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ABSTRACT

This booklet, one of a series developed by the Frederick County Board of Education, Frederick, Maryland, provides an instruction module for an individualized or flexible approach to 7th, 8th, and 9th grade science teaching. Subjects and activities in this series of booklets are designed to supplement a basic curriculum or to form a total curriculum, and relate to practical process oriented science instruction rather than theory or module building. Included in each booklet is a student section with an introduction, performance objectives, and science activities which can be performed individually or as a class, and a teacher section containing notes on the science activities, resource lists, and references. This booklet introduces the student to the effects of chemicals and chemical reactions on the environment. The estimated time for completing the activities in this module is 3-4 weeks. (SL)

AIDS TO INDIVIDUALIZE THE TEACHING OF SCIENCE

MINI-COURSE UNITS

BOARD OF EDUCATION OF FREDERICK COUNTY

1973

Frederick County Board of Education

Mini Courses for

Life, Earth, and Physical Sciences

Grades 7, 8, and 9

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1973

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FOREWORD

The contents represented in these modules of instruction, called mini ;es, is an indication of our sincere desire to provide a more individualized lexible approach to the teaching of science.

Data was accumulated during the school year relative to topics in life, earth, and physical science that were felt to be of greatest benefit to students. The final selection of topics for the development of these courses during the workshop was made from this information.

It is my hope that these short courses will be a vital aid in providing a more interesting and relevant science program for all middle and junior high school students.

Dr. Alfred Thackston, Jr.
Assistant Superintendent for Instruction

ACKNOWLEDGEMENTS

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ENVIRONMENTAL CHEMISTRY

Prepared by

Dr. Fred Meyers

CONTENTS

Estimated Teaching Time

3-4 weeks

ENVIRONMENTAL CHEMISTRY

INTRODUCTION:

The earth is our home -- we can no longer go on abusing it! We must learn to control our activities so that we can live in harmony with our environment. To do this will require that we make thoughtful and intelligent decisions based on knowledge.

Each one of us should know something about environmental chemistry, because we all have a shared responsibility for our environment. Our way of life today is greatly affected by the use of chemical processes. These processes extract many raw materials from the earth and atmosphere; they also put back into the environment not only various finished products but also many unwanted by-products.

Other human activities, in addition to chemical industry, also have effects on the chemistry of our environment. These activities include the burning of coal to generate electricity, the burning of gasoline in internal combustion engines, the disposal of solid wastes, the treatment of sewage, the control of insect pests, and the use of chemicals in food.

Today, man's impact on his environment has become so great, that every responsible person must learn all he can about the scientific principles which govern man's relationship to his environment. This unit is designed to acquaint you with different aspects of the so-called "environmental crisis". You will investigate ways in which the actions of man have affected his environment, and how these effects can be identified and measured. You will also learn about steps man has taken to control his effects on the environment.

It is hoped that this unit will increase your ability to understand some of our environmental problems. As you work through these investigations, keep in mind that your own activities, though they may seem small, are really quite important. If the war against pollution is lost, it will be because each person does not care. If workable solutions to environmental problems are to be found, they can only come as a result of your actions.

OBJECTIVES:

At the completion of this unit, the student should be able to:

1. identify two ways in which an object or individual can affect its environment.

2. describe how a chemical reaction changes its surroundings.

3. identify at least three major air pollutants and their main sources.

4. describe current environmental problems or projects related to your locality.

5. describe some effects of sulfur dioxide, SO_2 as an air pollutant.

6. identify smog and describe its causes.

7. describe the effects of auto exhaust fumes on a growing plant.

8. identify a method of detecting particulate pollution of the air.

9. describe one method of removing pollutants from the air.

10. identify several types of water pollution.

11. describe how pollution of water by sewage alters the oxygen availability to organisms living in the water.

12. identify two types of water pollutants contained in detergents.

13. describe a laboratory procedure for determining the presence of phosphates in detergents.

14. describe the effects of phosphates on the growth of algae.

15. identify two major groups of land pollutants and list at least two examples of each.

16. describe several ways in which chemical pollutants are spread widely in our environment.

ACTIVITIES:

A. LAB: Burning Match (Environmental Science, ISCS 3, pp.7-19)

Carry out Activities 2-1 and 2-2 and answer the questions following these activities, as directed by your teacher.

B. LAB: Combustion (Environmental Science, ISCS 3, pp. 59-61)

To begin to find out how combustion products cause air pollution, do the Activities 6-1, 6-2 and 6-3 and record your results. Answer questions 6-1 to 6-5.)

C. DATA STUDY: major pollutants of the air (Environmental Science, ISCS 3, pp. 62-63)

Table 6-2 on page 62 identifies the five major types of air pollutants in America and the sources which cause them. Table 6-3 gives a description of each type of air pollutant. Study the information given in these tables and answer the questions 6-6 through 6-10.

D. BULLETIN BOARD PROJECT: Pollution

Now that you have begun to learn about pollution, read your local papers and follow up any stories you can find about pollution. Your teacher will designate a bulletin board where information on this subject can be posted.

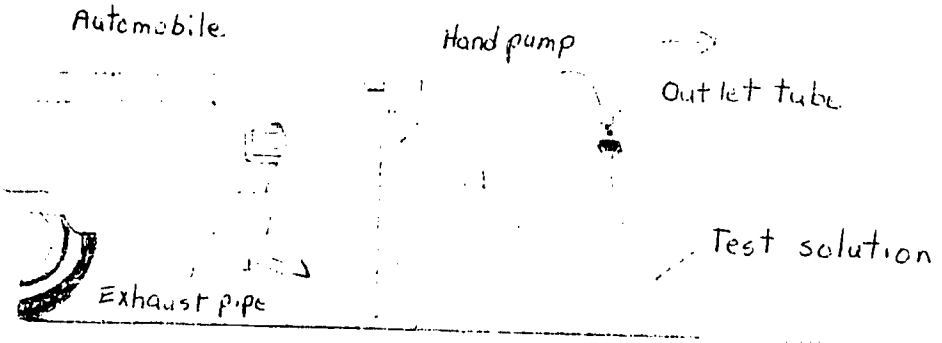
E. LAB: Sulfur Dioxide Study

Carry out the experiment and answer the questions in paragraphs 3-2 through 3-5 on pp. 36-37 of Pollution: Man's Crisis by Kelly & Wengert.

Scientists have shown that smog is produced by the chemical action of sunlight acting on hydrocarbons and nitrogen oxides in the air; these pollutants are produced mainly be automobile exhausts. You can test for nitrogen oxides in automobile exhaust gases by doing the following activity.

F. LAB: Test for Nitrogen Oxides in Auto Exhausts

Pour 500 milliliters of methyl orange solution and 500 milliliters of sodium bicarbonate solution into the collecting jar. Arrange the equipment as shown so that gases from the exhaust pipe of an automobile with the engine running can be pumped through the solution with a double-action hand pump. (CAUTION: DO THIS OUTSIDE AND AVOID BREATHING THE EXHAUST GASES.) Note any color changes in the methyl orange solution. This is a test for acid fumes from the nitrogen oxides in the gases. The more rapid the color change, the greater the concentration of nitrogen oxides.



The effects of air containing automobile exhaust gases on a growing plant can be studied in the following activity.

G. LAB: Effect of Auto Exhaust Gases on Plants

Obtain two young potted tomato plants, each about six inches high. Place each plant in a one-gallon size clear plastic bag and tie the open end of each bag around a rubber or plastic tube, as shown in the drawing. Water both plants regularly and keep them in sunlight. Attach a double-action hand pump to the tube so that air can be pumped into the bags. Once a day, use the exhaust pipe of an automobile with the engine running as a source of clean (not smoky) gases. Pump these into the bag surrounding the experimental plant and clamp the tube shut so that the gases do not escape. (CAUTION: DO THIS OUTSIDE AND AVOID BREATHING THE EXHAUST GASES AS MUCH AS POSSIBLE.) At the same time, pump a similar amount of air without exhaust gases into the bag surrounding the control plant. Keep the inlet tubes clamped shut for several hours after the gases are pumped into each bag. After several days, compare the color and texture of the leaves on both plants. List any differences in the general growth observed in the two plants. (See drawing on next page.)

Not all the pollutants of the air are gases. Solid particles such as dust and pollen also pollute the air. Pollution of the air by solid particles is called particulate pollution.

H. LAB: Particulate Pollution

To study particulate pollution, carry out Activities 6-4 and 6-5 on page 64 of Environmental Science, ISCS 3.

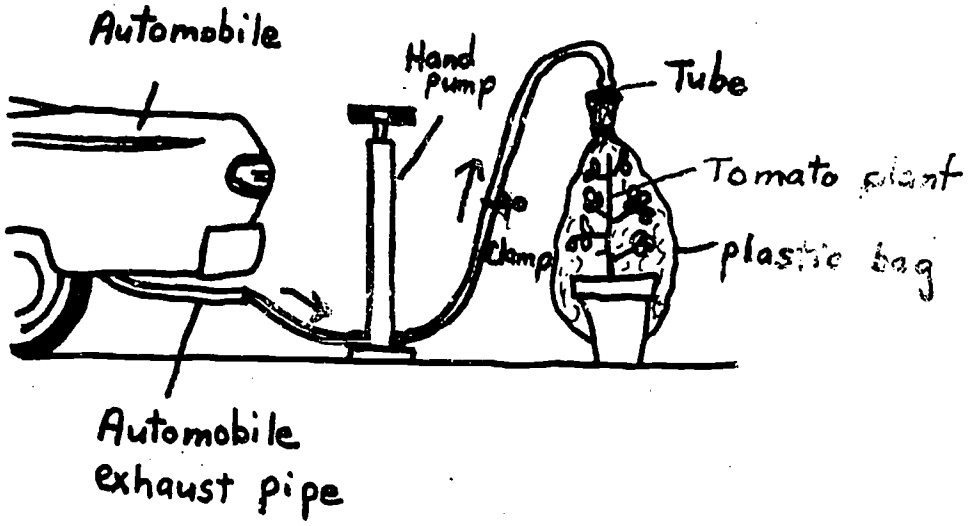
I. OPTIONAL LAB ACTIVITY: Absorption of Gases with Activated Charcoal

To investigate how some types of pollutants may be removed from the air, carry out the experiment and answer the questions given in paragraphs 3-9 through 3-17 on pp. 38-40 of Pollution: Man's Crisis, by Kelly and Wengert.

So far we have concentrated on air pollutants. Another major area of the environmental crisis has to do with the problem of keeping our water free of pollution. Almost all natural waters on the earth's surface contain tiny living matter -- microorganisms. These microorganisms use the dead bodies and waste output of other creatures as their source of food and energy. As they do this, they take in oxygen from the surroundings and release carbon dioxide.

Most living things must have some oxygen to live. Therefore, it is essential that this gas be available in the water environment. The need for oxygen by living things is called the biochemical oxygen demand (B.O.D.).

In the next activity, you will investigate how the B.O.D. of microorganisms is affected by changes in the water surrounding them. Then you may see that the B.O.D., in turn, affects the water. Keep in mind that decay organisms feed on waste material; therefore, sewage is a source of their food supply.


Automobile
Hand pump
Tube
Tomato plant
Tap
Clamp
plastic bag
Automobile exhaust pipe

J. Carry out Activities 3-1 through 3-6 on pp. 23-27 of Environmental Science, Probing the Natural World/3 (ISCS), and answer the questions following each activity.

You probably already know that detergents are also a source of water pollution. Detergents contain certain substances called enzymes and phosphates, which are helpful in washing clothes and dishes. However, these substances, particularly phosphates, greatly add to the pollution problem because they do not break down the way ordinary soap does. As a result, they appear unchanged, in rivers, lakes, and oceans.

K. Home Project: Check of Cleaning Agent Ingredients

Examine the packages of detergent and dishwashing preparations on grocery store shelves to find out what they contain. Record your results in a table like the following:

Name of Product	Phosphates Present	Enzymes Present
1		
2		
3		
4		

L. LAB: Test for Phosphates in Water

Test some detergents to determine if phosphates are present by carrying out the procedure in paragraph 4-32, page 54, of Pollution: Man's Crisis, by Kelly & Wengert.

M. EXTRA CREDIT LAB PROJECT: Effect of Detergents in Water on the Germination of Seeds

What do you predict will happen to seeds a farmer sows if the water he uses to "get them going" (germinate them) contains detergent wastes? If the answer to this question interests you, you may research it in a simple project that will require about three days to complete. (This project may be done at home.)

The directions for this project are contained on pp. 31-36 of Environmental Science, ISCS 3. Your teacher will provide you with the necessary detergent solutions.

N. LAB: Effect of Phosphates on the Growth of Algae

What effects do phosphates in water have on certain organisms living in the water? To answer this question, obtain 4 one-gallon jars and fill each jar with the same amount of water. Set them up in a row so that they all get the same amount of light and heat. Find some powdered fertilizer that is high in phosphate. Mix up one gram of fertilizer in the first jar, two grams in the second jar, and four grams in the third jar. Do not put any in the fourth jar; it will be the control. Pour a test tube of water containing algae in each of the four jars.

Observe each jar daily for algae growth. Is there any difference in "greenness" among the jars? What about the control jar? What is the relationship, if any, between the amount of phosphate in the jars and algae growth?

A third major category of pollution has to do with pollution of the land. Two important groups of land pollutants are solid wastes--garbage, junked cars, etc. -- and chemicals.

Chemical pollutants include fertilizers, pesticides, and herbicides. All of these types of land pollutants result, in part at least, from agricultural processes - the need to feed large populations in our urbanized society.

Some chemical pollutants, such as DDT, remain in the soil for long periods of time, without breaking down. Thirty years ago, before commercial production of DDT began, animal body fat was free of this chemical. Today, DDT can be found in fatty tissue of persons all over the world -- even where DDT is unknown. One way chemicals like DDT spread widely, is by contamination of foods. Chemicals can also spread by evaporation from soil and plants, wind drift, erosion of chemically treated soils, and finally, by leaching from the soil. Leaching means that chemicals leave the soil by soaking through the topsoil to the underground water system.

The following activity can be used to show how fast chemicals (whether fertilizers, pesticides or herbicides) leave the soil.

O. LAB: Leaching of Chemicals from the Soil

Carry out the experiments and answer the questions outlined in paragraphs 2-8 through 2-21 on pp. 27-34 of Pollution: Man's Crisis by Kelly and Wengert

P. Crossword Puzzle Exercise: Word Pollution

ACROSS

1 Branch of chemistry dealing with our total surroundings, _____ chemistry
3 Catalysts contained in a living thing; also used as ingredients of some detergents
6 Blanket of air surrounding the earth
7 Portion of earth's surface polluted by junked cars, garbage, etc.
8 Contamination of the air, water, or land; addition of anything where it doesn't belong
12 Science that deals with the composition of matter and the changes in its composition
13 Pollution of the air by solid particles, _____ pollution
15 A chemical pollutant used as a pesticide, can be found in fatty tissue of humans
16 Collective name for tiny living matter
19 Numerical scale from 0 to 14 which measures acid-base strength of solutions

20 Chemical formula for carbon monoxide, a major air pollutant
21 Chemical symbol for poisonous heavy metal sometimes used in gasoline additives
22 Substance which shows chemical change by changing color; e.g., litmus
26 One-celled plant; "pond scum"
27 Element of atomic number 26 and symbol Fe
29 Phosphates help make _____ water soft
30 Household device used to combat floor pollution
31 Synonym for combustion; cause of air pollution
34 Carbon monoxide, carbon dioxide, oxygen, hydrogen, etc.
35 Minerals added to soil for plant growth; type of chemical pollutant
38 Corruption by contact; pollution, e.g., DDT is spread widely by _____ of foods
40 - Discharge of gases from automobile engines; primary cause of air pollution
42 Cleaning agent which frequently contains phosphates and enzymes; soap substitute

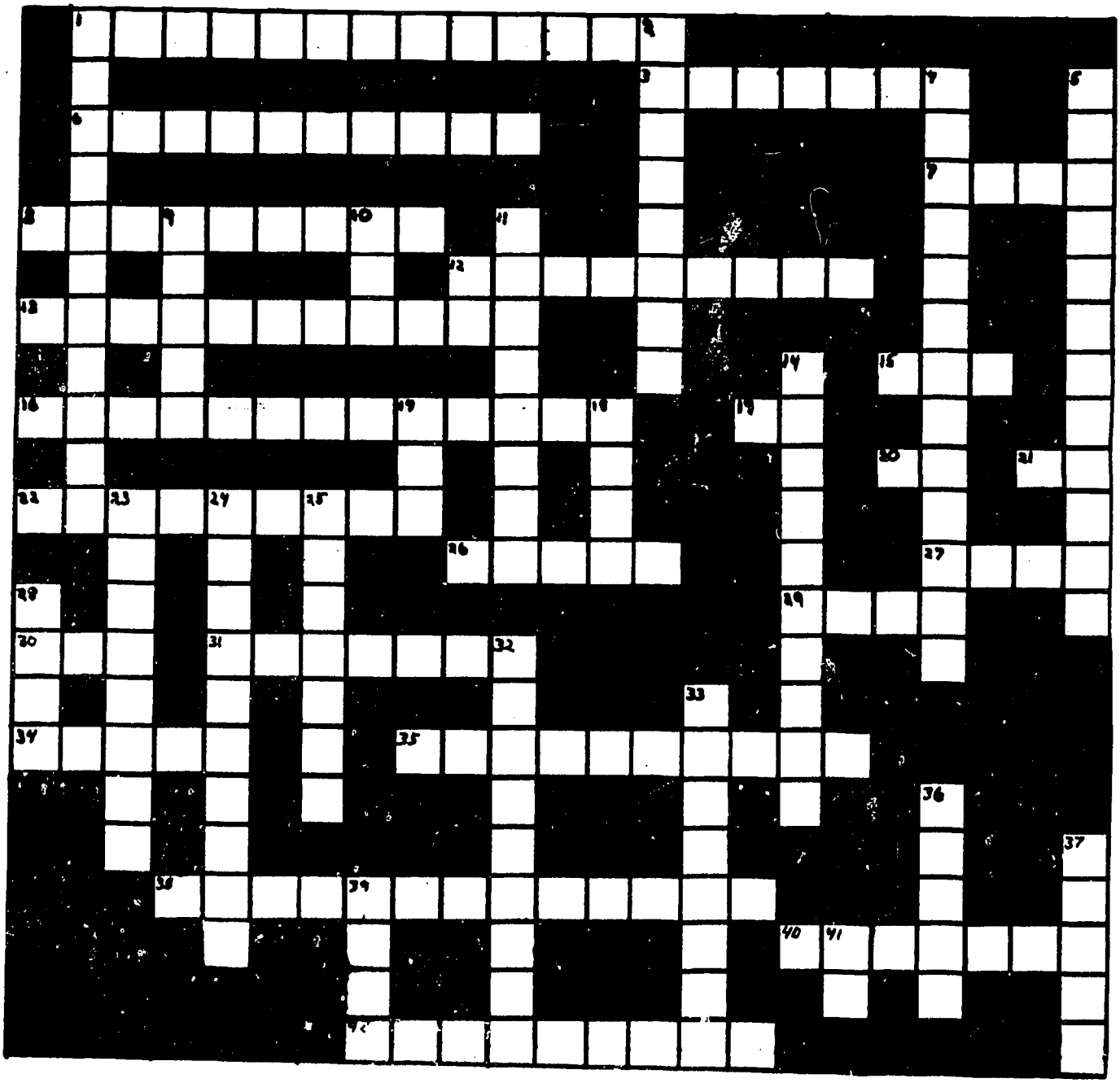
DOWN

1 Physical change from liquid to gaseous state; method by which chemical pollutants may spread from soil to atmosphere
2 Method by which chemicals leave the soil by soaking through the top soil to the underground water system
4 Major air polluting gas with pungent odor and which bleaches clothing; formula SO_2
5 Air pollutants resulting from incomplete combustion of gasoline; the chemical action of sunlight on _____ and nitrogen oxides causes smog
9 Metric unit of volume; equal to 1.06 quarts
10 Potential pollutant holding up development of Alaskan pipeline
11 Change in which the substances involved lose their properties and form an entirely new substance
12 Abbreviation for cent
14 Water pollutants contained in detergents and fertilizers
17 Mixture of gases which forms one major portion of our environment
18 Type of mineral silicate which separates into very thin leaves
23 The garbage problem: _____ of solid wastes
24 Chemical process which produces the power in automobile engines; largest single source of air pollutants
25 Pertaining to heat; form of pollution resulting from nuclear generating power plants
28 Visible air pollution; once thought to be combination of smoke and fog
32 To begin to grow or develop; to sprout - pertaining especially to seeds
33 Chemical element, symbol N, which forms gaseous oxides which pollute the air
36 Adjective describing cities; contrasted to suburban, and rural
37 Liquid portion of our environment
39 Nitric _____ and sodium sulfite are used to prepare sulfur dioxide
41 Chemical symbol for xenon

EVALUATION

The crossword puzzle exercise you have just completed provides a comprehensive review of the vocabulary words of this unit. See your teacher for any further evaluation.

CROSSWORD POLLUTION



Notes on Activities

A. Materials needed: friction matches, sandpaper, modeling clay

B. Materials needed: 600 ml beakers, baby food jar lids, cotton, wool cloth, styrofoam, tape, hand lenses, safety matches, turpentine

Arrange for ventilation during burning activities.

E. Materials needed (per setup): sodium bisulfite (1 gram), 2 ml sulfuric acid (diluted 3 parts H_2O to 1 part concentrated H_2SO_4), 2 test tubes (18 x 200 mm), 1 one-hole stopper with short piece of glass tubing to fasten on the rubber delivery hose, colored cloth, nylon stockings

This investigation should be done in a well ventilated area.

F. Materials needed; methyl orange solution, sodium bicarbonate solution, double action hand pump, access to automobile exhaust

Caution: Avoid breathing the exhaust gases as much as possible.

G. Materials needed: potted tomato plants, plastic bags, double action hand pump, access to automobile exhaust

H. Materials needed: tape, hand lenses or microscopes

I. Materials needed (per setup): three 250 ml flasks, 1 teaspoon of activated charcoal, 1 one-hole rubber stopper, glass tubing, three 250 ml beakers, 1 two-hole rubber stopper, 1 thistle tube, 1 delivery tube, teaspoon of baking soda ($NaHCO_3$), 100 ml beaker, test tube, hot plate, 150 ml lime water

The activated charcoal should be heated before the investigation to insure activation. The thistle tube must be below the surface of the solution or the CO_2 produced will escape from the thistle tube rather than from the delivery tube. If vinegar is added too rapidly, the CO_2 will be produced at an excessively rapid rate.

J. Materials needed (per team): 1 plastic spoon, 2 baby food jars, 1 teaspoon of powdered milk, 1 teaspoon of dry yeast, two 5 ml air pistons, 1 stirring rod, 3 test tubes, 13 x 100 mm, 1 test tube rack, watch or clock (per class): 100 ml of methylene blue solution in dropper bottles, test tube brushes, wax marking pencils

Materials needed (per team): various types of detergents (1 gram each), 6 molar nitric acid (5 drops), molybdate solution, hot water bath, three eye droppers

The molybdate solution is made by adding 12-36 grams of ammonium molybdate, $(NH_4)_6\ Mo_7\ O_{24} \cdot 4\ H_2O$, to one liter of solution. Make sure the water bath is hot, not just warm.

M. Materials needed (per team): 4 plastic petri dishes with lids, 1 paper towel, 64 radish seeds, 10 ml of 1% detergent solution, 10 ml of 5% detergent solution, 4 plastic vials with lids, 2 ml of methylene blue solution, 2 ml of phenol red solution, tape
(per class) wax marking pencil, 1 100 ml plastic graduated cylinder, scissors, medicine droppers

This activity will take several days to complete.

N. Materials needed (per team): four 1 gallon jars, seven grams powdered fertilizer of high phosphate content, water containing algae

O. Materials needed (per setup): plastic or glass column about 24 inches long by 1⅓ - 2⅔ inches in diameter, single-hole stopper with short pieces of glass tubing, cheese cloth to fit inside the column to hold the sand, washed, white sand, coarse sand, grape or bright-colored Kool-Aid, dozen small catch jars, such as baby food jars, ring stand, clamp to hold column to ring stand, 25 ml or larger graduated cylinder

Columns - make sure stoppers are secure. Sand should be as clean and pure as possible.

Audio-Visual Aids

1. Available from IMC:

a. Films

F1019	Clean Town, U.S.A.
F125	It's Your Turn
F874	A Town Washes Its Water

b. Filmstrips

FS614.7	Environmental Pollution...Our World in Crisis (set of 6 filmstrips)
FS333.9	Water and Life
FS540	Can the Chemist Renew the Supply?

c. Sound Filmstrip

SFS363.62	The Power and Energy Crisis: Technological Challenge of the Future (AP Special Report)

d. Games and Multimedia Kits

K614.71	Smog: The Air Pollution Game
K333.9	Dirty Water: The Water Pollution Game
MM614.7	Environmental Action: No Time To Waste
MM614.7	Recycling Resources

e. Slides

S628.54 (Sound)	Everything Has to Be Some Place (set of 66 slides, tape, script) Division of Solid Wastes
S333.9	Water Pollution (22 slides and teacher's guide)
S333.9	Air Pollution (22 slides and teacher's guide)

2. Free loan films which are listed in 1973-74 NSTA Catalogue, Environmental Education Materials:

a. Something in the Air, Caterpillar Tractor Film Library, 160 E. Grand Avenue, Chicago, Illinois 60611 (28 minutes, color)

Identifies kinds and quantities of air pollutants associated with internal combustion engines. Uses interview techniques to discuss the hopes and ambitions, fears and frustrations involved in industry's wrestling with the concept of "zero pollution".

b. The Trouble with Trash, Caterpillar Tractor Film Library, 160 East Grand Avenue, Chicago, Illinois 60611 (28 minutes, color)

Vivid, forceful portrayal of the positive features of land-fill methods of solid waste disposal. Discusses difficulties in finding suitable sites, assuming that the volume of waste cannot be reduced in the future.

c. Work in Progress, Order from Association - Sterling Films, 866 Third Avenue, New York, New York 10022 (27 minutes, color)

How the awareness of the industry to its responsibilities to the environment is leading to the use of improved pollution control equipment. Touches on recycling, electrostatic filters, and new waste water treatment facilities. Begins and ends with cartoon format.

Resources

1. Instructional resources:

a. Environmental Science, Probing the Natural World/Level III, ISCS Silver Burdette, 1972

b. Pollution: Man's Crisis, An Investigative Approach, by Kelly and Wengert, North Dakota Studies, 1971

c. Modern Science, Forces, Change and the Universe, by Blanc, Fischler, and Gardner, Holt, Rinehart & Winston, 1972

2. Reference resources:

a. Ginn Science Program - Advanced Level B, by Asimov and Gallant, Ginn and Company, 1973

b. Challenges to Science - Physical Science, by Williams, Bolen and Doerhoff, McGraw Hill, 1973

c. Anti-pollution Lab by Blanstein, Sentinel Book Publishers, Inc., 1972

d. Air Pollution Experiments for Junior and Senior High School Science Classes, Air Pollution Control Association, Publications Department, 4400 Fifth Avenue, Pittsburgh, Pennsylvania 15213 (38 experiments, 128 pages, 1972, $1.50/copy)

e. Environmental Pollution: Experiences/Experiments/Activities by Weaver Manufacturing Chemists Association ($1.24 per copy for either Student Edition or Teacher's Manual, 62 pages, 18 investigations). Order from Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017

3. Free printed materials:

a. A Primer on Air Pollution
A Primer on Solid Waste
A Primer on Water Pollution
Mobil Oil Corporation, Department ST, 150 East 42nd Street, New York, New York 10017

(Each primer is 4 pages, 11" x 15". One unit of 10 sets, 30 primers, per teacher)

b. Detergents and the Environment, Lever Brothers Company, Consumer Education Department, 390 Park Avenue, New York, New York 10022
(19 pages, classroom quantities)

c. The Story of Environment and Industry, American Iron and Steel Institute, Education Department, 1000 Sixteenth Street, N.W., Washington, D.C. 20036
(20" x 30" chart that folds into a 9"x 10" book format. Classroom quantities)

d. Natural Gas Energy and the Environment, American Gas Association, Educational Services, 1515 Wilson Boulevard, Arlington, Virginia 22209
(4 pages)

Crossword Puzzle Answers

ACROSS

1 environmental
3 enzymes
6 atmosphere
7 land
8 pollution
12 chemistry
13 particulate
15 DDT
16 microorganism
19 PH
20 CO
21 Pb
22 indicator
26 algae
27 iron
29 hard
30 mop
31 burning
34 gases
35 fertilizer
38 contamination
40 exhaust
42 detergent

DOWN

1 evaporation
2 leaching
4 sulfur dioxide
5 hydrocarbons
9 liter
10 oil
11 chemical
12 CT
14 phosphates
17 air
18 mica
23 disposal
24 combustion
25 thermal
28 smog
32 germinate
33 nitrogen
36 urban
37 water
39 acid
41 Xe

Evaluation Form for Teachers

1. Name of the mini course _____

2. Was this unit appropriate to the level of your students?

3. Explain how this mini course was used with your students. (Individual, small group, or total class)

4. Identify the plus factors for this course.

5. List the changes that you would recommend for improvement.

6. Did you use any other valuable resources in teaching this unit? If so, please list.

PLEASE RETURN TO SCIENCE SUPERVISOR'S OFFICE AS SOON AS YOU COMPLETE THE COURSE.

ADDITIONAL SCIENCE MINI-COURSES

LIFE SCIENCE	Prepared by
A Study for the Birds	Terrence Best
Creepy Critters (Snakes)	Terrence Best
How's Your Plumbing?	Paul Cook
Guess Who's Been Here for Dinner	Paul Cook
Plants - The "Other" Living Things	Sharon Sheffield
Let's Look at You - The Human Organism	Sharon Sheffield
Classification: Why is There a Need?	Melvin Whitfield
Protist: The "Unseen" Kingdom	Melvin Whitfield

EARTH SCIENCE	
Coastline Development	Nelson Ford
Ocean Currents	John Fradiska
Features of the Ocean Floor (Ocean Floor Topography)	John Fradiska
Space and Its Problems	John Geist
Invertebrate Fossils: Clues to the Distant Past	John Geist
An Attempt towards Independent Study in Astronomy	John Geist

PHYSICAL SCIENCE	
Household Chemistry	Ross Foltz
Notions on Motions	Kenneth Howard
Environmental Chemistry	Fred Meyers