ENVIRONMENTAL SCIENCE LAB WORK BOOK

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Environmental Work Book

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Preface

Environmental Science is a subject the world population needs to be concerned about. The animal kingdom, weather, population, famine, and the earth itself have been trying to get our attention for years. We need to heed these natural signs of problems before it's too late to change.

Most citizens of the world are somewhat familiar with those issues that are global in nature. These are the issues that create headlines and grab the imagination: global warming, nuclear power, ozone depletion, etc. Here in the United States, we can add other problems: non-point source pollution from farming, habitat loss caused by urban expansion, pollution of our common water resources and the air we breath, and our continuing attempts to correct these problems with less than perfect results.

This work book is intended to provide hands-on lab exercises for the non-scientist to better understand some of the many problems facing our world today. It tries to bring into focus what we, as private citizens, can do to change our part of the environmental world. We can make a difference by reducing the consequences of destructive environmental problems.

The materials used in these lab experiments and exercises are easy to obtain and are not dangerous or hazardous if manufacturers' instructions are followed.

Chapter 1

Environmental Current Events Log

Objectives:

1. **The student will develop an awareness about the amount of environmental information that is available in day-to-day life.**
2. **The student will use critical thinking to decide if the information provided is complete, unbiased, and factual.**

Introduction:

This Environmental Current Events Log is meant to bring to your attention the amount of consumer information that's available to you in your day-to-day life. If you see and take advantage of this information, it can help you be an environmentally wise consumer, and it will help you see through those who would use unrelated or useless information to sell you something.

Procedure:

For one week, keep a log of all environmentally related issues which appear in the media (including bill boards, TV, radio, newspaper), or other sources such as shopping for clothing, hardware items, food, recycling containers, etc. Record the date, source or location, significance, and if there is a bias.(Are they trying to sell you something?) Also indicate your reaction to the material and identify any parts that need further explanation. There will be a group discussion of your results during the next class meeting.

Current Events Log Data Sheet

Topic	Date	Source/ Location	Why is it important?	Bias	Your Reaction

Current Events Log Data Sheet (Cont.)

Topic	Date	Source/ Location	Why is it important?	Bias	Your Reaction

Current Events Log Data Sheet (Cont.)

Topic	Date	Source/ Location	Why is it important?	Bias	Your Reaction

Current Events Log Data Sheet (Cont.)

Topic	Date	Source/ Location	Why is it important?	Bias	Your Reaction

Current Events Log Data Sheet (Cont.)

Topic	Date	Source/ Location	Why is it important?	Bias	Your Reaction

Group Discussion:

How many total items? Count items by:

- **Water**
- **Air**
- **Waste/Hazardous Waste**
- **Recycling/Reuse**
- **Energy**
- **Wildlife**
- **Other**

Questions:

1.Did you learn anything?

2.Did any of the articles make you happy? Why?

3.Did any of the articles make you angry? Why?

4.Did any appear incomplete or leave out important information?

5.Each group member share one article you particularly liked.

Chapter 2

Household Hazardous Waste Audit

Objectives:

1. **The student will develop an awareness of the number of toxic or hazardous materials used in the average home.**
2. **The student will understand how and where to properly dispose of hazardous waste.**

Introduction:

We should all be aware that items we use around our homes are dangerous if not used and stored properly. Some are very caustic: some are flammable: some can cause illness or death if used improperly, and some can even be explosive.

We need to be aware of these potentially dangerous items. Read all of the manufacture's directions to ensure proper use of the product, where and how to store the remainder of the product, or how to dispose of any left over product and the container it came in.

Learn how to read labels. If you see words like caution, warning, danger, flammable, combustible, poison, or corrosive, these products probably contain hazardous materials and should be treated with a great deal of respect. They should also be disposed of properly. If you have questions about the proper disposal of any product, contact your county or state solid waste officer.

Procedure:

Develop a checklist by living area (kitchen, garage, etc.) for your home or apartment. Identify 40 hazardous items and evaluate each (using the following pages) and points:

What is its location?

What is its purpose?

Specify hazardous property (corrosive, toxic, explosive, irritant, flammable, or radioactive).

Is it obsolete, (Do you still need it?)

How should one dispose of it?

Are there safer alternatives available?

Hazardous Material Checklist

1. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

2. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

3. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

4. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

5. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

6. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

7. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Hazardous Material Checklist (cont.)

8. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

9. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

10. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

11. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

12. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

13. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

14. **Item -**
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Hazardous Material Checklist (cont.)

15. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

16. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

17. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

18. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

19. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

20. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

21. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Hazardous Material Checklist (cont.)

22. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

23. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

24. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

25. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

26. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

27. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

28. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Hazardous Material Checklist (cont.)

29. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

30. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

31. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

32. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

33. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

34. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

35. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Hazardous Material Checklist (cont.)

36. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

37. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

38. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

39. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

40. Item -
Location -
Purpose -
Hazardous Property -
Obsolete -
Dispose of -
Possible Alternative -

Discussion:

1. **Did the labels provide complete information on hazardous properties? (Were newer items more informative?)**

2. **Was information provided for proper disposal?**

3. **What improvements could be made so consumers know how to properly use and dispose of hazardous items?**

Chapter 3

pH Lab: Acids and Bases in Water

Objectives:

1. **The student will understand the definition of pH.**
2. **The student will learn where pH has significance and for whom.**
3. **The student will conduct a simple equalization procedure and understand its significance.**

Introduction:

WEBSTER'S NEW WORLD DICTIONARY defines pH, in part, as; "a symbol for the degree of acidity or alkalinity of a solution; pH 7, the value for pure distilled water, is regarded as neutral."

An acid is a substance that yields hydrogen ions when dissolved in water. Bases are substances that yield hydroxyl ions when dissolved in water.

Areas of significance include acid rain, sewer limitations, and hazardous waste definition. On a pH scale, the number seven is considered a neutral substance, neither acidic or alkaline. Anything higher on the scale, or greater than 7, will be increasingly alkaline; anything lower, or less than 7, will be increasingly acidic. The normal blood pH for humans and most mammals is 7.4, or slightly alkaline. A seemingly small change in pH, from 7.4 to 7.0, can severely depress nervous function in humans.

0	7	14
acidic	neutral	alkaline

Acid Rain:

Acid Rain results when pollutants such as oxides of nitrogen and sulfur, are emitted from factories and automobile exhausts into the atmosphere. These oxides are converted to acids through a series of chemical reactions with other substances. If one molecule of sulfur dioxide (SO_2) bonds itself to an atom of oxygen and then to a molecule of water the result is H_2SO_4 or sulfuric acid. Now, you have naturally occurring acid rain.

Acid deposition is being blamed for acidification of lakes, killing fish, and plants. It has also been blamed for deterioration of marble and limestone, a common building material in the United States and around the world. Limestone statues and treasures of the past, such as the Acropolis in Athens, the Jefferson Memorial in Washington, D.C., Mayan artifacts, and, in the Southwest, the ancient cities of the Ansazi Indians, have all been affected.

The EPA estimates the annual cost of repairing or replacing structures damaged by acid deposition may exceed $5 billion dollars. If this is true, we have a definite problem.

It's common knowledge that natural rain is slightly acidic anyway. The earliest record of acid rain dates to a Swedish report in 1848. Sulfur and nitrogen, the key components of acid rain, are generated naturally by decaying

organic matter in swamps and wetlands. Sulfur oxides are generated primarily by power plants, while nitrogen oxides are generated primarily by internal combustion engines (of cars). Different areas of the United States have acid rain caused by different sources. Power plants are the major source of acid rain in the Northeast, whereas cars are the major source in the West.

In the United States, 219 lakes have been identified as too acidic to support fish. Two hundred and six of these lakes are in the Adirondacks, but they account for only 4% of the lake surface of New York State.

Waste Water Limitations:

Most larger cities have waste water limitations of 6 to 9, or 5 to 10 units. These limits are established to protect the piping of the sewer line and the treatment works from corrosion and damage. Industrial dischargers outside these limits must neutralize their waste water before discharging into the sewer system.

Hazardous Waste:

The Environmental Protection Agency passed the Resource Conservation and Recovery Act in 1976 for cradle to grave handling of hazardous waste. One of the key sections defines what a hazardous waste is. One of the criteria is

corrosivity. The material must be a waste and a liquid. If it has a pH of 2.0 or less or 12.5 units or greater it is considered a hazardous waste. As a hazardous waste, there are special and specific requirements for handling and disposal.

Lab Procedure:

Acids and bases can be detected conveniently using indicators. Litmus paper shows only whether a solution is acidic (the paper turns red) or basic (blue). Laboratory pH paper is more precise. The indicator paper should be wetted with the liquid to be tested and compared with the pH color chart within 30 seconds.

Data Chart

Test and record the pH of the following substances:

Tap Water _____

Club Soda _____

Lemon Juice _____

Vinegar _____

Solution of Mild Soap _____
(1 spoonful soap & 1/2 cup water)

Solution of Bicarbonate of Soda _____
(1 spoonful soda & 1/2 cup water)

Ammonia Cleaner _____

Neutralization:

CAUTION

Use caution during the neutralization procedure.

Foaming or acrid fumes may be given off.

Low pH item before mixing.

Item_____ **pH**_____

High pH item before mixing.

Item_____ **pH**_____

pH after mixing together. pH_____

Discussion:

1. **Which of tested items could not be discharged into a sewer without treatment (assuming limits of 6 to 9 units)?**

2. **Which items would be considered hazardous waste?**

3. **How does tap water compare to acid rain (Assuming acid rain has a pH of 4.7.)?**

Chapter 4

Bottled Water Exercise

Objectives:

1. **The student will understand that there are differences in water depending on source and treatment method.**
2. **The student will determine which type of water tastes the best to you and why.**
3. **The student will learn to calculate drinking water costs.**

Introduction:

An adult person needs 2 liters, or 2.1134 gallons, of fresh water each day for consumption only. Water used for washing clothes, toilet use, dish washing and food preparation may add as much as 70 liters, or approximately 75 gallons, each day total. Water used for drinking purposes may come from many sources including city water treatment plants, ground water, wells, or commercially sold beverages like soft drinks or bottled water. These commercial suppliers are growing at an amazing rate each year.

Lab Procedure:

1. **Taste each water sample in small cups provided. The waters to be tested are tap water, Evian, H_2OH, Glenwood Inglewood, and distilled water. (You may have crackers to cleanse and freshen your mouth between water samples.)**
2. **Fill in your observations on the attached data sheet. A 100 is a perfect (good) score. Rank each item from 1 to 10.**
3. **Answer the follow-up questions and calculations.**

Data Sheet

Taste fresh/clean (10 if yes or 1 if no)

Water 1 Water 2 Water 3 Water 4 Water 5

Taste flat (1 if yes or 10 if no)

Water 1 Water 2 Water 3 Water 4 Water 5

Aroma (10 if good or 1 if bad)

Water 1 Water 2 Water 3 Water 4 Water 5

Chemical taste (1 if yes or 10 if no)

Water 1 Water 2 Water 3 Water 4 Water 5

Mineral taste (1 if yes or 10 if no)

Water 1 Water 2 Water 3 Water 4 Water 5

Aftertaste (10 if yes or 1 if no)

Water 1 Water 2 Water 3 Water 4 Water 5

Data Sheet (cont.)

Color (10 if none or 1 if colored)

Water 1 Water 2 Water 3 Water 4 Water 5

Clearness (10 if clear or 1 if cloudy)

Water 1 Water 2 Water 3 Water 4 Water 5

Appearance of container (10 if attractive or 1 if not)

Water 1 Water 2 Water 3 Water 4 Water 5

Price (10 if reasonable or 1 if expensive)

Water 1 Water 2 Water 3 Water 4 Water 5

Total points for each water (maximum of 100 points)

Water 1 Water 2 Water 3 Water 4 Water 5

Data Sheet (cont.)

	Water brand	cost/unit est. cost 1998	source from label	points
1.	Tap water	$0.00143/gal		
2.	Evian	$1.69/gal		
3.	H_2OH	$1.59/gal		
4.	Glenwood Inglewood	$0.68/gal		
5.	Distilled	$0.65/gal		

Choose tap water and one of the bottled waters. Figure and compare the cost per year for drinking water only.

For tap water: ($ per/gal can be obtained from utility company) or use $.0015/gal if price is not readily available.

2 ltr per/day X $\frac{365}{\text{yr.}}$ days X $\frac{.264 \text{ gal}}{\text{liter}}$ X $\frac{\$0.0015}{\text{gal}}$ = $\frac{\$}{\text{per yr.}}$

For Bottled water: (Cost per/unit can be obtained from label or at the store).

2 ltr per/day X $\frac{365}{\text{yr.}}$ days X $\frac{.264 \text{ gal}}{\text{liter}}$ X $\frac{\$}{\text{oz}}$ X $\frac{16 \text{ oz}}{\text{gal}}$ = $\frac{\$}{\text{per yr.}}$

NOTE: Here is a helpful conversion factor; 128 fluid ounces = 3.78 l = 1 gal.

Questions:

1. **Why do you think people buy bottled water?**

2. **Which source of water did you like best? Why?**

3. **How does the price of tap water compare to the price of bottled water?**

Chapter 5

Water Conservation

Objectives:

1. **The students will understand how even moderate water shortages can impact daily life.**
2. **The students will explore methods to reduce water consumption.**

Introduction:

Drought: What is it and what causes it? Drought happens when naturally occurring moisture, in the form of rain or snow, is less than normal for a given geographic area. When this happens, we call it a dry year and water reserves located in oceans, groundwater, rivers, lakes, and lowlands are being reduced, by human activities, faster then they can be replaced. This is called overdraft or water mining.

Have you ever wondered why rivers don't run out of water? The reason is that rivers flow in circles. Water takes on three different forms: liquid, ice, and vapor. When water evaporates, it takes the form of vapor when it escapes from rivers, lakes, oceans, trees, plants, animals, or anywhere there is moisture, by being heated by the sun or warm winds. Because it is warmer than the surrounding air, it rises into the atmosphere. As it rises, it begins to cool and condenses into small water droplets.

When enough of these droplets fill the atmosphere, clouds form. As the droplets combine and become larger, the clouds can no longer hold them and they fall as rain. The hydrologic cycle is now complete.

What we call dry years are generally caused by climatic changes, interrupting the hydrologic cycle. If this interruption lasts only a year or two and then returns to normal, recovery will occur within a relatively short period of time. But when these climatic changes hang on for an extended period, we have the beginnings of a drought.

Water shortages are occurring in West Africa, the Middle East, the

United States, and the Far East. In some areas the water table and aquifers are dropping at a rate of up to 5 feet a year.

Overdraft also causes subsidence, or sinking of the ground. In Bangkok, Thailand, the ground is sinking in areas as much as 5 inches every year because groundwater is being removed too quickly.

A related problem is facing Florida. Salt water is contaminating the water table. It appears as though salt water is being pulled in to replace groundwater being removed faster than natural replacement. This phenomenon is happening in the Netherlands and Israel, also. This is called salt water intrusion.

The water that occurs naturally under the surface of the earth will not disappear, but will it be usable for human consumption? That is up to us.

All living things need water. We require water in some form, daily, to survive. Humans can live longer without food than they can without water. Without water, our flower gardens will not live long enough to produce the flowers and seeds for regeneration. The soil of our vegetable gardens will dry out, and the plants will die long before the vegetables have had time to ripen. The fruit produced from fruit trees, if produced at all, will be stunted, usually bitter and dry.

The experts are telling us that some areas may run out of usable water in the foreseeable future. It is also believed that the world never loses its water. How can both of these statements be true? The key word here is usable. We are contaminating these water supplies.

People do strange things once in a while. How many of you have changed the oil in your car, accidentally spilled oil on the ground, and, instead of cleaning it up, let it stay there long enough to soak into the ground? How about spilling gasoline (while servicing the lawn mower) or other petroleum based products in the yard and not cleaning them up?

Eventually these contaminants could percolate down through the

soil to the water table and contaminate the groundwater. The contamination could continue into the aquifer that furnishes water from deep wells that service towns and cities. These kinds of backyard spills contribute to the whole problem if you multiply them by the number of households in a given area.

The same scenario takes place on a larger scale in large metropolitan areas. How about the salt used on roadways in colder climates, contamination from industrial parks, and chemicals from farms? Think about the fertilizers and chemicals used on a field of corn or wheat. Some of these chemicals can and do seep into groundwater and surface water. Think of the damage this could cause to a breeding wetland if the chemicals were weed killers or insecticides.

Livestock feed lots are another problem as well. The excrement of the animals may also percolate down through the earth and eventually end up in the groundwater. Now, think of what will happen if the farmhouse well is serviced by groundwater.

Nature will take care of some contaminants by cleaning the water through percolation. But nature can't do everything. There are some things that we have discarded that nature just can't handle. Then we must clean it up ourselves, and in most cases it costs a lot of time and money. If it had been properly disposed of in the first place, it wouldn't have posed a problem at all. The closed landfills in the United States are examples of old problems we are now cleaning up.

On this page, list as many possible contaminants as you can that could affect our groundwater supply.

Contaminant	**Source of contaminant**	**Where will contaminate go during rain runoff?**

Water Conservation Exercise

Procedure:

You are a family of four adults living in San Francisco.

You are allowed 1,400 gallons of water per week for the four of you.

1. Work out a weekly water budget for personal hygiene, clothes washing, dish water, etc. Use work sheet for your calculations.

For this exercise, use:

1. Toilet - 5.5 gal/flush (example, 4 flushes/day/person = 22 gal).

2. Shower - 3.4 gal/min x 4.8 min shower = 16.3 gal.

3. Washing machine - 55 gal/load.

4. Dishwasher - 14 gal/load.

5. faucet - 1.5 gal/min.

6. Bath - 50 gal, if full/bath.

7. Lawn watering - 35 gal/half acre.

8. Brushing teeth - 1 gal.

Data Sheet

Weekly Totals for Family of Four Adults

Activity	**Gallons Used**

Total weekly usage_____gallons

Discussion:

1. **Could your family of four live on 1,400 gallons of water per week?**

2. **What if your family consisted of 2 adults and 2 children in diapers?**

3. **What could you do to save water?**

4. **What would you have to give up?**

Chapter 6
Air Pollution
(Particulate Matter)

Objective:

1. **The student will understand that the air we breath can contain varying amounts of dust (particulate).**
2. **The student will study his/her urban environment for variations in particulate matter.**

Introduction:

What is air? It's what we breath. It's one of the many things that keeps us alive, but just what is it? Dry air is made up of many gases. Normally these gases are made up of 78% nitrogen, 21% oxygen, plus trace amounts of other gases such as argon, ozone, carbon dioxide, and methane.

Air pollution comes from human activity, especially combustion. Power plants and burning of the rain forest are two examples Air pollution can also occur naturally. Wind storms, earth quakes, volcanos, and geothermal or sulfur springs are examples.

Particulate Matter (PM) may be a major health problem. A large number of studies report associations between particulate matter and increased death and illness, especially for elderly people and those with respiratory and cardiovascular disease. PM may also increase asthma problems in children. The EPA has decided to regulate finer particulates because they cause, or contribute to, more severe health concerns.

Procedure:

The class will make a community-wide survey of particulate fallout and plot the results on a map of your area. Obtain some small, open top boxes all the same size. Use masking tape to stick a clean piece of white typing paper in the bottom of each box. Place the boxes at various locations for a dry (no precipitation) period of at least 48 hours and compare the relative darkness on the paper. You can vary the experiment by using a strip of exposed masking tape to collect solids and then observe or count them under a microscope.

For each paper or tape monitor, record the following information:

1. **Date and time of set up.**
2. **Date and time removed. (Note: leave all monitors in place for about the same amount of time.)**
3. **Type of area. (industrial, automobiles, etc. with a specific description of immediate surroundings)**

4. **Address of the monitor (so it can be mapped).**

After picking up the monitors, make the darkest location equal to 100% and rank the rest accordingly (half as dark = 50% for example). Does the particulate fallout vary with height? (Try some rooftops if you can.) Make a map with monitor locations or test spots. See if you can trace the major causes in heavy fallout areas.

Monitor #1.

1. **Date and time of set up.**

2. **Date and time removed. (Note: leave all monitors in place for about the same amount of time).**

3. **Type of area (industrial, automobiles, etc. with a specific description of immediate surroundings).**

4. **Address of the monitor (So it can be mapped).**

Monitor #2.

1. Date and time of set up.

2. Date and time removed.

3. Type of area.

4. Address of the monitor.

Monitor #3.

1. Date and time of set up.

2. Date and time removed.

3. Type of area.

4. Address of the monitor.

Make additional copies of this page as needed.

Chapter 7

Indoor Air Pollution

Objective:

1. **The student will be aware of contaminates present in his/her home and how they move through the home.**

Introduction:

Annual national costs of medical care resulting from indoor air pollution (IAP) health effects may be over $1 billion, as estimated by the EPA. Some of the major forms of IAP are volatile organic compounds (VOCs) (such as tobacco smoke and formaldehyde), radon, asbestos, particles, and particulates from inadequate cleaning of air conditioning filters and ducts. Energy efficient building designs can contribute to the problem due to decreased ventilation. In many new buildings, for example, the windows do not open. Indoor air pollution can cause everything from itchy eyes and runny noses to more serious health problems.

A building can become sick with indoor air contamination from such things as poor ventilation and inadequate cleaning of air conditioning filters and ducts. It's now suspected that some summer colds people develop are from a bacterial or viral agent from poorly maintained air conditioning systems. For whatever reason IAP may affect us all at one time or another.

Procedure:

Part I. Class members should check the following at home:

1. **The water collection pan of the refrigerator. Is standing water present? Is there anything growing in the water? These pans should be cleaned regularly.**

2. **Furnace filter. Is it changed regularly, and is yours clean?**

3. **Humidifier, if you have one. Check water holder. Is it clean or cloudy? It should also be cleaned on a regular basis.**

4. **Items from your dry cleaning establishment. Do they contain perchlorethylene, a potential carcinogen? Do you detect a faint odor when you bring these items into your home? Also, check your bill to see if an environmental charge has been added to cover air pollution controls required at the business.**

5. **New carpet or furniture. Were any odors detected when these items were placed in your home?**

Part II Dispersal of gases in air.

1. Pour some perfume or after shave lotion in a saucer in a closed room. Smell the liquid and note its odor intensity which will be called 100. Cover the saucer. Now sit in some other part of the room and uncover the saucer (note the time). When you become aware of the smell, note the time and intensity (1/2 as strong would be 50). Repeat with different nonhazardous materials and conditions (use of a fan, open windows, closed windows, etc.).

Chapter 8

Solid Waste Generation

Objectives:

1. **The student will evaluate the amount of trash generated at home.**
2. **The student will determine if improvements can be made to reduce the amount of waste generated.**

Introduction:

At only 5% of the total population of the world, the United States generates 25% of the waste. We generate this amount of waste both as a society and as individuals. Each person is estimated to generate an average of 4.7 pounds of waste each day, or 0.75 tons per year.

Procedure:

1. Just before your garbage pick-up at home, sort through your waste containers. List items that:

a. Were not totally used before being thrown away.

b. Could have been recycled, but weren't.

2. Weigh your trash and recyclables daily for a week. Measure the weight of the following (a bathroom scale can be used for this purpose):

Monday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Tuesday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Wednesday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Thursday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Friday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Saturday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

Sunday:

metal waste _____

newspapers _____

food waste _____

cardboard _____

other _____

mixed solid waste _____

Total per day _____

3. Estimate the percentage of waste generated from the average of the materials brought into your home during the same seven day period.

Percentage of waste_____

4. Find out where each category of recyclables is disposed of for your household. Call your county, state, or disposal company for information on:

metal waste

newspapers

food waste

cardboard

mixed solid waste

5. What department or company did you call for each item?

metal waste

newspapers

food waste

cardboard

mixed solid waste

6. What do you think you could do personally to reduce waste?

7. What can your school do to increase recycling?

8. What can the United States do to reduce waste?

9. Divide total solid waste by the number of people in your home. What is the pound per person average and how does this compare to the 4.7 pound per day estimated.

Chapter 9

Waste Minimization Lab

Objectives:

1. **The student will develop an appreciation of some of the environmental difficulties encountered during factory production.**
2. **The student will determine the factors that can be changed to improve recycling and reuse of potential scrap during manufacturing operations.**

Introduction:

Waste management can be accomplished both at home and at work. It involves looking at standard operating procedures (SOPs) in new and sometimes innovative ways. Some examples of waste minimization, approaches, and techniques include the following: 1.) improved inventory control/management (purchasing smaller quantities or substituting less toxic materials), 2.) equipment modification (installing equipment that produces less waste and having a good preventative maintenance program), 3.) production process changes (segregating wastes by type to improve recovery and eliminate quality control problems),and 4.) recycling and reuse (using of closed loop systems or waste exchanges).

Waste minimization can be both high and low tech. Tracing all raw materials and wastes generated and attaching costs can yield some surprising results and also some good ideas for making improvements.

Procedure:

Take a piece of construction or notebook paper which has a rip in it. Using the cookie cutter provided and the following rules, determine how many tracings of the cookie cutter can be made.

1. Keep the cookie cutter in one direction only (assume it is a unidirectional conveyorized stamping line).

2. Avoid any material defects like rips or holes in the paper.

3. Maximize material use and minimize scrap.

In 5 minutes, trace as many parts as you can, while meeting customer specifications.

Answer the following questions:

1. How many students traced over 10 parts?_____

8 - 10 parts?_____

6 - 8 parts?_____

4 - 6 parts?_____

less than 4 parts?_____

2. What amount of waste was generated (percentage of the total)?

a. From unused, damaged, raw material. _____%

b. Scrap material (edges around parts.) _____%

c. Reject parts (due to defects in material or during cutting.) _____%

d. Good parts. _____%

Total should be 100%

3. Which items were difficult about the layout?

a. Keeping parts consistent and in the same direction?

b. Using as much of the raw material as possible?

c. Avoiding material damage and defects?

d. Other?

4. What could be improved in this process?

a. Automation?

b. Recycling reject parts?

c. Purchase of recycled raw material?

d. Other?

5. What were you thinking about during the process of tracing?

a. Quality factors (list)?

b. Cost factors (list)?

c. Environmental issues (if so, in what way)?

Chapter 10

Landfills

Opening a New Disposal Site

Objectives:

1. **The student will understand how difficult and costly it is to build new landfills.**
2. **The student will understand that you may have a personal position regarding landfill sites, even though you think a new landfill is needed.**

Introduction:

The city of Sweetland has a population of 30,000. It is located in a county with a total population of approximately 70,000. The city manager has been told by elected members of the city council that the existing city disposal site does not meet regulatory requirements. It is not lined and does not have required monitoring or methane gas wells and it must be closed. The city manager has found a nearby site, and the property owner is willing to sell the land to the city. Before making the purchase, the city retained an engineering consultant to determine the suitability of the land for use as a disposal site. The conclusion was that it would be usable as a landfill disposal site.

State of the art landfills are built to reduce possible environmental problems. At the bottom and sides of the landfill, clay and plastic liners are used to contain and collect leachate (liquid generated as the waste degrades sometimes called garbage juice). The leachate is treated before discharge or sent to a local water treatment plant. Gas wells are installed to vent or collect potentially explosive methane gas for beneficial energy use. Monitoring wells are installed to test groundwater to make sure the landfill does not leak. This monitoring must continue for 30 years after the landfill is closed and capped.

Activity:

There is always a problem when a landfill or disposal site is proposed for a certain location. It's called NIMBY by people in the business of selecting sites. NIMBY translates to Not In My Back Yard.

In the following activity, you will portray a member of one of these four groups:

1. **Neighboring land owners of very expensive homes**

2. **Pollution control agency**

3. **City council member who is up for re-election in a few months**

4. **A "radical" environmental group**

In your group, discuss these questions:

1. **What are your objectives regarding this new disposal site?**

2. **What questions do you want answered about the new disposal site?**

3. **Do you think the new disposal site should be approved?**

Chapter 11

Risk

Objective:

1. **The student will understand that risk is a subjective area and that a person's experiences and ideas influence risk perception.**

Introduction:

Several years ago, The Natural Resources Defense Council (NRDC) spearheaded a movement in California to ban 24 agricultural chemicals. Alar was one of those chemicals. This chemical was said to cause cancer in laboratory rats. Extensive studies were conducted, being careful to follow scientific protocol. No credible evidence was ever found to link alar to cancer in lab rats when used as the manufacturer directed. There were, however, some rats that developed tumors after repeated megadoses of alar.

Extrapolating that information to humans, the NRDC said a person would have to eat 28,000 pounds of apples every day for 70 years to produce a tumor similar to the rats.

The antiAlar attack caused the apple industry to lose millions of dollars. The EPA bowed to pressure and decertified it, and the manufacturer removed it from the market.

Alar wasn't a pesticide. It was a growth regulator that helped to keep apples on the tree longer, promoting better color and a more crisp apple. An important fact to keep in mind, of all the pesticide residues we eat, 99.99% are the natural pesticides of the fruits or vegetables, not what a farmer adds to his fields to promote a larger yield.

Risk Perception:

Recent news stories list many things for us to worry about; killer bacteria, aircraft safety, and nuclear explosions are just a few. All

activities have some inherent risk raising public concern and confusion. Many situations can make you aware that hazardous materials do exist in our environment. The actions you take to increase or reduce your exposure are influenced, at least in part, by your perceived idea of the risk involved.

The following is taken from Peter Sandman:[1]

Characteristics of risk that influence people's perception of risk.

Seriousness of illness -- is it a temporary illness or permanent or death?

Dread factor -- is it cancer or AIDS?

Timing of illness -- is there a long gap between exposure and the illness?

Scientific knowledge -- how certain are scientists about the relationship between exposure to hazardous substances and illness in humans?

Social and political dynamics of the community -- have community action groups made people aware of the risk?

Catastrophic potential -- could many people be killed at one time?

Recent trends -- is it a new and increasing risk?

Equity -- who bears the risk: rich or poor, children or adults?

Control/voluntariness -- how easily can people control their risk and do they have a choice about their exposure?

Physical distance -- do people live or work close to the source of exposure?

Benefits -- do the exposed people benefit from the source of exposure?

Activity:

Part I Community Environmental Risk Concerns:

Have you found yourself in any of the following situations? Under each example, list some of the questions you would like answered. Also, review the list just shown and indicate if any of the factors are present.

You notice that the air in your place of work has an unusual smell.

You discover asbestos ceiling tiles in your basement.

You read in the newspaper that a cancer causing pesticide is commonly used on fruits and vegetables.

You hear on the local news that 80 tons of a cancer causing chemical is released into the air from a factory 2-miles from your house.

You hear from a neighbor that high levels of radon have been found in houses in your subdivision.

Your office is adjacent to the designated smoking break room which is poorly ventilated.

You are notified by the city public works department that several of the city's water wells are being closed due to contamination by an industrial chemical.

Part II Risk Ranking:

Rank these activities from the most risky to least risky (in your opinion): alcoholic beverages, bicycles, commercial aviation, contraceptives, electric power (non-nuclear), food coloring, food preservatives, fire fighting, general (private) aviation, home appliances, high school and college football, handguns, hunting, large construction, motor vehicles, motor cycles, mountain climbing, nuclear power, prescription antibiotics, power mowers, police work, pesticides, railroads, smoking, swimming, surgery, spray cans, skiing, X rays, vaccinations. Use the form on the following page.

1.	**16.**
2.	**17.**
3.	**18.**
4.	**19.**
5.	**20.**
6.	**21.**
7.	**22.**
8.	**23.**
9.	**24.**
10.	**25.**
11.	**26.**
12.	**27.**
13.	**28.**
14.	**29.**
15.	**30.**

Discuss your personal conclusions in a group concerning why you have ordered the activities in a certain way.

Chapter 12
Storm Water

Objective:

1. The student will understand that many sources of water pollution can be identified and removed.

Introduction:

Thousands of contaminants are released into our nation's storm water every day. The Environmental Protection Agency (EPA) requires that many industries apply for permits to help control storm water discharges. The purpose of this requirement is to protect our rivers, streams, and lakes.

In the mid-1980s, the National Urban Runoff Program concluded that a significant portion of water pollution comes from contaminated storm runoff. Add together all the storm water from parking lots, industries, roads, and agricultural land, and you have a lot of water and a lot of water pollution.

Procedure:

Part I

During a dry day, start a log of 5 different outside locations. Survey the ground to see if any spills, litter, or residue are there. Some possible locations are the following: gas stations, home, city road, parking lot of a grocery store or mall, etc. List any powders or discolorations, and try to identify what it is.

Location #1

Location #2

Location #3

Location #4

Location #5

What could be done to control any items observed?

Part II

During a wet day, place an open quart jar outside and collect rainwater directly. Also, collect a quart jar of storm water runoff. Seal and bring to class for observation. NOTE! Never collect water near a storm drain as these areas are very dangerous. The exit of a parking lot or driveway is a much safer spot. (Watch for traffic while collecting your sample.) Test pH and note any color, solids, or other material present. Compare the runoff water sample with the rain water sample.

Rain water

pH_____

Observations:

Storm water

pH_____

Observations:

Which is cleaner?

Chapter 13

On Your Own Environmental Tours

Objective:

1. **The student will increase awareness of environmental claims used to market and sell products.**
2. **The student will evaluate environmental claims for clarity.**
3. **The student will examine global aspects of the products we buy.**

Introduction:

Environmental issues now touch virtually every aspect of our lives. Many companies are using environmental attributes to sell products and want to be perceived as supporting the environmental movement. Some of the environmental claims used on product packaging are fuzzy and hard to understand. What does "environmentally friendly" really mean? An on-going discussion in government and industry is the need to standardize environmental claims so everyone (especially the consumer) understands what they mean. Some characteristics of "green" products include reduced packaging, items that can easily be recycled, items that incorporate energy saving devices, and items that were made with recycled content.

We are also a global economy. Many items are made in other countries and shipped to the shelves of our stores. Regulations in the United States are probably not the same as the country of manufacture. They may be more, or less, strict. Our food products are grown in other countries, too, and shipped to our grocery stores. Some fruits and vegetables may have residues from chemicals we have banned in the United States.

Procedure:

Choose one tour and then report back to class on your findings.

You may want to complete this task in groups of two or three.

Visit an office supply store or grocery store.

Where did you visit_____

Time and date of visit_____

A. Find 15 products with environmental claims or symbols and list them:

	Item	**Claim or symbol**	**Cost**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			

	Item	**Claim or symbol**	**Cost**

12.

13.

14.

15.

B. Find 5 comparable items of the same approximate quality with and without environmental claims and record cost differences (an example would be 50 pages of recycled paper vs. 50 pages of virgin paper).

Item	Cost with env. claim	Cost without claim
1.		
2.		
3.		
4.		
5.		

C. Find 5 items from other countries. What are they and what countries do they come from.

Item	Country of origin
1.	
2.	
3.	
4.	
5.	

Note: If you visit a grocery store, you may have to ask about the origin of fruit, etc.

Questions:

Can you understand what the environmental claim means (are they specific or general)?

List claim	**What it means**
1.	
2.	
3.	
4.	
5.	

Chapter 14

Future Exercise

Objective:

1. **The student will understand how environmental issues will affect our quality of life in the future.**

Introduction:

Many people wonder what the United States and the rest of the world will look like in the future. Population is sure to increase from our current levels, while other precious resources such as energy and water will decrease. These factors, and many others, will affect the nature and quality of our lives.

Exercise:

1. **Decide, as a group, what the future will look like for those living in the United States in the year 2100. Order your conclusions for the following areas, indicating what environmental issues will affect each area: (population growth, energy shortages, global warming, ozone depletion, etc.).**

Population:

Energy:

Food:

Water resources:

Economics:

Transportation:

Housing:

Recreation:

Travel:

Entertainment:

Technology:

Wildlife:

How will the rest of the world perceive the United States?

Will the United States be a good place to live?

2. Form groups and plan and act out a 5-minute play on the "typical" United States family of the year 2100 (choose one) a.) going on vacation, b.) going shopping, or c.) going out to dinner.

Appendix A.

Tables of Weights and Measures

Linear Measure

1 mil =	**0.001 inch**	**= 0.0254**	**millimeter**
1 inch =	**1,000 mils**	**= 2.54**	**centimeters**
12 inches =	**1 foot**	**= 0.3048**	**meter**
3 feet =	**1 yard**	**= 0.9144**	**meter**
5-1/2 yards or 16-1/2 feet =	**1 rod -**	**= 5.029**	**meters**
40 rods =	**1 furlong**	**= 201.168**	**meters**
8 furlongs or 1,760 yards or 5,280 feet =	**1 (statute) mile**	**= 1.6093**	**kilometers**
3 miles =	**1 (land) league**	**= 4.83**	**kilometers**

Square Measure

1 square inch	**= 6.452**	**square centimeters**
144 square inches =	**1 square foot**	**= 929.03 square centimeters**
9 square feet =	**1 square yard**	**= 0.0283 square meters**
30-1/4 square yards =	**1 square rod**	**= 25.292 square meters**
640 acres =	**1 square mile**	**= 2.590 square kilometers or 259.00 hectares**

Appendix A (cont.)

Dry Measure

	1 pint =	33.60 cubic inches	= 0.5506 liter
2 pints =	1 quart =	67.20 cubic inches	= 1.1012 liters
8 quarts =	1 peck =	537.61 cubic inches	= 8.8098 liters

Liquid Measure

1 gill =	4 fluid oz. =	7.219 cubic inches	= 0.1183 liter
4 gills =	1 pint =	28.875 cubic inches	= 0.4732 liter
2 pints =	1 quart =	57.75 cubic inches	= 0.9464 liter
4 quarts =	1 gallon =	231 cubic inches	= 3.7854 liters

Metric System

Linear Measure

	= 1 millimeter		= 0.03937 inch
10 millimeters	= 1 centimeter		= 0.3937 inch
10 centimeters	= 1 decimeter		= 3.937 inches
10 decimeters	= 1 meter		= 39.37 inches or 3.2808 feet
10 meters	= 1 decameter		= 393.7 inches
10 decameters	= 1 hectometer		= 328.08 feet
10 hectometers	= 1 kilometer		= 0.621 mile or 3,280.8 feet
10 kilometers	= 1 myriameter		= 6.21 miles

Appendix A (cont.)

Land Measure

1 square meter	**= 1 centiare**	**= 1,549.9 square inches**
100 centiares	**= 1 are**	**= 119.6 square yards**
100 ares	**= 1 hectare**	**= 2.471 acres**
100 hectares	**= 1 square kilometer**	**= 0.386 square mile or 247.1 acres**

Volume Measure

1,000 cubic millimeters	**= 1 cubic centimeter**	**= 0.06102 cubic inch**
1,000 cubic centimeters	**= 1 cubic decimeter**	**= 61.023 cubic inches**
1,000 cubic decimeters	**= 1 cubic meter**	**= 35.314 cubic feet**

Capacity Measure

10 milliliters	**= 1 centiliter**	**= 0.338 fluid ounce**
10 centiliters	**= 1 deciliter**	**= 3.38 fluid ounces or 0.1057 liquid quart**
10 deciliters	**= 1 liter**	**= 1.0567 liquid quart or 0.9081 dry quart**
10 liters	**= 1 decaliter**	**= 2.64 gallons or 0.284 bushel**
10 decaliter	**= 1 hectoliter**	**= 26.418 gallons or 2.838 bushels**
10 hectoliters	**= 1 kiloliter**	**= 264.18 gallons or 35.315 cubic feet**

Appendix A (cont.)

Weights

10 milligrams	**= 1 centigram**	**= 0.1543 grain**
10 centigram	**= 1 decigram**	**= 1.5432 grains**
10 decigram	**= 1 gram**	**= 15.432 grains or 0.035274 ounce (avdp.)**
10 grams	**= 1 decagram**	**= 0.3527 ounce**
10 decagrams	**= 1 hectogram**	**= 3.5274 ounces**
10 hectograms	**= 1 kilogram**	**= 2.2046 pounds**
10 kilograms	**= 1 myriagram**	**= 22.046 pounds**
10 myriagrams	**= 1 quintal**	**= 220.46 pounds**
10 quintals	**= 1 metric ton**	**= 2,204.6 pounds**

Bibliography

1. **Sandman,Peter. November 1987.“Risk Communication; Facing Public Outrage.” EPA Journal, pp.21-22.**