selected states for the execution of the agency's programs, considering regional needs and the implementation of federal environmental laws (www.EPA/GOV). There are altogether ten established regions. Region six is responsible within the states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas (as shown in Figure-1).

An Air Pollution Index (EPA)

Based on an overall appraisal of the effects of various pollutants, a Pollutants Standard s Index (PSI) has been adopted by the EPA (40 CFR 58). The PSI is reported and used by many U.S. cities to indicate their day-to day air quality. The PSI index assigns a numerical rating to air quality, with descriptions of the air quality as shown in Table 1-10. (One can call this phone number (505) 768-4725 in the Albuquerque area and find the air quality for that particular day.) There are six subindexes that contribute to the PSI-one each for TSP, SO_3 , CO, O_3 , and NO_2 , and one for the product of the TSP and SO_2 concentrations. Each subindex ranges from 0 to 500, with 100 corresponding to the primary NAAQS and 500 corresponding to significant harmful effects.

South Valley Partners in Environmental Justice

Environmental health is a process of linking health to what take place in one's environment and community. The environment includes the relationships between our health and our home, workplace, school, and the outdoors, including the air we breath and the water we drink. On Thursday, June 21, 2001 the Bernalillo County Environmental Health Department conducted a meeting - South Valley Reserve Conference at the Hispanic Community Center. The facilitator was Magdalena Avila. The participants were residents of the South Valley, community volunteers and representatives of the Health and Environmental Departments of Bernalillo County and the city of Albuquerque. The information collected from this meeting follows:

Public Concerns

The priority concerns were presented by five South Valley community volunteers on : air quality, dumping litter and trash, groundwater protection/contamination, health issues, and land use/development. Tables were set up for discussions on the five major areas of concerns. During breakout discussion sessions, facilitators (one community volunteer and one employee from Bernalillo County) lead a discussion on all concerned topics.

I attended the breakout session of Air Quality. The community representative discussed eight areas of concerns, or issues. They are as follows:

1. Issues:
    a. Severe odor from South Valley sewage treatment plant.

b. Need timeline for odor control. Should be done by end of 2001.
c. How is odor measured?

Potential Actions:

a. Contact Lawrence Real (Albuquerque Chief Administrator Officer) about bid/contract for odor control and also contact Citizen Advisory Board for odor control.
b. Encourage better training for operators.

1. Issues:

a. Air contamination from junk and wrecking yards.
b. Dumping of fluids on the ground.

Potential Action:

a. Speak with Rich Powell from New Mexico Environmental Department (NMED about the problem.

2. Issue

a. Burning of weed, fields, garbage.

3. Issue

a. Fear of fire from petroleum storage tank farms

4. Issues:

a. Noise, dust, fumes from Albuquerque Raceway, Low flying commercial and military aircraft creating high noise.
b. Fallout of kerosene from aircraft.
c. Lack of response from Albuquerque International Airport and the military

Potential Actions:

a. Need community advocate for noise/fuel issues.
b. Future Albuquerque Public Schools/City of Albuquerque noise monitoring stations at Ernie Pyle and Kit Carson Schools.

Issues:

a. Health effects: asthma, diabetes, high leukemia rates in Adobe Acres area.
b. Insurance did not used to cover asthma, so now doctors are labeling it more often. High Asthma rates in Kinney Brick, Adobe Acres and Mountain View.

Potential Actions:

a. Call Bill Flynn, 768-2661, from Tools for Schools for advice in schools. Oxygen provided at schools for Asthma attacks.
b. Encourage Bernalillo County and City of Albuquerque to develop indoor air relugation.
c. Call for Air Quality Control Board to expand the "prohibited tree list" to all of Bernalillo County (not in just in the Albuquerque City limits).
d. Encourage community people to plant native species.
e. Contact Dr. Robert Sapien, Medical Director of Pediatric Emergency Medicine and associate Professor of the Department of Emergency Medicine and Pediatrics at the University of New Mexico.

Issues:

a. Blowing dust.
b. Encourage certain trees be planted through ordinance.

Potential Actions:

a. Call Mark dear about dust complaints-(505) 768-1958.
b. Educate the community that people who disturb areas over 3/4 acre must have a surface disturbance permit (?).

Issue:

a. Unknown Sources: what you do not know about can still hurt you.

Potential actions:

a. Neighborhood survey.
b. Epidemiological study by the Department of Health. Contact, James Padilla & Mac Souel.

Air Monitoring Station Information at South Valley

We also discussed an air monitoring station in the South Valley. At present no air monitoring station is in the South Valley. The previous air monitoring station was located at the City of Albuquerque publicly owned Treatment Works. The air pollutants measured were carbon monoxide, ozone, and coarse particulate matter. Meteorological parameters measured were: wind speed, wind direction, ambient temperature (at 3.5 meter) ambient pressure.

These are the anticipated station characteristics: Location at Mountain View Community Center; air pollutants measured will be carbon monoxide, ozone, course particulate matter, fine particulate matter, hydrogen sulfide. meteorological parameters measured will be: wind speed, wind direction, ambient temperature (at 2 and 10 meters), ambient pressure, and relative humidity.

Additional/Future Plans

1. Facilitate educational presentations about the stations measurement capabilities and what the data means. Schedule periodic open house/station visits.
2. Install a personal computer and data acquisition system at the Mountain View Community Center for remote data access.
3. Integrate the ozone data with all other Bernalillo County ozone data for Air Quality Index reporting.
4. Air quality index and pollen data available daily by calling 768-4734. Anticipated air monitoring start date, January 2002. For more information see reference (contact Mr. Fabian Macias Environmental Department of city of Albuquerque and environmental web sites: city of Albuquerque, Santa Fe and EPA).

The meeting adjourned with many agendas. Students can take part in these kind of meetings and became involved with the problems in their community (please see refence for contact persons at Bernalillo County and Albuquerque Air Quality Division).

Implementation

Lesson Plan #1: Air Pollution Word Search Activity

Purpose and Objective: To improve students' vocabulary and knowledge of air pollution.

Grade Level: 8 to 12 grades.

Time: one period.

Procedure

Teach about what air pollution is. During this period students will learn terms and definitions of several words related to air pollutiuon. The textbook used will be *Air Pollution Control*. Chapter one of this book gives overall information on air pollution. Students will learn different terminology of the air pollution and can easily do the word search 1A and 1B (see Appendix). Also, ask students to write the definitions of those words.

Assessment: Student's understanding of words.

Lesson Plan # 2: Air Pollution Survey (Community involvement- South Valley and Rio Grande High School)

Grade Level: 8 to 12.

Time: Three to four weeks.

Objectives:

The students will be able to:

1. Identify the different sources of air pollution.
2. Evaluate knowledge of air pollution concepts in school and community.

3. Brainstorm ways of reducing air pollution.
4. Instruct school and community in reduction of air pollution.

Background

Air pollution refers to contamination of the air by harmful gases or particles. Pollutants can be released by individuals, homes, automobiles, and industry. Once the sources of air pollution are identified, examination of methods to prevent the release of pollutants can be explored. Vocabulary: air pollution , Nox, VOC, emissions, acid rain, smog, ozone, CFC's, EPA, Clean Air Act

Materials:
Example surveys
Stopwatch to measure cars passing
Internet access, phones, fax, business letter guidelines

Procedure:
1. Lecture about air pollution concepts, Clean Air Act, and air pollution prevention.
2. Split the class into three teams.
a) Team One- Design surveys for the school and community to evaluate how much people know about air pollution. Students can visit community centers and express their point of view or understand other people's problem by attending meetings.
b) Team Two- Survey cars and buses. How many cars pass by the school in a certain period of time at different times of the day. How many people are in each car? How many people ride city buses during a day?
c) Team Three- Contact representatives from local industries about their air pollution policies using the internet, phones, fax, and letters.
3. The teams will collect data for three weeks. The students will switch teams each week so that all students experience each job.
4. At the end of the data collection period, students will compile their data and begin to identify areas in which their community might have air pollution problems and what can be done to reduce the pollution (sample issues: car pooling, natural gas automobiles, emissions standards, alternative energy sources, etc…).

> The final project will be to design fliers, posters, video messages, announcements, etc... for the school and community to inform them of the class's results and encourage them to be aware of air pollution.

Enrichment:

a). Coordinate study with air issues in current city council/legislative/congressional session or political campaigns.
b). Invite guest speakers from EPA, industry, environmental organizations.
c). Have a school car pooling rewards program or other contest to encourage clean air measures.

Lesson Plan # 3: The Environmental Quiz

Objective and Purpose

One of the important goals is for the student to understand air pollution sources and their effects. This lesson plan introduces the meaning of the Clean Air Act, emissions from motor vehicles and their effects on the atmosphere.

Grade Level: 8 to 12

Time: three to four days.

Procedure

One of the many responsibilities of the Environmental Protection Agency is to enforce The Clean Air Act (a law passed by Congress). Congress found that Most people live in urban areas, growth results in air pollution, and air pollution endangers life. Congress decided that prevention and control of air and other pollution at the source was appropriate. In 1970 Congress gave EPA broad authority to regulate emissions from motor vehicles. So EPA created the Motor Vehicle Emissions Laboratory (now called the National Vehicle and Fuel Emissions Laboratory) to control mobile source emissions.

This laboratory conducts over 10,000 vehicle tests each year. Other work includes research and development, engine testing, fuels testing, and writing regulations. Ask students to work in group of three or four. Let them discuss the questions and answer them. At the end of the quiz answer every one of them and discuss.

Environmental Quiz:

1) Which pollutants come from mobile sources?

- Hydrocarbons (Paraffins, Olefins, Naphthenes, Aromatics)
- Nitrogen oxides (NO, NO_x, NO_2)
- Carbon dioxide (CO_2)
- Carbon monoxide (CO)
- Particulates (any material collected on a filtering medium after exhaust dilution)
- Air toxins (???)
- None of the above
- All of the above
- Discuss why do you think your answer is correct.

2) The combination of nitrogen oxides and hydrocarbons in the presence of sunlight causes:

- Global warming
- Smog (ozone)
- Stratospheric ozone depletion

- Acid rain

3) Ozone is beneficial to our environment at high altitudes, yet harmful at low altitudes.
- TRUE
- FALSE

4) During the last 20 years, average ambient air levels of ozone, carbon monoxide, and lead have:
- gone up 10 percent
- gone up 50 percent
- not changed
- gone down

5) Which mobile source pollutant can not be controlled by emission control technology?
- Ozone forming hydrocarbons (CnH2n+2)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Air toxins
- Particulate matter (solid emissions)

6) Tailpipe exhaust is not always the greatest source of vehicle emissions?
- TRUE
- FALSE
- Discuss your answer.

7) Which of these vehicle fuels causes the least pollution?
- Electricity
- Reformulated Gasoline
- Natural Gas
- Alcohol
- Hydrogen
- Beer

8) What region of the US has experienced the worst effects from acid rain?
- Northwest
- Northeast
- Southwest

- Southeast

9) Which of the following is the biggest polluter of our air?

- City buses
- Passenger cars and light trucks
- Over-the-road trucks
- Power plants

10) Estuaries suffer some of the worst effects of water and air pollution. Which of the following best describes an estuary?

- The area where fresh water and salt water meet
- A large inland body of water
- An ancient river bed
- None of the above

11) The largest contributor of NEW toxic pollution to the upper Great Lakes is:

- Air pollutants
- Sewage treatment plants
- Factories

12) Which of the following is the source of radon in homes?

- Ultraviolet radiation
- Defective heating systems
- Uranium in rock formations
- None of the above

13) Where is there most potential for future gains in reducing motor vehicle emissions?

- Better control of emissions from vehicles in actual use
- Use of clean transportation alternatives such as mass transit
- Use of cleaner fuels
- All of the above

Assessment: Students knowledge and participation**.** Ask students to write an essay on global warming, acid rain, air pollution and health effects, etc…

Lesson Plan # 4: Air Pollution Control (A practical approach)

Purpose: To show how air pollution is controlled.

Time: One Week

Grade level: 9 to 12 grades

Essential Elements:

1) Properly demonstrate the use of laboratory equipment.
2) Observe physical and chemical properties of matter.
3) Measure physical and chemical properties of matter.

Objectives

At the end of the lesson the student will be able to distinguish between an electrostatic precipitator and a wet scrubber, and the principles behind the operation of these control techniques.

Focus

When any product is made by industry, waste may be produced that can pollute the air. Wet scrubbers and electrostatic precipitators are two devices used to clean up the air waste stream before it enters the atmosphere.

Background

Air contaminants are emitted into the atmosphere as particulates, aerosols, vapors, or gases. The most common methods of eliminating or reducing pollutants to an acceptable level are destroying the pollutant by thermal or catalytic combustion, changing the pollutant to a less toxic form, or collecting the pollution by use of equipment to prevent its escape into the atmosphere. Pollutant recovery may be accomplished by the use of one or more of the following:

Baghouses

Dry particulates are trapped on filters made of cloth, paper or similar materials. Particles are shaken or blown from the filters down into a collection hopper. Baghouses are used to control air pollutants from steel mills, foundries, and other industrial furnaces and can collect more than 98 percent of the particulates.

Cyclones

Dust-laden gas is whirled very rapidly inside a collector shaped like a cylinder. The swirling motion creates centrifugal forces causing the particles to be thrown against the walls of the cylinder and to drop into a hopper. Cyclones are used for controlling pollutants from cotton gins, rock crushers, and many other industrial processes and can remove up to 95 percent of solid pollutants.

Electrostatic precipitators

By use of static electricity, they attract particles in much the same way that static electricity in clothing picks up small bits of dust and lint. Electrostatic precipitators, (98 to 99 percent effective) are used instead of baghouses when the particles are suspended in very hot gases, such as in emissions from power plants, steel and paper mills, smelters, and cement plants.

Wet scrubbers

Particulates, vapors, and gases are controlled by passing the gas stream through a liquid solution. Scrubbers are used on coal burning power plants, asphalt/concrete plants, and a variety of other facilities that emit sulfur dioxides, hydrogen sulfides, and other gases with a high water solubility. Wet scrubbers are often used for corrosive, acidic, or basic gas streams. (Note that recovery control devices include adsorption and condenser techniques as well.)

Activities:

Here are two activities to help demonstrate how a wet scrubber and an electrostatic precipitator work. Activity 1A. demonstrates how to build a wet scrubber.

Activity 2A. demonstrates how to build an electrostatic precipitator.

Assessment: Restate objectives, begin questioning.

1) Which type of air cleaner would be the best for removing particles?
2) Which type of air cleaner would be the best for removing waste gases?
3) Does a wet scrubber clean up all of the pollutants?
4) What problems are produced by having too many pollutants in the air we breathe?
5) If industry is just part of the problem, what can we do to control the amount of air pollution that we cause?

Activity 1 A: How to Make a Wet Scrubber

Purpose: To become familiar with a wet scrubber by building and using one. (See diagram A)

Time required: one or two periods

Materials:
Paper towels, 12-cm piece of glass tubing, three 2.5-cm pieces of glass tubing, three 55-ml flasks, two glass impingers (glass tubing drawn at one end to give it a smaller diameter so as to let out smaller bubbles), heat source (burner or hot plate), three two-hole rubber stoppers (of a size to fit the mouths of the flasks), two 30-cm pieces of rubber tubing, ringstand apparatus and vacuum source

Background information

The wet scrubber is one of the most common pollution control devices used by industry. It operates on a very simple principle: a polluted gas stream is brought into contact with a liquid so that the pollutants can be absorbed.

Procedure

Write your answers on a separate sheet.

1) Set up the apparatus as shown in Diagram A. Put a paper towel in a 55-ml flask and place this above the burner.
2) Using a two-hole stopper that makes an air-tight seal with the flask, insert a 12-cm section of glass tubing through one of the holes. The tubing should reach to approximately 1.2-cm from the bottom of the flask.

3) Insert a 2.5-cm piece of glass tubing into the other hole of the stopper.
4) Connect a 30-cm piece of rubber tubing to the 2.5-cm piece of glass tubing, making sure an air-tight seal exists.
5) Fill a second 500-ml flask approximately 3/4 full of water. Using a second double-hole stopper, put a 2.5-cm piece of glass tubing into one of the holes, and insert the glass impinger into the other.
6) Construct a third flask like the second.
7) Connect the rubber tubing and heat the first flask (combustion chamber) until smoke appears.
8) Put a vacuum on the third flask to draw a stream of smoke through the second flask (the wet scrubber). If smoke collects in the second flask above the water, a second scrubber can be added.
9) Ask the students if particles are the only pollutants produced by industry. Discuss how a wet scrubber collects not only particulate matter but also captures waste gases. Demonstrate how the water scrubber works. Discuss that the white plume you see coming from a smokestack may really be steam coming from a water scrubber.
10) After observing the wet scrubber, answer the following questions: Why does the water in the wet-scrubber change color? Why does the wet-scrubber have an impinger (in other words, why is it important for small bubbles to be formed)? What does the scrubber filter out of the air? Not filter out? Suggest ways to dispose of the pollutants that are now trapped in the water.

Activity 2A: How To Make An Electrostatic Precipitator

Materials, Equipment, and Preparation:

- **plastic tube (fluorescent light tube)**
- **wire coat hanger**
- **plastic grocery bag**
- **electric blow dryer**
- **punch holes, black pepper or rice krispies**

Time: One to two periods

Background
The electrostatic precipitator works on the principle of a static electric charge attracting particles where they are removed. A two-foot plastic tube in which fluorescent lights are stored can be used to simulate an electrostatic precipitator. The plastic tube can be charged by running through it a coat hanger with a plastic grocery bag attached. (see diagram B). (The plastic bag, as it moves through the tube strips the negatively charged electrons from the inside of the tube making the overall net charge positive. Anything that has a negative charge will be attracted to the tube because opposites attract.) Hold the tube over some punch holes, black pepper, or rice krispies. Hold an electric hair dryer so the air stream blows across the top of the tube. The air mass creates a low pressure area at the top and the greater air pressure at the bottom pushes the punch holes up the tube (this is called Bernoulli's Principle). If the tube is charged, the punch holes will stick to the sides. This activity can be used to study static electricity. If the tube is not charged, the holes will shoot out in a spray. This activity can be used to study Bernoulli's principle.

Extension: Balloon Activity

Materials: pepper or ashes and balloons

Procedure
Give each student an inflated balloon and some black pepper. Rub the balloon on your hair or with a piece of cloth. Hold the balloon over the pepper on your desk. What happens to the pepper? Ask the students, What produces air pollution? Discuss that industry is just one producer of air pollution. Ask, What kinds of pollutants are produced by industry? Discuss that particles (called particulate matter) can be captured before they enter the atmosphere by an electrostatic precipitator. Demonstrate with the plastic tube and black pepper how particles are attracted to the sides of the tube in an attraction much like the pepper was attracted to the balloon.

Lesson Plan # 5: Air Pollution and EPA's (Environmental Protection Agency)

Web Page searching.

Purpose: To learn how to use EPA's web page, city's and county's web pages and state's web page.

Grade: 9 to 12

Time: Two weeks.

Background
Air pollution affects everyone. Every day, the average adult breathes over 3,000 gallons of air. Children breathe even more air per pound of body weight and are thus more susceptible to air pollution. Millions of people live in areas where urban smog, very small particles, and toxic pollutants pose serious health concerns. These health concerns can stem from either short-term or long-term exposure to air pollution. When people have a short-term exposure to air pollutants above certain levels, they may experience temporary health concerns such as eye irritation and burning, throat irritation, and difficulty breathing.

Long-term exposure to air pollution can cause chronic health concerns such as cancer and damage to the body's immune, neurological, reproductive, and respiratory systems. The problem of air pollution is also found outside of major urban centers. Air pollution can be wide-ranging as well as persistent. Many air pollutants, such as those that form urban smog and toxic compounds, remain in the environment for long periods of time. These air pollutants can also be carried hundreds of miles by winds and can thus affect areas far-removed from the source of the pollution.

The U.S. EPA has developed the AIRNow website to provide the public with easy access to national air quality information. The website offers daily air quality forecasts as well as real-time air quality for over 100 cities across the U.S., and provides links to more detailed state and local air quality websites.

The AIRNow program was initially funded by EPA's Environmental Monitoring for Public Access and Community Tracking (EMPACT). It is a joint partnership between EPA, and state and local air quality agencies. The mission of the AIRNow program is to provide air quality forecasts and real-time air quality information in a visual, easy-to-understand format.

The AIRNow website presents comprehensive air quality maps and forecasts supplies real-time images of air quality and visibility via webcams, displays air quality forecasts (good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, hazardous) for "air action days" in major metropolitan areas around the country, and provides suggestions on what you can do to help improve the air quality where you live. The AIRNow website has four primary areas: Ozone Maps, Air

Quality Forecasts, "Where I Live," and Publications.

Ozone Maps - Real-time ozone air quality maps covering 38 U.S. States and parts of Canada. During the ozone season (May through September for most areas), these maps are updated daily every two (2) hours.

Air Quality Forecasts - Daily air quality forecasts provided by state and local air agencies for over 150 major U.S. cities.

Where I Live - The majority of the information available via AIRNow is obtainable at a local level (i.e., your state). Direct access to ozone maps and animation, air quality forecasts and website links to state and local information are all here.

Publications - Documentation on the Air Quality Index (AQI), air pollution health effects, and more. To use web pages of city of Albuquerque, Bernaillo County and State Environmental Department (Santa Fe), please see references in Appendix.

Lesson Plan # 6: Determine the effects of air pollutants on living things (plants)

Purpose: To understand the effect air pollution by doing experiment.

Grade: 9 to 12 .

Time: One to two days.

Materials:
Containers (jars or closed tanks), seeds or newly sprouting plants, and air pollutants (such as carbon monoxide from automobile exhaust)

Procedure
Teachers and students can formulate a number of experimental designs from this topic. The most common seeds used are probably radish seeds in a small amount of water. The most convenient source of pollution is automobile exhaust fumes.

1) Place radish seeds in two wide mouth bottles.
2) Add enough water to just cover the seeds.
3) Close one of the bottles and place it aside for use as a control.
4) Expose the other bottles to automobile exhaust fumes for one minute.
5) Close the second bottle.
6) Observe after 48 hours and 72 hours.
7) Compare results in both bottles.

Questions:
1) What type of seeds or plants were used in your experiment?
2) What pollutants were your plants exposed to?
3) What effect did each pollutant have on each plant species?
4) Does the length of time that the seeds were exposed to pollutants affect growth?
5) In what ways might humans be affected by these pollutants?
6) If substances are produced to kill plants (herbicides), what effects could they have on humans sprayed with these chemicals?

7) Ask students to repeat the experiment with different kinds of seeds and use different kind of pollution and study the difference.

Lesson Plan # 7: Ground-level Ozone

Objective: To plot data and ozone measurements for a two-or three-week period and evaluate the data collected.

Grade: 9 to 12 .

Time: One to four weeks.

Background
Ozone is the same molecule regardless of where it is found, but its significance varies. Stratospheric ozone is found nine to 18 miles high where it shields us from harmful ultraviolet rays from the sun. A high accumulation of ozone gas in the lower

atmosphere at ground level is air pollution and can be harmful to people, animals, crops, and other materials. Elevated levels above the national standard may cause lung and respiratory disorders. Short-term exposure can result in shortness of breath, coughing, chest tightness, or irritation of nose and throat. Individuals exercising outdoors, children, the elderly, and people with pre-existing respiratory illnesses are particularly susceptible.

Chemists say the materials damaged by ozone include rubber, nylon, plastics, dyes, and paints. Ozone pollution, or smog, is mainly a daytime problem during summer months because sunlight plays a primary role in its formation. Nitrogen oxides and hydrocarbons are known as the chief "precursors" of ozone. These compounds react in the presence of sunlight to produce ozone. The sources of these precursor pollutants include cars, trucks, power plants and factories, or wherever natural gas, gasoline, diesel fuel, kerosene, and oil are combusted. These gaseous compounds mix like a thin soup in the atmosphere, and when they interact with sunlight, ozone is formed. Large industrial areas and cities with heavy summer traffic are the main contributors to ozone formation.

When temperatures are high and the mixing of air currents is limited, ozone can accumulate to unhealthful levels. The United States Environmental Protection Agency has set the National Ambient Air Quality Standard for ozone at 0.12 parts per million (ppm). Ozone concentrations of 0.125 ppm (125 in parts per billion) or above are considered an exceedance of this standard because of mathematical rounding.

Activity: Ozone And Weather

Procedure

1. Divide the class into groups of five or six students.
2. Each team should then assign a different radio station, television station, or newspaper to each student. For example, Team 1 has five students. Student A will collect data from reports on radio station KXXX. Student B will collect data from television station WXXX. Student C will collect data from television station WBBB. Student D will collect data from newspaper X. Student E will collect data from newspaper Y. Students can also call the city’s hotline on "Ozone Query" for yesterday’s peak ozone concentrations in the Albuquerque area. The National Weather Service can also provide weather information.

3. Data Collection
Have the students obtain weather and ozone data over a two-week period. The students will need to collect the following weather information: temperature, precipitation, wind speed, cloud cover, wind direction, time of day for report location of data collected (e.g., downtown, the radio station, the local airport, etc..)

After the two-week period, have each group compare and contrast their reports. Ask the students the following questions:

Did each radio station, television station, newspaper or other source report the same information? What was different? What was similiar? What factors would cause the reports to be different or the same?

4. Mapping
Obtain maps of your city or area for each team. Have each team research and label the following areas: major traffic arteries and hubs, including airports, train stations, and bus stations; manufacturing areas; commercial centers; major topographical features such as mountains, valleys, or bodies of water.

5. Plotting
Ask students to review the background information on factors affecting ozone formation. Then, ask them to answer the following questions and to label each area on their maps. Which areas might be high "ozone producers"? Label these "high ozone production." What places should a person with respiratory problems avoid on ozone action days? Label these "sensitive." Which areas are downwind from high ozone-production areas? (Hint: Use the weather data to determine prevailing winds.) Label these "downwind."

Where are low-lying areas located in which ozone can collect located? Label these "depressions." Are any residential areas located in or near areas identified in the areas above? Label these as "critical residential areas."

Are any elementary or preschools located near critical areas? Label these as "critical schools." Are any residential senior-citizen or nursing homes located near critical areas? Label these as "critical senior-citizen centers." Are any medical centers located near critical areas? Label these as "critical medical areas."

6. Interpreting patterns

Ask students to find the three days with the highest ozone readings. Ask them to identify any common factors for those three days such as high temperatures, weather, or day of the week. Explain that scientists investigate the true composition of air pollution by tracking common factors and then seeking explanations for correlations.

7. Design

Have the students design a graph or chart that would correlate one or more factors to the high ozone readings.

Write the following scenarios on the chalkboard. Ask the students to determine in which scenarios they would declare an Ozone Action Day. Then they should write a paragraph for each scenario explaining their choice.

A) Question

It is 8 a.m. on a typical weekday. There is rush-hour traffic on all the highways. The weather forecast is mostly sunny skies, light winds from the southeast, temperature to reach 98 degrees, and a 30 percent chance of late morning thunderstorms. The current ozone reading is 30 parts per billion (ppb). Should you declare an Ozone Action Day?

Answer

Yes, because of the traffic, light winds, and the temperature. The 30 percent chance for precipitation means that any showers would be isolated, so you will probably have high levels of ozone.

B) Question

It is 6 a.m. on Saturday. The forecast for the day is overcast skies, light and variable winds, and a maximum temperature of 91 degrees. No ozone reading is available. Should you call an Ozone Action Day based on the information you have?

Answer

No, sunny to partly cloudy skies are required for the photo chemical process that creates ozone.

C) Question

For this question, consider the South Valley's most busy area. It is 9 a.m. Yesterday was an Ozone Action Day. The weather today is very much like the weather yesterday. One difference is that today is a holiday and many people are off from work and school. The ozone reading is 40 ppb. The safety and comfort of many people depend on your decision. What will it be?

Answer

The answer is no, because you should not expect to have the high rush-hour traffic congestion.

To participate in a World Wide Web site for hands-on, inquiry-based science involving ozone monitoring by students, teach them to use different web sites. This lesson plan will give an idea about greenhouse effects in every day life.

APPENDIX

Table 1-1

Composition of dry air

Gases	Percent of Volume
Nitrogen	78.03
Oxygen	20.09
Argon	0.94
Carbon Dioxide	0.03

Balance*	0.01
Total	100.0

* Includes Hydrogen, Helium, Neon, Krypton, Xenon, and the various pollutants.

Table 1-2

National U.S. Emission Estimates, 1981 (millions of metric ton/year)

Source Category	Particulates	SOx	NOx	VOCs	CO
Transportation					
Highway	0.1	0.4	6.6	6.3	62.3
Aircraft	0.1	0.0	0.1	0.2	1.0
Railroad	0.1	0.1	0.7	0.2	0.3
Other	0.1	0.3	1.1	1.0	5.9
Subtotal	0.4	0.8	8.5	7.7	69.5

Stationary Source Fuel Combustion

Source Category	Particulates	SOx	NOx	VOCs	CO
Electric Utilities	1.0	14.8	6.6	0.0	0.3
Industrial Furnaces	0.4	2.3	2.9	0.1	0.6
Commercial	0.1	0.5	0.2	0.0	0.1
Residential	0.6	0.2	0.4	0.8	5.3
Subtotal	2.1	17.8	10.1	0.9	6.3

Miscellaneous

Source Category	Particulates	SOx	NOx	VOCs	CO
Industrial Processes	3.7	3.9	0.6	9.8	6.2
Solid Waste Disposal	0.4	0.0	0.1	0.6	2.1
Forest Firs	0.8	0.0	0.0	0.8	5.7
Other Burning	0.1	0.0	0.0	0.1	0.7
Organic Solvents	0.0	0.0	0.0	1.4	0.0
Subtotal	0.9	0.0	0.2	2.3	6.4
Total	8.5	22.5	19.5	21.3	90.5

Source: U.S. Environmental Protection Agency, 1982.

Table 1-3

The Spectrum of Atmospheric Particle Size.

Dustfall	Suspended Particulate Matter	Very Fine Suspended Particles	Size Diameter in Microns
Raindrops			10,000
Beach Sand			1,000
			100
	Talcum Powder		10

			1.0
			0.1
			0.01
		Molecules	0.001
			0.0001

Source: "Air Pollution, Threat and Response" David A. Lynn, 1976.

Table 1-4

Annual emissions of Sulfur Oxides (estimates for 1970)

Fuel Combustion Transportation

Source Category	Emissions, millions of tons/year	Percent Total
Gasoline Motor Vehicles	0.2	0.6
Diesel, Aircraft, Trains, Vessels	0.6	1.8
Off-Highway Vehicles	0.2	0.6
Total Transportation	1.0	3.0

Stationary Sources

Source Category	Emissions, millions of tons/year	Percent Total
Coal	22.2	65.4
Fuel Oil	4.2	12.4
Natural Gas	------	----

Wood	0.1	0.3
Total Stationary Source	26.5	78.1
Total fuel Combustion	27.5	78.1
Industrial Processes	6.0	17.7
Agricultural Burning	0.1	0.3
Solid Waste Disposal	0.1	0.3
Miscellaneous	0.2	0.6
Total	33.9	100.0

Source: EPA publication No. AP-115, January 1973.

Table 1-5

Annual emissions of Nitrogen Oxides (estimates for 1970)

Fuel Combustion Transportation

Source Category	Emissions, millions of tons/year	Percent Total
Gasoline Motor Vehicles	7.8	0.6
Diesel, Aircraft, Trains, Vessels	2.0	1.8
Off-Highway Vehicles	1.9	0.6
Total Transportation	11.7	3.0

Stationary Sources

Source Category	Emissions, millions of tons/year	Percent Total

Coal	3.9	17.1
Fuel Oil	1.3	5.7
Natural Gas	4.7	20.6
Wood	0.1	0.4
Total Stationary Source	10.0	43.8
Total fuel Combustion	21.7	95.5
Industrial Processes	0.2	0.9
Agricultural Burning	0.3	1.3
Solid Waste Disposal	0.4	1.8
Miscellaneous	0.2	0.9
Total	22.8	100.0

Source: EPA publication No. AP-115, January 1973.

Table 1-6

Annual emissions of Carbon Monoxide Oxides (estimates for 1970)

Fuel Combustion Transportation

Source Category	Emissions, millions of tons/year	Percent Total
Gasoline Motor Vehicles	95.8	
Diesel, Aircraft, Trains, Vessels	5.6	
Off-Highway Vehicles	9.5	
Total Transportation	110.9	

Stationary Sources

Source Category	Emissions, millions of tons/year	Percent Total
Coal	0.5	0.3
Fuel Oil	0.1	0.1
Natural Gas	0.1	0.1
Wood	0.1	0.1
Total Stationary Source	0.8	0.6
Total fuel Combustion	111.7	75.1
Industrial Processes	11.4	7.7
Agricultural Burning	13.6	9.3
Solid Waste Disposal	7.2	4.9
Miscellaneous	4.5	3.0
Total	148.6	100.0

Source: EPA publication No. AP-115, January 1973.

Table 1-7

Annual emissions of Hydrocarbons (estimates for 1970)

Fuel Combustion Transportation

Source Category	Emissions, millions of tons/year	Percent Total
Gasoline Motor Vehicles	16.6	47.6
Diesel, Aircraft, Trains, Vessels	0.9	2.8

Off-Highway Vehicles	2.0	5.7
Total Transportation	15.5	55.9

Stationary Sources

Source Category	Emissions, millions of tons/year	Percent Total
Coal	0.2	0.6
Fuel Oil	0.1	0.3
Natural Gas	0.3	0.8
Wood	------	----
Total Stationary Source	0.6	1.7
Total fuel Combustion	20.1	50.6
Industrial Processes	9.5	27.2
Agricultural Burning	2.8	8.0
Solid Waste Disposal	2.0	5.7
Miscellaneous	0.5	1.5
Total	34.4	100.0

Source: EPA publication No. AP-115, January 1973.

Table 1-8

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set national ambient air quality standards for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set national ambient air quality standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m3), and micrograms per cubic meter of air (µg/m).

National Ambient Air Quality Standards

Carbon Monoxide (CO_2)

Pollutant	Standard Value	Standard Type
8-hour average	9 ppm (10 mg/m^3)	Primary
1-hour Average	35 ppm (940 mg/m^3)	Primary

Nitrogen Dioxide ((NO_2)

Pollutant	Standard Value	Standard Type
Annual Arithmetic Mean	0.053 ppm (µg/m^3)	Primary & Secondary

Ozone (O_3)

Pollutant	Standard Value	Standard Type
1-hour average	0.12 ppm (235 µg/m^3)	Primary & Secondary
8-hour Average**	0.08 ppm (157 µg/m^3)	Primary & Secondary

Lead (Pb)

Pollutant	Standard Value	Standard Type
1Quaterly Average	1.5 µg/m^3	Primary & Secondary

Particulate (PM 10) Particles with diameters of 10 micrometers or less

Pollutant	Standard Value	Standard Type
Annual Arithmetic Mean**	50 µg/m^3	Primary & Secondary
24-hour average**	150 µg/m^3	Primary & Secondary

Particulate (PM 2.5) Particles with diameters of 2.5 micrometers or less

Pollutant	Standard Value	Standard Type
Annual Arithmetic Mean	15 µg/m^3	Primary & Secondary
24-hour average	65 µg/m^3	Primary & Secondary

Sulfur Dioxide (SO_2)

Pollutant	Standard Value	Standard Type
Annual Arithmetic Mean	0.13 ppm (80 µg/m^3)	Primary
24-hour Average	0.14 ppm (365 µg/m^3)	Primary
3-hour Average	0.50 ppm (1300 µg/m^3)	Secondary

Parenthetical value is an approximately equivalent concentration.

** The ozone 8-hour standard and the PM-2.5 standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision. The updated Air Quality Standards website has additional information.

Table 1-9
EPA Time Line --June in EPA History

Year	Event
1973	EPA sets auto maintenance regulations
1977	EPA safe drinking water standards go into effect.

1978	EPA announces new rules on industrial growth in clear air areas.
1979	Carter Administration proposes hazardous waste cleanup fund.
1984	EPA announces Supreme Court approval of Bubble Policy on air pollution control.
1986	President Reagan signs Safe Drinking Water Act Amendments.
1989	EPA announces Occidental Chemical will clean up Love Canal wastes.
1990	EPA signs charter to open Regional Environmental Center for Central and Eastern Europe.
1992	EPA stars program to promote energy-saving computers.
1999	EPA, DOE announce first Energy Star buildings.
2000	EPA reports on economic benefits of clean water.

Source: http://www.epa.gov/history/month/jun.htm (last updated June 04, 2001)

EPA United States Environmental Protection Agency

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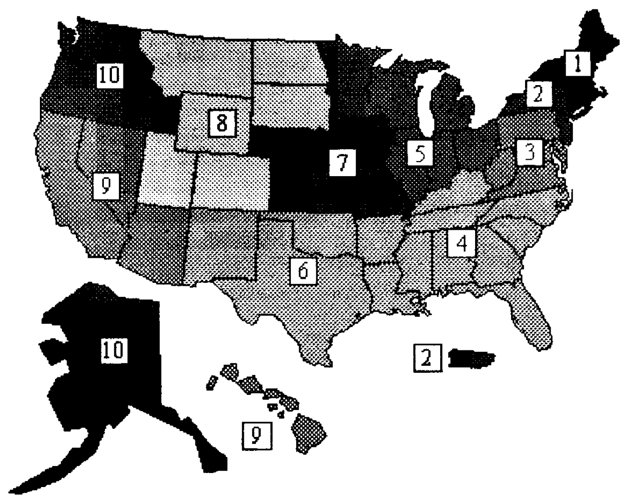
Regions

Each EPA Regional Office is responsible within selected states for the execution of the Agency's programs, considering regional needs and the implementation of federal environmental laws.

Select a region by clicking within the area of the map covered by the region, or use the links located below the map to go directly to a region.



Region 1 - responsible within the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

Region 2 - responsible within the states of New Jersey, New York, Puerto Rico and the U.S. Virgin Islands.

Region 3 - responsible within the states of Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia.

Region 4 - responsible within the states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee .

Region 5 - responsible within the states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin .

Region 6 - responsible within the states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

Region 7 - responsible within the states of Iowa, Kansas, Missouri, and Nebraska

Figure 1: Regions

Nebraska.

Region 8 - responsible within the states of Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

Table 1-10

PSI Values and Air Quality Descriptions

Air Quality Index	Air Quality Description for the Ozone Season
0 - 50	GOOD
51 - 100	MODERATE

** Unusually sensitive people should consider limiting prolonged outdoor exertion.

101 - 150	Unhealthy for Sensitive Groups

** Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.

151 - 200	Unhealthy

** Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion. Everyone else, especially children, should limit outdoor exertion.

201 and above	Very Unhealthy

** Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should limit outdoor exertion.

Check the Air Quality Index for actual air quality conditions based on measured concentrations of ozone and other air pollutants.

Ozone Alert Days

On Ozone alert Days, weather conditions (usually hot temperatures coupled with sunny conditions and little wind) are likely to lead to unhealthy concentrations of ground level ozone pollution. Ozone alert days may fall into a "red" or "Orange" category with "red" indicating a more severe pollution problem than "orange".

Both "red" and "orange" Ozone alert days indicate Ozone levels that exceed the 8-hour health standard for ozone set by the U.S. Environmental Protection Agency.

Health effects: People with asthma or other respiratory problems are at the greatest risk of experiencing shortness of breath, coughing or other symptoms as they work or play outdoors. But even healthy children and adults who are playing,

working or exercising outdoors may feel the effects of ozone as concentrations reach their peak during the mid-afternoon hours. As a result, people should consider planning vigorous outdoor activities for the morning or evening hours.

Actions to reduce air pollution: Reduce driving by taking the bus for just 25 cents on Ozone Alert! Days, carpooling, telecommuting or otherwise reducing the amount of driving done that day. Area residents should also wait until after sundown to refuel automobiles or mow lawns.

Moderate Days

On "yellow" days, weather conditions (usually warmer temperatures, mostly sunny conditions and little wind) may lead to increased ground-level ozone pollution. Health effects: Unusually sensitive persons may experience shortness of breath, coughing, or other symptoms if they work or play outdoors for prolonged periods.

Actions to reduce air pollution: Area residents should consider carpooling, riding the bus, combining many car trips together to make one longer trip, or otherwise reducing automobile usage.

Good Days

On "green" days, weather conditions (usually mild temperatures coupled with wind and/or rain) are expected to keep air quality within acceptable limits. Health effects: Ozone concentrations should have no adverse health impacts on area residents.

Actions to reduce air pollution: It is always a good idea to be mindful of how individual behaviors affect air quality and to look for opportunities to reduce the number of miles you drive an automobile, a leading source of air pollution.

The Air Quality Index, or AQI, represents actual monitored concentrations of air pollutants, which is a prediction of the next day’s air quality based on forecasted weather conditions. The AQI converts measured concentrations of ozone, carbon monoxide, nitrogen dioxide, particulate matter, and sulfur dioxide to a value from 0 - 500. An Index value of 100 is equal to the federal air quality standard. Therefore, Index values above 100 are unhealthy, and the higher the number, the worse the air quality. The AQI represents the air pollutant that reaches the highest concentration during the day.

Word Search 1A

Air Pollution Word Search

There are 25 words that are often used in connection with air pollution listed in the word search below. Can you find them?

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

Here are the words to look for:

Ash	Atmosphere	Automobile	Breathe
Carbon Dioxide	Carbon Monoxide	Carpool	Clean Air
Disease	Dust	Environment	Exhaust
Filters	Government	Hydrocarbons	Industry
Inversion	Lungs	Mucus	Oxygen
Pollution	Population	Smog	Smoke
Waste			

Word Search 2A

Air Pollution W

There are 15 words that are often us
word search below. Can you find then

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

Here are the words to look for:

Air	Breathe	Bu
Car	Clouds	D
Eyes	Fresh	Lu
Nose	Oxygen	Pc
Sick	Smog	Tr

Diagram A

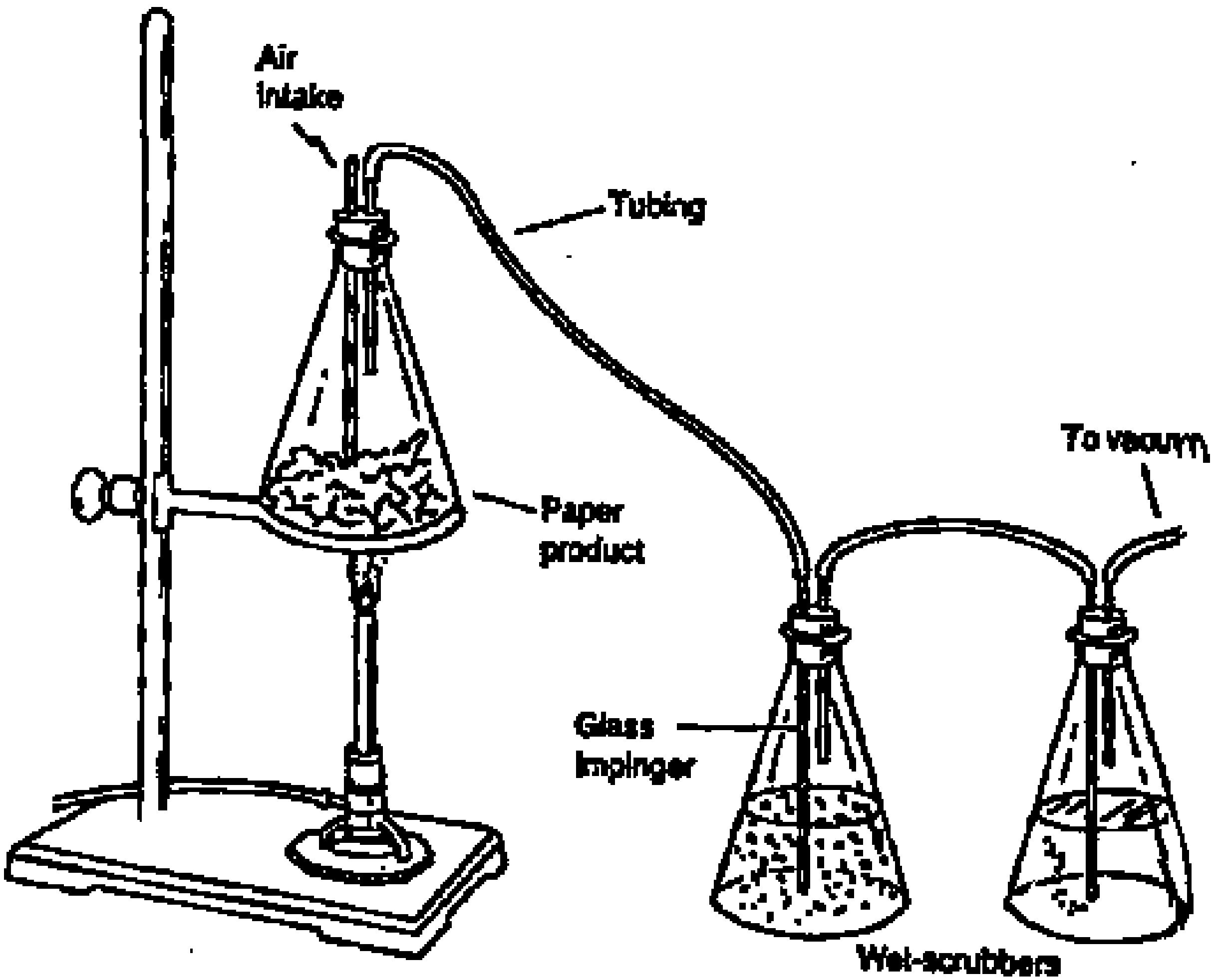


Diagram B


Uncharged
Charging