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ABSTRACT

This volume is the twenty-third in a series of 29 coordinated MINNEMAST units in mathematics and science for kindergarten and the primary grades. Intended for use by third-grade teachers, this unit guide provides a summary and overview of the unit, a list of materials needed, and descriptions of six groups of lessons. The purposes and procedures for each activity are discussed. Examples of questions and discussion topics are given, and in several cases ditto masters, stories for reading aloud, and other instructional materials are included in the book. The preparatory lessons in this volume revolve around a field trip designed to introduce students to the importance of moisture, temperature, and light for living things. Each of these conditions is explored further in a subsequent set of lessons. After a review of the material learned, the final set of lessons concern seasonal changes. (SD)

CONDITIONS AFFECTING LIFE

MINNEMAST

UNIT

MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

MINNEMAST COORDINATED MATHEMATICS–SCIENCE SERIES

KINDERGARTEN

1. WATCHING AND WONDERING
2. CURVES AND SHAPES
3. DESCRIBING AND CLASSIFYING
4. USING OUR SENSES
5. INTRODUCING MEASUREMENT
6. NUMERATION
7. INTRODUCING SYMMETRY
8. OBSERVING PROPERTIES

FIRST GRADE

9. NUMBERS AND COUNTING
10. DESCRIBING LOCATIONS
11. INTRODUCING ADDITION AND SUBTRACTION
12. MEASUREMENT WITH REFERENCE UNITS
13. INTERPRETATIONS OF ADDITION AND SUBTRACTION
14. EXPLORING SYMMETRICAL PATTERNS

SECOND GRADE

15. INVESTIGATING SYSTEMS
16. NUMBERS AND MEASURING
17. INTRODUCING MULTIPLICATION AND DIVISION
18. SCALING AND REPRESENTATION
19. COMPARING CHANGES
20. USING LARGER NUMBERS
21. ANGLES AND SPACE
22. PARTS AND PIECES

THIRD GRADE

23. CONDITIONS AFFECTING LIFE
24. CHANGE AND CALCULATIONS
25. MULTIPLICATION AND MOTION
26. WHAT ARE THINGS MADE OF?
27. NUMBERS AND THEIR PROPERTIES
28. MAPPING THE GLOBE
29. NATURAL SYSTEMS

OTHER MINNEMAST PUBLICATIONS

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(Description of content of each publication)

MINNEMAST RECOMMENDATIONS FOR SCIENCE AND MATH IN THE INTERMEDIATE GRADES
(Suggestions for programs to succeed the MINNEMAST Curriculum in Grades 4, 5 and 6)

CONDITIONS AFFECTING LIFE

UNIT 23

MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT
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Third Printing
1971

CONDITIONS AFFECTING LIFE

This unit was developed by MINNEMAST on the basis of experiences of the many teachers who taught an earlier version in their classrooms.

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CONTENTS

Complete List of Materials for Unit 23

(Numbers based on class size of 30.)

total number required to teach unit	item	lessons in which item is used
30	**Student Manuals	
1	**handbook: Living Things in Field and Classroom	1,2,7,10,14
1	film: Living Things Are Everywhere; book: Let's Go Outdoors by Harriet Huntington	1
1	whistle	2
2	*plastic shoe boxes, with covers	2,3
48	*4-oz. covered plastic containers	2,3,8,13
30	*magnifiers	2
31	*trays	3,6,8,9,11,12
1	roll of transparent tape	3,8
10-15 lbs.	soil (any kind)	3,5,8,11
1	*package of grass seed	3,8
30-40	rocks collected on field trip	3
60	yarn, string or *brass fasteners for Record Booklet and story booklets	3,17
1	bulletin board reserved for this unit, paper, *yarn and magic marker	all
30	*rulers	4,10
	chalk, in several colors	4
8	*thermometers	5,6,8,9,11,12,13
1	*light meter	5,6,8,9,11,12
1	*grease pencil	5,8,11
5	*medicine droppers	5,6,8,11
45	*1-oz. containers	5,6,8,11
8	*craft sticks or rulers	5,8
8	*quarter-teaspoons	5,11
6 cups	water	5
1	*package of radish seeds	5,11
1	*roll of plastic wrap	5,11
54	*rubber bands	5,11
1	*roll of masking tape	5,6,8,11

15	3-1/2 inch squares of blotting paper	6
15	*petri dishes and covers	6,9
15	*1-oz. plastic containers	6,8,11
15	scissors	6,9,16
1	mealworm colony (30-40 beetles)	6,9,13
1	sow bug colony (30-40 bugs)	6,9
1	earthworm colony (30-40 worms)	6,9
6	**Radish Growth Charts	7
1	**transparency of Radish Growth Chart	7
1	overhead projector	7
1	lamp with 75-watt bulb	8
	newprint to cover area 4' x 8'	8
1	single-edge razor blade	8
32	*12-oz. styrofoam cups	8,12
1	*roll of aluminum foil	8,11
8	*plastic teaspoons	8
1	film: Desert Community	9
6	pieces of construction paper	9,12,18
1	lamp, with 25-45 watt bulb, and box at least 3" taller than top of bulb	11
1	aquarium; *fish net	12
8	goldfish	12
1	clock with a second hand	12,18
1	*measuring cup	12
8	*16-oz. plastic containers	12
32	ice cubes	12
	crushed ice	13
1/4 cup	salt	13
8	12-inch pendulums made of *ruler, *tape, 12-inch length of *thread and *sinker ("bob")	13,18
30	boxes of crayons; pencils; paste; paints	16,17
1	world globe (optional)	16

*kit items as well as

**printed materials available from Minnemath Center, 720 Washington Avenue S.E., Minneapolis, Minn. 55455

INTRODUCTION

In this unit the children study three environmental conditions that profoundly affect life. These are moisture, light and temperature. The children learn how these conditions and their effects can be detected and measured. They investigate the effects of these conditions on the growth of plants and on the behavior of animals, and they also consider the part these conditions play in determining where plants and animals normally live.

What the children experience

The children begin their studies by taking a field trip. They observe plants and animals in a natural ecological setting. They pay particular attention to plants and animals that live under rocks, logs and boards, and try to discover what conditions of moisture, light and temperature cause living things to be in these places. Eventually these considerations reveal the necessity for designing controlled experiments. The children should begin to realize the relation between field and laboratory investigations.

How the children participate

Even though the children are not able to contribute many ideas at first, always invite them to participate in planning the experiments. You may have to step in with a system the children have not themselves devised, but even so they still have much to learn from setting up and working with the systems provided in the unit. It will be necessary for you to point out to the children what they are trying to do in each experiment and why they are doing it. It will also be necessary, as the children do one experiment after the other, to show them that in each experiment they are applying the techniques of a general scientific method.

Standards of experimentation

As far as equipment and recording data are concerned, the experiments in this unit are controlled to the degree that is suitable for third grade children. Even if more sophisticated, expensive equipment does give more exact conditions for experiments, its complexity makes it less useful for young children. By using methods and equipment that are understandable to the young child, the experiment itself can be more meaningful, and it can be duplicated or extended by the child at home working with simple equipment. It is important for the children to realize that the results of their experiments point in particular directions, but that because their measurements and the conditions of the experiments are not perfectly exact, they can not say, "This would always happen," about any of the factors that they have tested. But the children can say that they have enough evidence to make some predictions that can be tested further. For instance, after the experiment with mealworm beetles and different conditions of light, the children can say, "The mealworm beetles we experimented with went to the dark side of the container more often than they did to the light side." This is a comment about what they directly observed and may not generalize to all mealworm beetles. Similar statements that say, "Thus, this appears to be so," can be made about the other moisture, light and temperature experiments.

The format of the unit

At the beginning of each lesson, its purposes are stated and the materials listed. Procedure is given in terms of directions for demonstrations, instructions for organizing the class to perform experiments, and suggested questions and answers. The procedure is provided in this form because it is one of the clearest ways to describe the logic and structure of the lessons. The questions and answers are given in detail because they indicate in a concise way what the authors have in mind for the development of the lesson. You may find it advisable to use additional questions and to modify those suggested. And, of course, the children may respond with satisfactory answers that are not included in the suggested

possibilities. As you become familiar with the lessons, you will undoubtedly modify them to fit the needs of your class.

The concept of systems

The MINNEMAST "systems" thread develops the concept that an investigation of a phenomenon or problem can frequently be simplified by concentrating attention on certain objects and their interrelationships. A scientist is concerned with gathering information about the way things happen and with organizing his observations so that they will be meaningful and useful. When he notices a phenomenon, he focuses his attention on a limited set of objects involved in that phenomenon. This set of objects and the relationships that exist among them is the system on which he makes observations and tests his discoveries.

A mathematician also finds it useful to think in terms of systems. To him, a system is a set of elements (symbols or numbers) together with a set of statements relating these elements. Further relationships among the elements are discovered through formal logic. In contrast with a scientific system, a mathematical system is not observable or testable in terms of physical phenomena.

The relationships among the elements in a scientific system are sometimes similar to those of a mathematical system. When this is the case, the mathematical system might be used as a model to explain or discover relationships within a scientific system. The observable relationships of the scientific system are tested to see if they do indeed correspond to the mathematical relationships. This way of looking at things can be a great help in understanding a complex situation or in solving a complicated problem. The systems concept helps one to focus his attention on those elements that are relevant to a particular problem.

The systems thread provides situations in which the children (1) select relevant elements to observe, (2) discover relationships among these elements, and (3) verify the relationships by testing. For example, in this unit, the effect of

temperature on the breathing rate of goldfish (the phenomenon) is investigated. The children focus their attention on a system that includes a goldfish, ice cubes for lowering the temperature of the water, a thermometer for measuring the water temperature, and a device for timing the breathing rate of the fish. They discover that the rate of breathing is reduced as the temperature is lowered. This discovery is checked when the temperature of the fish is lowered still further.

The manner in which the systems thread runs through the MINNEMAST program is indicated by the following brief summary:

Unit 15, Investigating Systems

Systems are treated in a qualitative manner in Unit 15. The word "system" is scarcely mentioned and it is used without definition. The systems investigated and the experimental methods used are extremely simple. One technique is to remove one object at a time from a system to find out which objects are necessary, and which unnecessary, for the phenomenon to continue.

Unit 19, Comparing Changes

In Unit 19, a quantitative treatment of systems is introduced. For example, the children discover and describe changes that can then be represented as functional relations between quantities that describe certain properties of a system, such as the relation between the height of a corn plant and its age.

Unit 23, Conditions Affecting Life

In this unit the systems used are taken from nature and are somewhat more complex than in previous units. Every setup for the performance of a controlled experiment can be thought of as a "system" that enables the experimenter to vary a certain condition while keeping the others constant. The mental processes involved in deciding on a suitable system to solve each problem are stressed, so that a general method emerges -- one that can be applied to corresponding problems in which analyses of systems are useful.

Unit 24, Change and Calculation

Two systems (a pouring system and a balance-beam system) are investigated in quantitative terms. The children are also introduced to the idea of "states of a system" as a means of describing a system at any instant in time.

Unit 29, Natural Systems

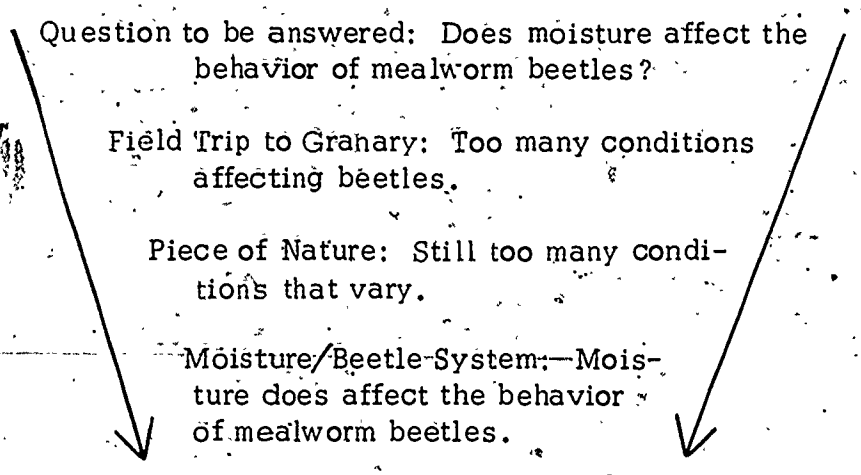
This unit acquaints the children with several natural systems that are studied quantitatively as well as qualitatively. For example, they use a stream table as a system with which to investigate effects of flowing water. This unit reinforces and summarizes the various aspects of the "systems" thread.

Summary devices

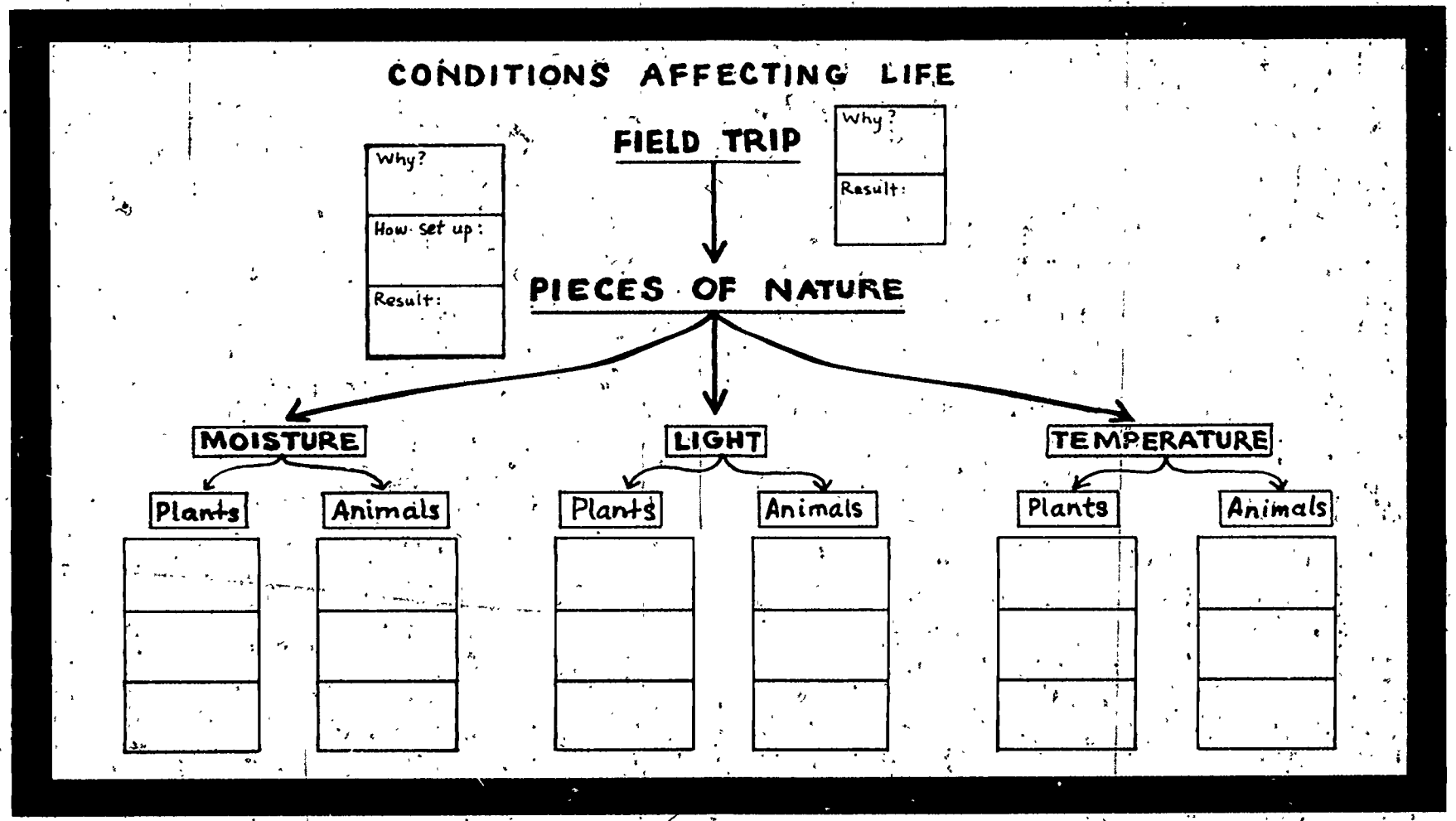
Two kinds of devices are used to keep the children aware of the main purposes of the unit (to find out the effects of moisture, light and temperature on living things). One device is the continuing development of a bulletin board diagram that summarizes the investigations of the unit. (The last three pages of this introduction show three possible arrangements for the bulletin board diagram.) The diagram is started early in the unit when, in Lesson 3, the children discuss what they found out about the conditions of moisture, light and temperature from their field trip in Lesson 2. As the unit progresses, the diagram is expanded again and again, so that the general scheme used in all of the experiments is quickly evident. The diagram is really a visual aid in pointing out what is common in the various experiments.

At the conclusion of all the experiments, the bulletin board diagram presents a summary of all the methods, processes and accomplishments of the unit. It can also be thought of as a representation of the processes involved in arriving at the experimental systems. For example, the children will be able to see that they started with a broad environmental setting (the field trip) as a way of trying to answer a question and then found it necessary to narrow down this setting to experimental systems from which they could get answers to each question.

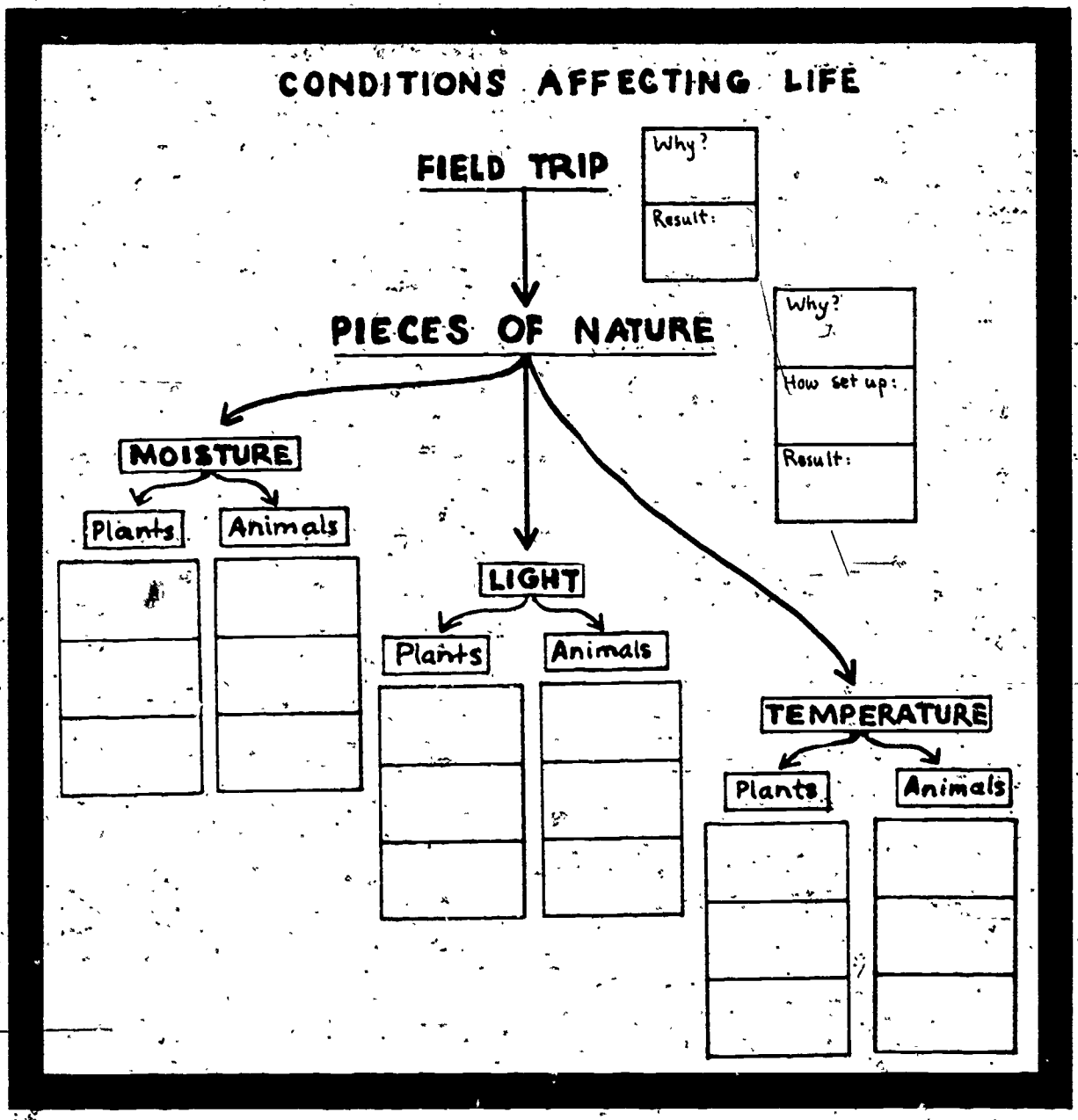
The second summary device is a flow chart used in Lesson 15 as a more concise representation of the narrowing down process involved in setting up an experimental system that will answer a specific question. It shows the children how it is possible to convert complex natural phenomena into simplified, controlled systems for the purposes of experimentation. A copy of a typical flow chart showing the narrowing down process is this:



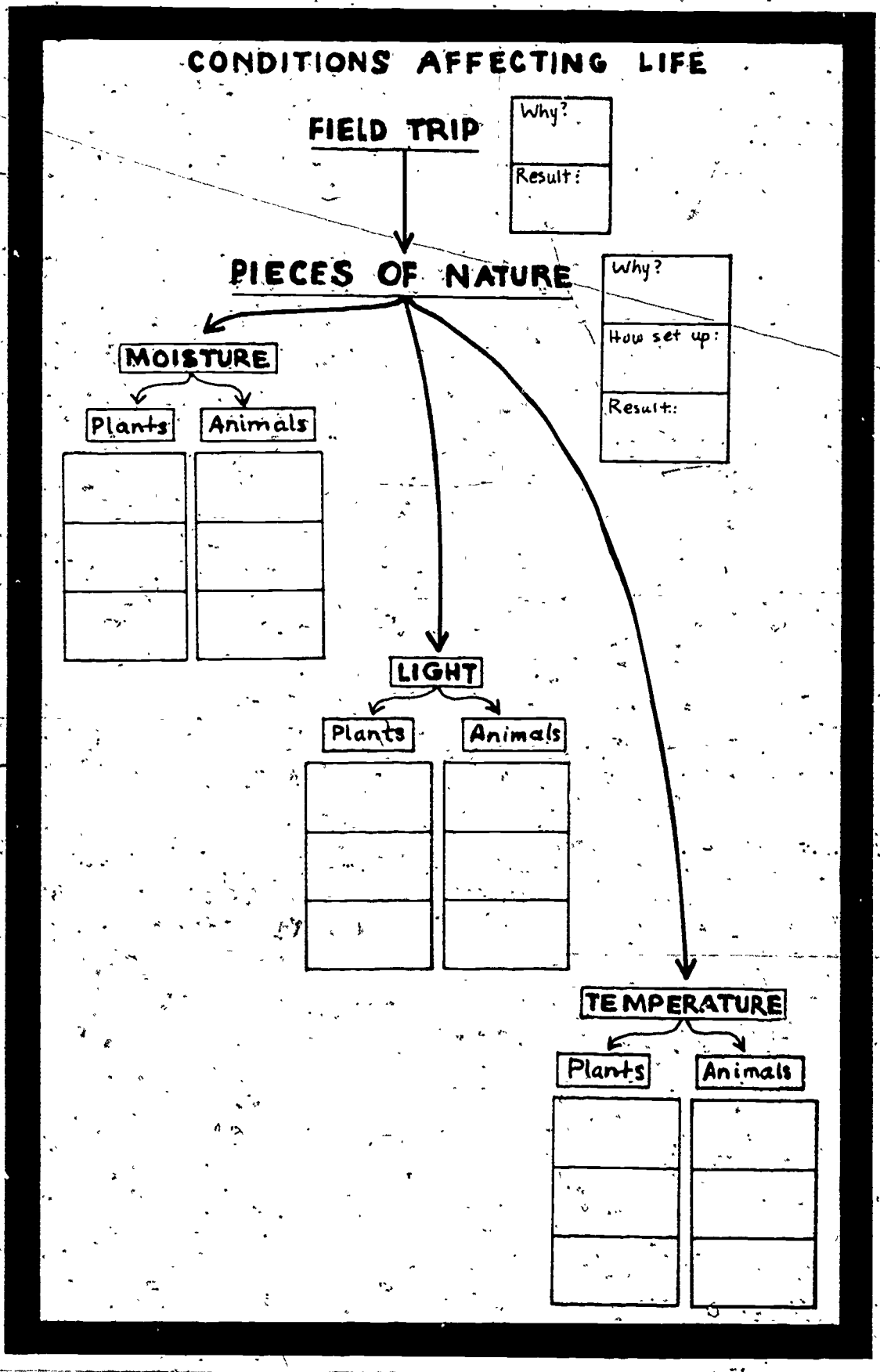
On a wide rectangular board, your completed diagram for this unit might be arranged like the one shown here. Papers with divisions are large information sheets. The top space poses the problem, the middle space tells how the children set up the experiment, and the bottom space gives the result.



Suggested arrangement of diagram on a square bulletin board



Suggested arrangement of diagram on a long, narrow bulletin board.



NOTES ON TEACHING THIS UNIT

1. Buy 60 to 80 mealworm larvae immediately so that they will develop into adults (beetles) by the time you need them for Lesson 6. The larvae can be purchased from pet stores, as well as from biological supply houses. They cost about a cent apiece. Read the instructions for maintaining a mealworm colony in the appendix at the back of this manual, and then assign a child to look after them. Mealworms are easy to keep and their life cycle is interesting. You may wish to use these animals for more experiments than this unit requires. If so, see Behavior of Mealworms, Elementary Science Study, Education Services, 1964.

2. Arrange to have the use of one bulletin board exclusively for this unit during the entire teaching time.

3. Set up an aquarium and stock it with one goldfish for each group of four children in your class, plus a spare or two. The aquarium need not be expensive -- a large dishpan will do -- but be sure to read the instructions for goldfish maintenance in the unit appendix. Goldfish are hardy and a child could be assigned to take care of them. They can be purchased at stores such as Kresge's and Woolworth's as well as at pet shops.

4. Try to obtain the film, Living Things Are Everywhere, for Lesson 1. The film, Desert Community, should be ordered for Lesson 9. Also try to get one or two of the many suitable films on the subject of how plants and animals prepare for winter to use with Lesson 17. If you can not show a film at the time recommended, show it whenever you do have it.

TEACHING TIME

The entire unit should take about six weeks. Teaching time for individual lessons is given in the commentary for each section and in the lesson commentaries, too. You may wish to extend the teaching of this unit over a period that lasts from September to December. This would be a particularly good idea if you teach in an area where there are obvious changes in the environment from autumn to winter.

It is planned that this unit be taught concurrently with Unit 24, Change and Calculations. A suggested schedule for teaching the two units is provided on the next page.

SUGGESTED SCHEDULE FOR TEACHING MINNEMAST UNITS 23 AND 24 CONCURRENTLY

	UNIT 23 This unit generally should be taught three days a week for periods of 40 to 50 minutes.					UNIT 24 This unit generally should be taught every day for periods of approximately 30 minutes.				
	Mon.	Tues.	Wed.	Thurs.	Fri.	Mon.	Tues.	Wed.	Thurs.	Fri.
1st week	Lesson 1*	Lesson 2*	Lesson 3*							
2nd week			Lesson 4	Lesson 5		Lesson 1	→	Lesson 2	→	Lesson 3
3rd week	Lesson 6		Lesson 7	Lesson 8		Lesson 3	Lesson 4	→	Lesson 5	Lesson 6
4th week	Lesson 9		Lesson 10			Lesson 7	Lesson 8	Lesson 9	Lesson 10	Lesson 11
5th week	Lesson 11	Lesson 12	Lesson 13		Lesson 14	Lesson 12	→	Lesson 13	→	Lesson 14
6th week	Lesson 15	Lesson 16	Lesson 17	Lesson 18		Pouring System**	Pouring System	Pouring System	Pouring System	Pouring System
7th week	Lesson 19					Balance Beam System**	Balance Beam System	Balance Beam System	Balance Beam System	Balance Beam System

* It is important to teach Lessons 1, 2 and 3 on the days specified.

** Half of the class does one system one week, then the other system the following week.

SECTION I PREPARATORY LESSONS

PURPOSE

The four lessons of this section prepare the children for the more scientifically controlled experiments in the remainder of the unit. The purposes of these lessons are:

- To make the children aware that moisture, light, and temperature are three of the important environmental conditions that affect the way all life reacts.
- To have the children discover that neither the observations made during a field trip nor an experiment that is random and unquantified can help them arrive at any reliable conclusions concerning the effects of any of the three conditions on living things.
- To have the children realize that they cannot learn much about any one condition when all three conditions vary simultaneously.
- To lead the children to think of ways of experimenting with just one condition at a time, in order to be able to reach some conclusions about its effects on plants and animals.

COMMENTARY

The children begin, in Lesson 1, by considering how they themselves are affected by changes in the amount of moisture, light, and warmth in their environment. Then they move on to consider how animals and plants might be affected by these same factors. The entire unit then becomes an attempt to help children find some answers to these questions:

Does the amount of moisture in the environment affect the way plants and animals react?

Does the amount of light affect the way plants and animals react?

Does the amount of heat affect the way plants and animals react?

Section I takes only a small step in the direction of answering the questions, since its main purposes -- as stated above -- are introductory and preparatory.

TEACHING TIME

If you start this unit by teaching Lesson 1 on a Monday, and do Lesson 2 (the field trip) on Tuesday, your timing will be just right for Lesson 3, which has to begin on a Wednesday. Total teaching time for this section ought to be between three and five hours. The lessons extend over seven school days, with a good deal of time left open (especially on Thursday, Friday and the second Monday) for teaching another MINNEMAST unit. Approximate teaching times for the lessons are:

Lesson 1 (Monday) - 40 to 80 minutes. Include showing of recommended film, if possible.

Lesson 2 (Tuesday) - 45 to 90 minutes. Field trip preceded by discussion of the purposes.

Lesson 3 (Wednesday) - 30 to 40 minutes.
(Thursday) - 10 to 20 minutes.
(Friday) - 5 minutes.
(Second Monday) - 5 minutes.

Lesson 4 (Second Tuesday) - 20 to 30 minutes.

OPTIONAL BOOKS

The following books will enrich the work done by the children in Section I:

Caudill, Rebecca. A Pocketful of Cricket. (Holt, Rinehart and Winston, New York, 1964.)

Huntington, Harriet E. Let's Go Outdoors. (Doubleday and Company, Inc., New York, 1939.)

McClung, Robert M. Bufo, The Story of a Toad. (William Morrow and Company, New York, 1954.)

Stevens, Carla. Catch A Cricket. (Young Scott Books, New York, 1961.)

Lesson 1: INTRODUCING THREE ENVIRONMENTAL CONDITIONS

Activity A of this lesson gives the children an opportunity to examine their own human responses to changes in the environment. Activity B asks them to compare their own responses with what they think might be the responses of other living things to similar changes. The lesson is a preparation for the field trip in Lesson 2. It is essential that the children know -- in advance -- why they are taking the field trip, what a "condition" is, what conditions to look for in the animals' homes, and why they are collecting the small animals. This lesson begins with the children's own experiences and goes on to show that other living things are also affected by environmental conditions, though sometimes in different ways.

We seldom think about our reactions to environmental conditions such as dressing to adapt to the weather. Some of these reactions are illustrated for the children in a series of cartoons in their Student Manuals. The cartoons illustrate three main environmental conditions that affect behavior. These are moisture, light, and temperature. By discussing the behavior of the characters in the cartoons, the children become aware that these three external conditions affect real people. When they are aware of the different conditions and of how people react to them, they are asked, "Do other living things react to moisture, light, and temperature also? If so, how? Will the responses of an earthworm exposed to large amounts of moisture, or light, or heat, be the same as those of a person?"

Whenever you begin to use the word "condition" by itself, be sure that the children associate the word with moisture, light, or temperature.

At the conclusion of the lesson, let the children take the cartoons and pictures of animals home.

MATERIALS

- cartoons and pictures of small animals in the Student Manuals
- other pictures of small animals (optional)

- Living Things Are Everywhere, Encyclopedia Britannica Films. 16 mm, 11 minutes, color, sound. Available from your local film rental source or, if necessary, can be obtained from the audio-visual departments of universities.
- Living Things in Field and Classroom, MINNEMAST
- Let's Go Outdoors, by Harriet Huntington. Doubleday, Doran and Co., Inc. New York, 1939. (optional)

PROCEDURE

Activity A

Ask the children to look at the Set A cartoons in their Student Manuals.

Set A Cartoons

Picture 1

Picture 2

Have them describe the differences between Pictures 1 and 2. (In Picture 1, it is raining and the children are dressed in rain clothes. In Picture 2, it is not raining and the children are dressed differently.)

WHAT KINDS OF WEATHER ACCOUNT FOR THE DIFFERENCES IN THESE TWO PICTURES?

Most children will probably say that it is raining in one picture and not raining in the other. Bring out and emphasize the fact that there is more water or moisture shown in one picture than in the other. Discuss with the children if the amount of moisture affects our behavior and what we do to protect ourselves from too much of it.

Next have the children look at Pictures 3 and 4.

Set A Cartoons

Pictures 3 and 4

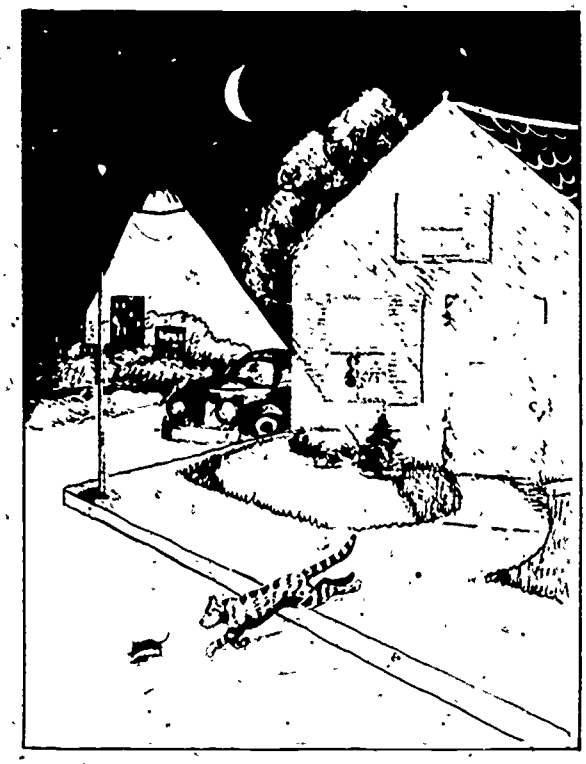
Ask what is wrong with these pictures. During the discussion, emphasize the main idea again -- that the amount of moisture affects the way we live. Also elicit from the children the things that man has devised to avoid the discomfort of too much moisture -- the raincoat and rubbers; the waterproof homes; etc.

Write "moisture" on the chalkboard. Tell the class that moisture is only one of the things that affect the way we live. Have the children look at the pictures of Set B, and see if they can discover another thing that affects the way we live. The children will probably say that these are pictures of day and night. Lead them to realize that one difference between day and night is the amount of light that is present. Ask them to describe how behavior is changed by light or the absence of it. Then have them discuss some of the ways man has been able to overcome unwanted light (by means of shades, awnings, sunglasses, tinted windshields, beach umbrellas, etc.). And have them also discuss how man has managed to provide more light when he needs it (by means of house and street lamps, candles, flashlights, headlights, light for night ball games, etc.).

Set B Cartoons

Picture 5

Picture 6



Pictures 7 and 8

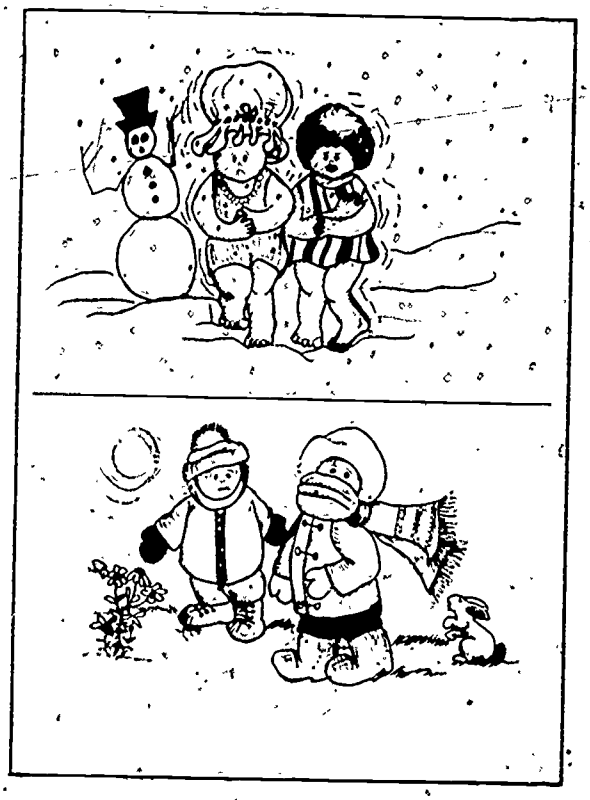
Tell the children that they have now talked about two things (conditions) -- moisture and light -- that affect the way we live. Now ask them to look at the pictures in Set C, to see if they can figure out a third thing (condition) that affects us.

Set C Cartoons

Picture 9

Picture 10

Pictures 11 and 12



Answers will probably vary. The most common answer may be that the pictures show winter and summer scenes. Lead the children to the generalization that during different seasons -- or even during shorter periods, such as weeks or days -- we usually have some differences in temperature. Hold a discussion of some of the ways the changes in temperature affect the way we live. Also bring out in the discussion some of the things man has done to overcome these differences in temperature -- how he uses different kinds of clothing, heating systems for homes, air conditioners, car heaters, etc.

Activity B

Remind the children that they have now discussed three of the conditions that affect the way we live -- moisture, light and temperature. Then ask:

DO YOU THINK THAT MOISTURE, LIGHT, AND TEMPERATURE AFFECT WHAT OTHER LIVING THINGS DO?

Let the children speculate about this. Then ask:

IF OTHER LIVING THINGS REACT TO THESE CONDITIONS, DO YOU THINK THEY REACT IN THE SAME WAYS THAT WE DO?

This question, and others, could lead to a very enjoyable discussion, e.g.,

DOES A RABBIT WEAR A RAINCOAT WHEN IT RAINS?

DOES AN EARTHWORM TURN ON A HEATER OR WEAR WARMER CLOTHING WHEN IT IS COLD?

Next ask:

WHAT DO ANIMALS DO TO MAKE THEMSELVES COMFORTABLE? DO THEY FIND PLACES TO LIVE THAT HAVE SUITABLE AMOUNTS OF MOISTURE, LIGHT, AND TEMPERATURE?

IF THEY DO, WHAT COULD WE CALL SUCH PLACES? (Animal homes.)

Now ask the children to tell about any animal homes they have seen. Urge them to be specific about describing the kind of place and the time they saw each of the homes. After these reports, ask:

IF WE WERE TO GO TO THE WOODS, TO THE PARK, OR TO A VACANT LOT, WHERE WOULD WE BE LIKELY TO FIND SEVERAL SMALL ANIMALS LIVING IN ONE PLACE? (Trees, holes in the ground—various answers.)

HAVE ANY OF YOU EVER TURNED OVER A ROCK OR A LOG ON THE GROUND? DID YOU FIND ANYTHING INTERESTING BENEATH THE ROCK OR LOG? (Yes, animals.)

WHAT KINDS OF ANIMALS DID YOU SEE?

Answers will include a few animals. List these on the board. Then lead the children to the idea that perhaps a film or photographs will suggest other animals that could be added to the list. Show the film, Living Things Are Everywhere, if you have it. Then have the children turn to the pictures of small animals in their Student Manuals. These include an earthworm, snail, slug, cricket, toad, beetle (with larva and pupa), sow bug, centipede, ant (with eggs, larva and pupa), salamander, and millipede.

Ask the children why they think these animals might live under rocks.

> WHAT CONDITIONS WOULD YOU FIND UNDER A ROCK? WOULD IT BE WARM OR COLD, WET OR DRY, SUNNY OR DARK?

Let the children speculate freely, but keep the discussion rather short and limit it to just a few other animals. Ask the children to talk about only one animal and its home at a time. Children may suggest that earthworms live under rocks so that the birds can't eat them, or that toads live there because they eat insects that live there, or that ants may live there to get protection from the rain.

> TOMORROW WE WILL GO ON A FIELD TRIP TO LOOK UNDER ROCKS, LOGS, AND BOARDS. WE WILL OBSERVE CAREFULLY WHAT KIND OF ANIMALS LIVE THERE AND WHAT THEIR HOMES ARE LIKE. WE WILL BRING BACK A FEW SMALL ANIMALS TO STUDY.

Emphasize the two purposes of the field trip: (1) to observe the conditions at each location where an animal is found and (2) to collect small animals for further observations in the classroom.

NOTE: Before teaching Lesson 2, make a preliminary survey of the site for the field trip. You will find many more animals in a wet, shady area than in a dry, sunny one. (However, some children should check out a drier area.) Select a site that has at least five places in it where you are sure animals will be found, so that the trip will be a success. Also, consult Living Things in Field and Classroom so that you will know how to keep most of the small animals alive in the classroom.

On this field trip, the children explored dry, grassy areas, as well as shady ones.

They looked for little animals that lived under the bark of a tree.

In the wet, cool, dark place under a rock, they found many small animals to collect.

Lesson 2: TAKING A FIELD TRIP

In the previous lesson the children learned that three conditions (moisture, light, and temperature) affect the way people live. Then they speculated about whether these same conditions also affect the way animals live, and, if so, how? This field trip by no means answers the question, nor is it intended to do so. Its purposes are (1) to give the children the opportunity to observe, as well as they can, the conditions that exist in the places where animals are found and compare them with the conditions in the places where animals are not found, and (2) to have the children find some small animals to bring back to the classroom for further study.

Observations of the conditions will not be precise. By touching and looking at the underside of a rock and comparing it with the top of the rock or the ground nearby, a child should be expected to say that underneath the rock it is dripping wet, wet, damp, or dry. By looking, he should be able to describe the condition of the light as sunny or shady, or if the rock was found firmly pressed into the ground, deduce that under the rock it is very dark. By touch, he should be able to say that the ground under the rock is cold, cool, or warm as compared with the top of the rock or the ground around it.

You will go over all the details of the field trip before you leave, but even with this careful preparation in the classroom, you may have to repeat some of the instructions during the actual trip. For example, the children will probably become so interested in the animals they find that they may have to be reminded quite often to observe the conditions in the various areas.

Discussion of the field trip is outlined in Lesson 3, where the children's uncertainties about why the animals were attracted to certain places are used to motivate the setting up of "pieces of nature" indoors. In preparation for this, be sure that each child brings back a small rock from the field trip, and that the class collects enough small animals so that each child can have several for future studies. Earthworms and sow bugs are particularly needed.

The MINNEMAST handbook, Living Things in Field and Classroom, is recommended as one of the materials to be taken along on the trip because the children may find animals other than those you are prepared to keep in the classroom. The handbook will help you decide whether you can (or want to) maintain such animals, or whether the children should just observe them in the field and let them go.

MATERIALS

— 1 whistle

— 2 plastic shoe boxes with covers

— Living Things in Field and Classroom

-- for each pair of children --

— 4-ounce covered plastic dish, magnifier optional

PROCEDURE

In the classroom, explain to the children that you are just as eager as they are to get started on the field trip, but that first you must make sure they understand why they are taking the trip, what they will do when they get to the field, and how they are to do it. Ask them to pay close attention, so that the discussion will be short and the trip successful and enjoyable.

Elicit from the class the two purposes of the field trip. Write them on the chalkboard:

WHY WE ARE TAKING A FIELD TRIP:

1. To observe the differences in moisture, light, and temperature under and around the rocks, logs, or boards where the animals are found, and compare them with places where no animals are found.

2. To find and collect animals that live under rocks, logs, and boards.

Next discuss with the class exactly what the children should try to find out. Write these points on the board, too:

WHAT WE WANT TO FIND OUT:

1. Why do animals live under rocks, logs and boards?

2. Why do they live under some rocks and not under others?

Remind the children that to try to answer these questions they will have to observe the moisture, light, and temperature in each place where animals are found under rocks and the conditions under rocks where no animals are found.

Now tell the children that, on the field trip, they will be working in pairs. Each pair will have a covered dish in which to collect some small animals. If anyone finds an animal too large for his dish, he will bring it to you to be put in a shoe box.

Now make clear the following procedures:

Assigned Areas

Tell the children that when they reach their destination, you will assign a specific area to each pair of children. In this area the partners will turn over rocks, logs, and boards, observing all animals they can find living there. No pair may trespass on another pair's assigned area.

Show the children your whistle. Explain that when you blow it, the children are to stop what they are doing and come to the place where you are. Say that the sound of the whistle will mean that someone has discovered something you want the whole class to see.

Collecting Small Animals

Show the children the covered container that each pair will use to collect small animals. Ask the children what other things they should put in with the animals to make them feel more at home. If they don't know, tell them that

you want each child to collect a small stone for use in the next lesson, and that they may also bring back a piece of bark if an animal was found under bark, some grass if found on grass, some sand or earth if found on that.

Turning Over A Rock

Tell the children to keep in mind the fact that when anyone turns over a rock or log, that person may be disturbing the home of several animals living beneath it. The animals will behave just as people would if their homes were being wrecked -- they will run for their lives. The moment a rock is lifted, the animals will be scurrying here and there to escape. In most cases they will go into tunnels in the soil and disappear from view. Since the animals will be hurrying away, the children should not turn over a rock until both partners have made all their observations about the rock and are crouched down beside it with the dish poised to catch whatever they can. (Go over this again in the field. Show the children how to make observations about the light under and around the rock by noticing whether it is flat on the bottom and pressed into the earth, or whether it is round on the bottom and just providing shade for the animals. Then show them how to crouch with the dish ready.)

Remind the children that after they have seen all they want to, the person who turned the rock over must put it back in place. This restores the home, so the animals can come back to it.

The Trip

After this preparation, give each pair of children one four-ounce plastic covered container and, if you choose, a magnifier, and take them to the field. Encourage them to collect lots of sow bugs and earthworms for use in other lessons. Motivate them by showing your own enthusiasm over their discoveries. When the children have completed their investigations, remind each one to take a small rock back to class.

After The Trip

See that all the collected animals are put in surroundings

where they will thrive. This generally will mean providing sand or soil, moisture, a few rocks to hide under, and holes for air. For more specific information, consult the handbook.

A whistle-blowing event is pictured above. One boy found a snake during this field trip. It was observed in the field and then released, in keeping with the advice in the Minnemast Handbook, Living Things in Field and Classroom.

NOTE: Ask several children to bring in any type of plain soil for the next lesson (it may be sandy, moist or dry but must not contain grass or other plants). You will need approximately one quart for your demonstration and about one quart for every four children in the class.

The photograph above shows how one teacher's demonstration planting of a "piece of nature" looked after the grass seeds had grown. Note how one shoe box is hinged to another with tape. The second shoe box is used as a cover to retain the moisture. A setup like this can be used to maintain sow bugs and earthworms for later studies. It is not suitable for mealworms.

This photograph shows how one child's piece of nature looked after the grass seeds had grown. Not all children should have results like this. Some may have no grass at all and others may have [illegible]kly-looking grass, depending on how they set up their experiments.

Lesson 3: SETTING UP PIECES OF NATURE (Start on Wednesday)

Be sure to have the children set up their pieces of nature on a Wednesday to permit seed germination and growth over the weekend.

The purposes of this lesson are: (1) to help the children associate "field" and "laboratory;" (2) to provide opportunities for trial-and-error experiments; (3) to review what the children have studied in this unit so far, and why and how they did it.

The lesson begins with a discussion of the field trip. The children soon realize that they are not sure what condition or what combination of conditions attracts animals to live under rocks or in other places where they found them. To show the need for setting up model pieces of nature that can be studied in the classroom, they discuss the difficulty of continually taking field trips to reach conclusions concerning these conditions. Then the children make suggestions about what such a model should consist of, and you demonstrate by putting the various components together. Next the children set up their individual pieces of nature. They are free to use as much or as little soil, water and grass seed as they wish, and to select a location in the room that provides as much or as little light and heat as they choose. Each child keeps a record of his original setup and of his daily observations in a Record Booklet made by removing pages 25-32 from his Student Manual and fastening them together (with yarn, for example).

On Thursday, after a brief recording of observations about the pieces of nature, conduct a review of the previous work. To do this, use the bulletin board you have set aside especially for this unit. (The diagram of the completed bulletin board provided in the unit introduction will be helpful in showing you how this first material will tie in with the rest.)

This lesson requires thirty to forty minutes on Wednesday, ten to twenty minutes on Thursday, and only a few minutes on Friday and on the following Monday. Work with the pieces of nature and the Record Booklets is concluded in

Lesson 4 on Tuesday. For your convenience the procedure describes what is to be done on each of the four school days the lesson covers, instead of being divided into activities.

MATERIALS

-- for your demonstration (Wednesday) --

- tray
- 2 plastic shoe boxes (1 for cover)
- tape to hinge the shoe boxes together
- soil (any kind)
- water
- grass seed
- 1 or 2 rocks from field trip

-- for each child (Wednesday) --

- tray
- 2 sixteen-ounce plastic containers
- tape to hinge the containers together
- soil (any kind) in plastic bag or on paper towel
- water in cup
- some grass seeds in 1-ounce container
- 1 or 2 small rocks from field trip
- Record Booklet (pp. 25-32 removed from Student Manual)
- yarn, string or brass fasteners to hold booklet together

-- for each child (Thursday) --

- piece of nature
- Record Booklet

-- for the review (Thursday) --

- bulletin board reserved for this unit
- letters cut out for headings, "FIELD TRIP" and "PIECES OF NATURE," or these words written on separate slips of paper

small animals, bring out your demonstration tray. If they do not, say:

PERHAPS WE COULD GO OUT TO THE SCHOOL YARD AND SHOVEL UP A PIECE OF EARTH WITH A ROCK ON IT AND BRING IT BACK TO CLASS. BUT THIS WOULD MEAN GOING OUT AGAIN. BESIDES, WE WOULD DESTROY A LARGE PART OF THE YARD IF WE EACH DUG UP A PIECE OF NATURE.

IS THERE ANY WAY WE COULD PUT SOME THINGS TOGETHER IN THE CLASSROOM THAT WOULD BE JUST ABOUT LIKE A PIECE OF NATURE?

WHAT THINGS WOULD WE NEED TO MAKE A MODEL OF A PIECE OF NATURE?

If the children still can't suggest what to do, bring out your tray of demonstration materials and show it to them.

DO THESE MATERIALS GIVE YOU AN IDEA?

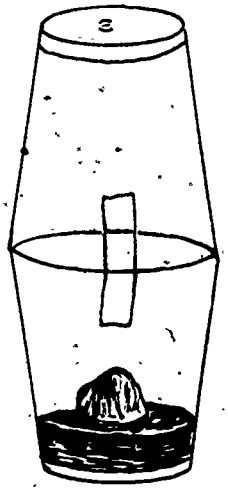
As the children offer suggestions, set up your piece of nature, one step at a time. This will involve putting soil, water, and a rock or two in one of the shoe boxes.

THERE SEEMS TO BE SOMETHING LACKING IN OUR PIECE OF NATURE. WHAT IS IT? (Grass. There was grass around the rocks where we found the animals, and some of the animals we found were in grass.)

WELL, I DON'T HAVE ANY GRASS, BUT I HAVE GRASS SEEDS. HOW SHOULD I PLANT THEM IN MY PIECE OF NATURE?

Let the children tell you the amount of seeds to plant, where and how deeply to plant them, etc. When your piece of nature is completed, put the second shoe box in place on top of it. Ask the children if they know why you are using a cover. Explain that you are not going to add any more water to your piece of nature, so it is necessary to retain whatever moisture you have put in it.

Also assemble on trays all the materials each child will need to set up his piece of nature. Hinge the containers with tape for the children. Keep these materials handy, but hidden, until you have given your demonstration.



Child's completed piece of nature

You may wish to cut out the letters for the bulletin board headings at this time, too.

PROCEDURE

Wednesday: Setting Up the Pieces of Nature (30 to 40 minutes)

Call on individual children to report on the animals they found during the field trip. (They can do this in a show-and-tell manner.) Direct them to the purposes of the trip by asking:

WE WANTED TO COLLECT SOME SMALL ANIMALS, BUT WHAT DID WE WANT TO FIND OUT ABOUT THE PLACES WHERE WE FOUND THEM? (We wanted to find out how wet or dry their homes were, how light or dark, and how warm or cool.)

WHAT CONDITIONS OF MOISTURE, LIGHT AND TEMPERATURE DID WE FIND IN THE PLACES WHERE WE FOUND ANIMALS?

No general agreement concerning the amount of moisture, light and temperature is desired here. Let the children

express their opinions freely. Then narrow the discussion down to a consideration of the conditions under rocks, logs and boards.

WE FOUND MANY OF THE ANIMALS UNDER ROCKS, LOGS AND BOARDS. WHICH OF THE THREE CONDITIONS DO YOU THINK ATTRACTS THE ANIMALS TO THESE PLACES? IS IT THE MOISTURE, THE LIGHT, OR THE TEMPERATURE?

WHAT ANSWERS DID WE FIND TO THESE QUESTIONS DURING OUR FIELD TRIP?

Direct the discussion to the forming of hypotheses, such as:

1. Maybe it is moisture alone that attracts animals to live under rocks, logs and boards.

2. Maybe it is darkness that attracts them there.

3. Maybe all three conditions (of the moisture, the light, and the temperature) attract them.

4. Maybe only two of the conditions attract them.

HOW CAN WE FIND OUT WHICH OF THESE HYPOTHESES IS CORRECT?

IF WE TOOK A GREAT MANY FIELD TRIPS COULD WE FIND OUT?

Whatever the answers, explain that it would take too much time from other school work to go to an area repeatedly to check on conditions there.

IS THERE ANY WAY WE COULD STUDY -- RIGHT HERE IN THE CLASSROOM -- WHAT IT IS THAT ATTRACTS THE ANIMALS TO LIVE UNDER ROCKS?

Encourage speculation. The children may themselves suggest the idea of a "piece of nature." If they do, ask what materials they would need to set it up. If they then suggest a container, some soil, grass, water, rocks, and

small animals, bring out your demonstration tray. If they do not, say:

PERHAPS WE COULD GO OUT TO THE SCHOOL YARD AND SHOVEL UP A PIECE OF EARTH WITH A ROCK ON IT AND BRING IT BACK TO CLASS. BUT THIS WOULD MEAN GOING OUT AGAIN. BESIDES, WE WOULD DESTROY A LARGE PART OF THE YARD IF WE EACH DUG UP A PIECE OF NATURE.

IS THERE ANY WAY WE COULD PUT SOME THINGS TOGETHER IN THE CLASSROOM THAT WOULD BE JUST ABOUT LIKE A PIECE OF NATURE?

WHAT THINGS WOULD WE NEED TO MAKE A MODEL OF A PIECE OF NATURE?

If the children still can't suggest what to do, bring out your tray of demonstration materials and show it to them.

DO THESE MATERIALS GIVE YOU AN IDEA?

As the children offer suggestions, set up your piece of nature, one step at a time. This will involve putting soil, water, and a rock or two in one of the shoe boxes.

THERE SEEMS TO BE SOMETHING LACKING IN OUR PIECE OF NATURE. WHAT IS IT? (Grass. There was grass around the rocks where we found the animals, and some of the animals we found were in grass.)

WELL, I DON'T HAVE ANY GRASS, BUT I HAVE GRASS SEEDS. HOW SHOULD I PLANT THEM IN MY PIECE OF NATURE?

Let the children tell you the amount of seeds to plant, where and how deeply to plant them, etc. When your piece of nature is completed, put the second shoe box in place on top of it. Ask the children if they know why you are using a cover. Explain that you are not going to add any more water to your piece of nature, so it is necessary to retain whatever moisture you have put in it.

Now tell the class that each child will have a chance to set up his own piece of nature. Have the trays of materials distributed. Then ask:

IF WE WANT TO FIND OUT IF MOISTURE, LIGHT AND TEMPERATURE AFFECT ANIMALS, SHOULD WE ALL SET UP OUR PIECES OF NATURE IN THE SAME WAY?

WHAT DIFFERENCES MIGHT THERE BE IN THE LIGHT, MOISTURE, AND TEMPERATURE BETWEEN TOM'S PIECE OF NATURE AND DIANE'S? (Tom might use a great deal of water and select a dark, cool place for his piece of nature. Diane might use just a little water and put her experiment in a light, warm place.)

Ask the children to assemble their pieces of nature. Tell them they may use as little or as much soil, water and grass seed as they wish. Encourage different children to plant their grass seeds at different levels in the soil. When the pieces of nature are ready, suggest that they be put in locations that will provide different amounts of light and heat. Some experiments should be placed in sunny, warm spots, others in shady, warm spots, others in shady, cool spots, and some even in a cupboard or drawer. (This wide variation in sets of conditions will help you motivate the children later to narrow their investigations in future experiments.)

Now ask the children to remove, carefully, pages 25-32 from their Student Manuals. Give them pieces of yarn or string, or brass fasteners, to put through the holes in these pages. Tell the children they will use these Record Booklets to record whatever they used to make their pieces of nature; and for daily observations of what changed and what stayed about the same. Have them write their names on the booklet covers. (They may color the covers later, if you wish.) Then ask them to fill in the blanks on the page for Wednesday. You may need to help with some of the questions. The answers can be as qualitative or quantitative as the children wish.

The reduced version of the first page in a Record Booklet, shown below, gives some of the possible answers that different children might give. It does not represent the work of just one child.

FIRST DAY (WEDNESDAY)

SOIL

What kind? Sandy ; mixed sand and dirt ; black dirt

How deep? 1" ; ½ way up

SEEDS

What kind? grass

How many? ½ ounce ; pinch ; spoonful

How deep? Planted on top ; on bottom

ROCKS

How many? 1 rock ; 2 rocks

How large? egg size

How deep? covered up ; on surface

MOISTURE

How much? a lot ; just a little ; ¼ cup

LIGHT

Is the light the same everywhere in your Piece of Nature? No

TEMPERATURE

Is the temperature the same everywhere in Your Piece of Nature? No

Comments I put my piece of nature in the sunlight ; in a cupboard

Thursday: Bulletin Board (10 to 20 minutes)

Before starting the work at the bulletin board, have each child observe his piece of nature and fill in his observations on the appropriate page of his Record Booklet. Encourage the children to record what remained the same, as well as what changed.

SECOND DAY (THURSDAY)

Did you notice any changes in your Piece of Nature from yesterday? Yes

Changes in:

SOIL No change

SEEDS A few seeds are sprouting

ROCKS No change

MOISTURE Wet under rock ; water on inside of cover

LIGHT No change

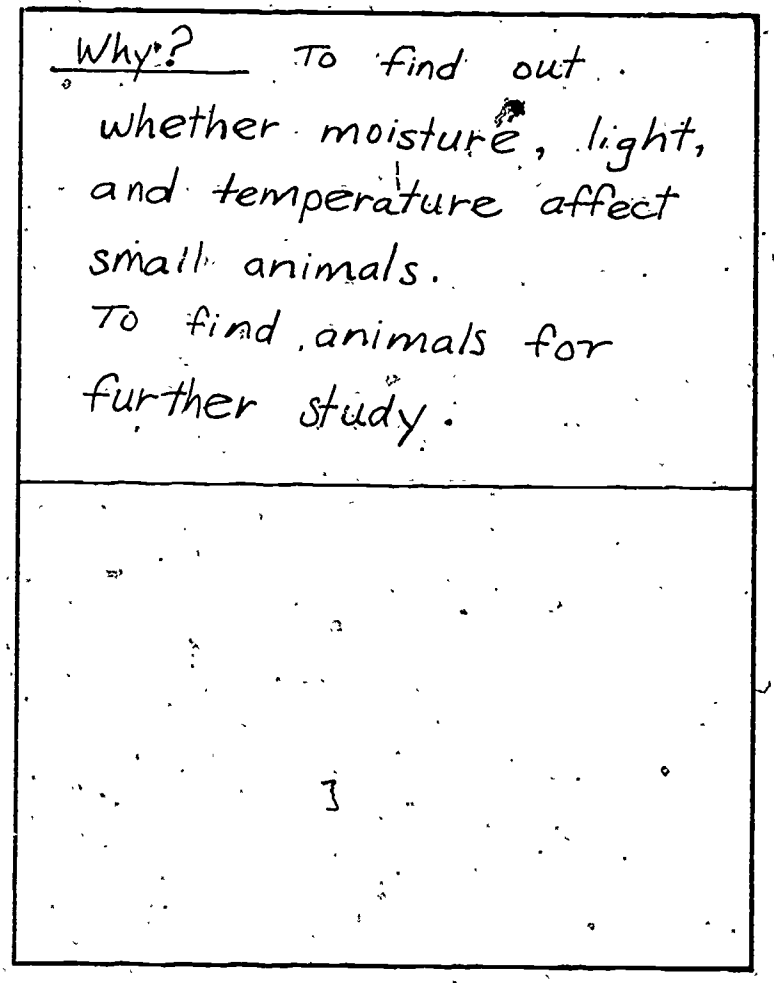
TEMPERATURE Cold under rock

Other changes

Then have the children gather in front of the bulletin board, and ask:

WHY DID WE GO ON A FIELD TRIP THE OTHER DAY? (To find out whether moisture, light and temperature affects animals; to find some small animals.)

Remind the children of the cartoons they looked at to see how different amounts of moisture, light, and temperature affect people. Then, on a large piece of paper, write the reasons for taking the field trip.



WHAT DID WE FIND OUT ON OUR FIELD TRIP? DID WE FIND OUT WHICH DIFFERENCES IN THESE CONDITIONS ATTRACT SMALL ANIMALS? (No. We couldn't decide whether it was the moisture, light or temperature that affected the animals.)

Elicit that there were many conditions present at one time, so it was impossible to tell whether it was the moisture, light, or temperature that affected the animals and attracted them to the area where they were found. One field trip wasn't enough to find out, and the class decided it would take too many field trips to make sure.

Draw a line across the first piece of paper and write what happened on the lower half of it:

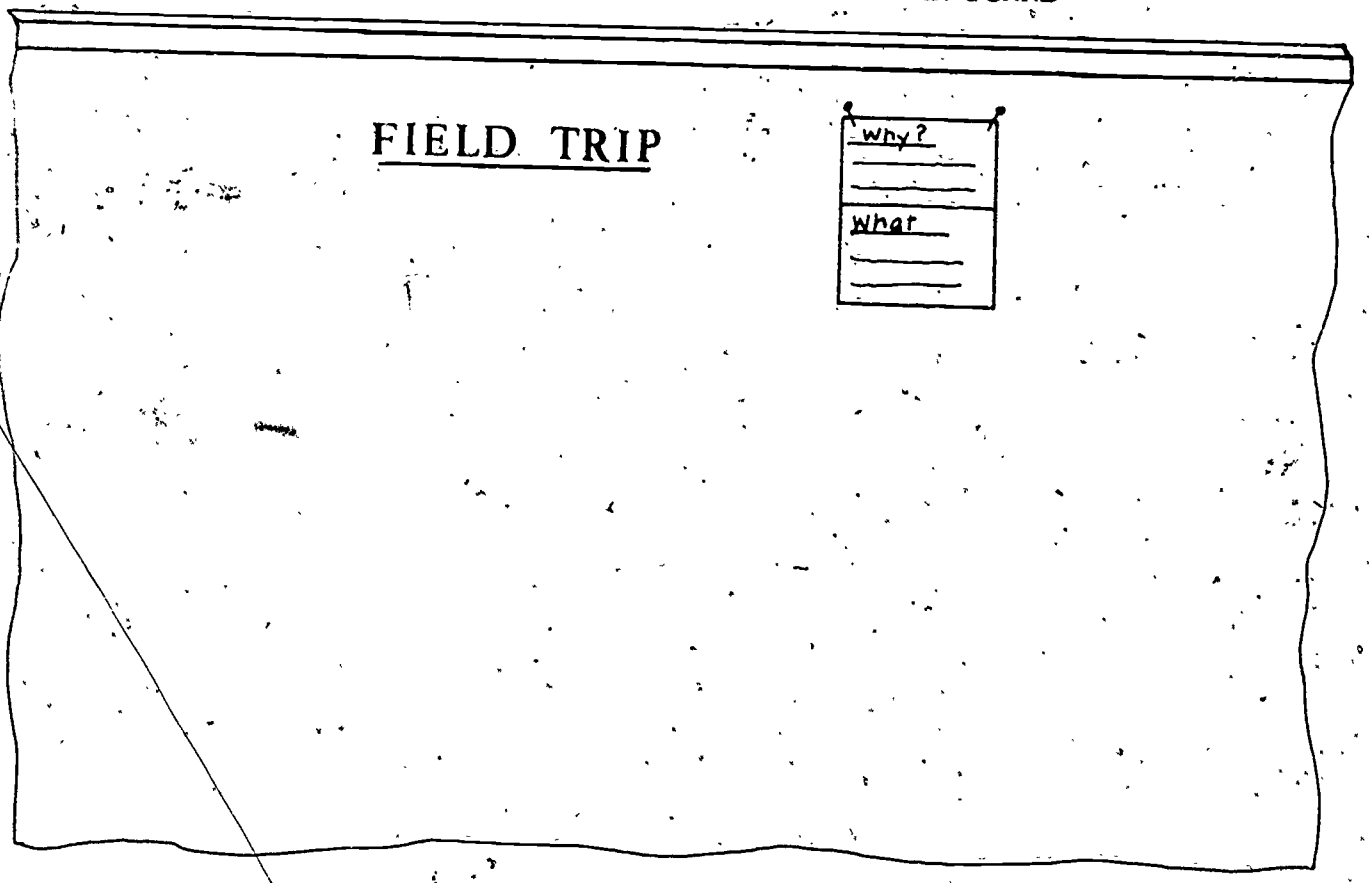
Why? To find out whether moisture, light, and temperature affect small animals.
To find animals for further study.

What Happened?

- Found small animals
- Many conditions; we couldn't decide if it was moisture, light or temperature that affected the animals.

Pin the heading, "Field Trip," near the top and center of the bulletin board. Next to it, pin the information that gives the reasons for taking the trip and the results.

"CONDITIONS AFFECTING LIFE" BULLETIN BOARD

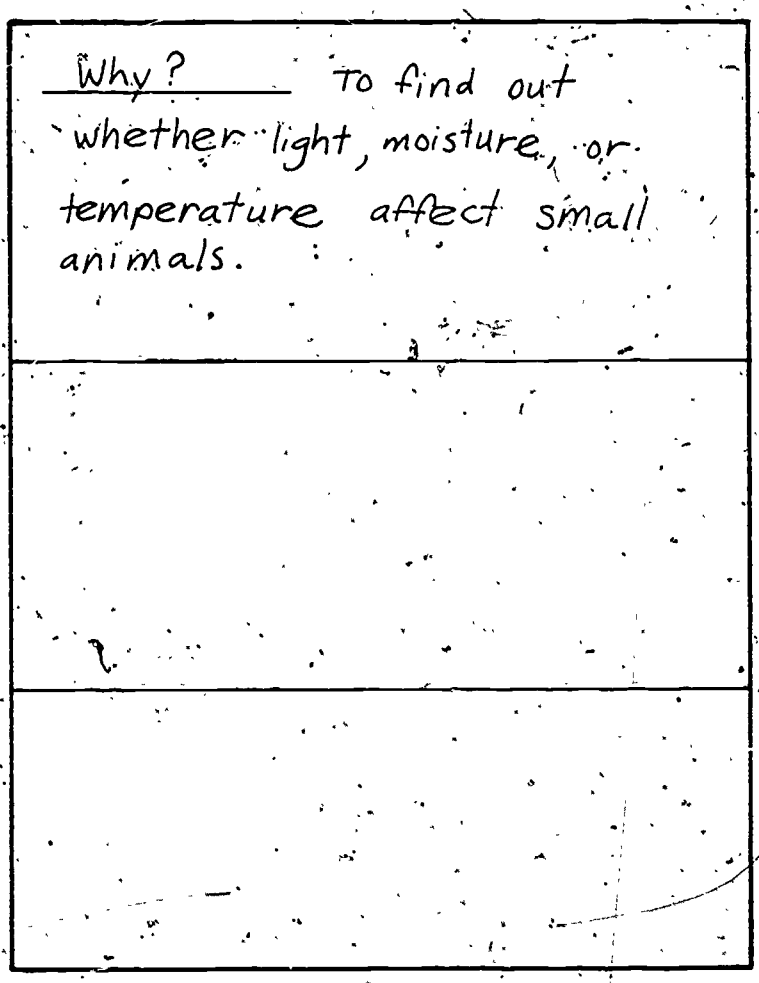


Then ask:

WHAT DID WE SET UP IN OUR CLASSROOM AFTER WE WENT ON OUR FIELD TRIP? (Our pieces of nature.)

WHY DID WE SET UP PIECES OF NATURE? (So we could study -- right here in our room -- whether moisture, light and temperature affect animals, and to find out which condition attracts them.)

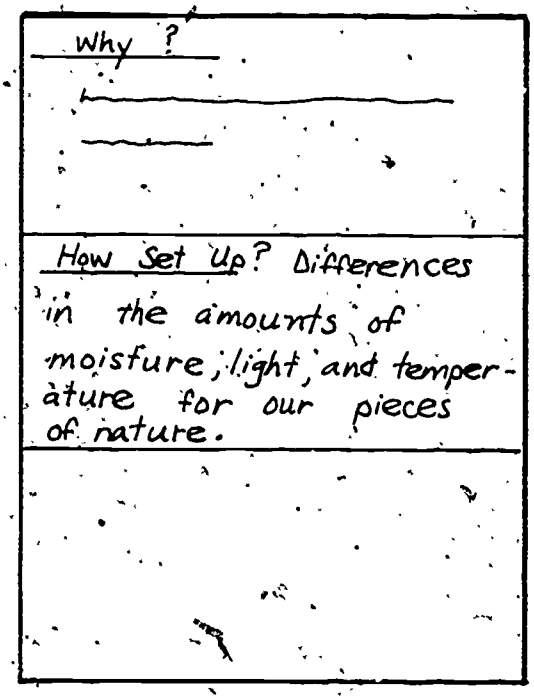
Draw two lines across a piece of paper to separate it into three spaces. In the top space, write the children's reasons for setting up their pieces of nature:



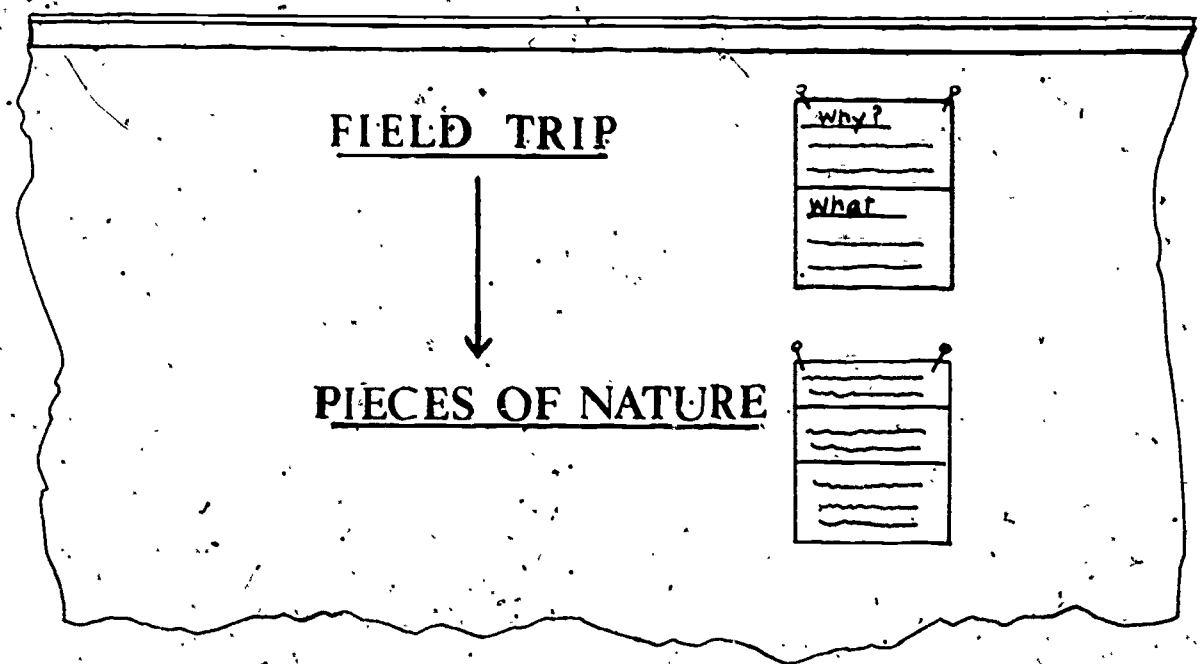
Then say:

WE SET UP PIECES OF NATURE IN ORDER TO TRY TO STUDY WHETHER IT WAS THE MOISTURE, THE LIGHT, OR THE TEMPERATURE THAT ATTRACTED THE ANIMALS TO CERTAIN PLACES. HOW DID WE SET UP THESE CONDITIONS IN THE PIECES OF NATURE? (We used different amounts of water in our pieces of nature, and we put them in places in the room where the light and temperature were different.)

In the middle space of your piece of paper, write the children's description of the differences in the ways they set up their pieces of nature. Tell the children that the bottom space of this piece of paper will be used to fill in what they find out from their pieces of nature.



Pin the heading, "PIECES OF NATURE," on the bulletin board below "FIELD TRIP." Next to it, pin the information sheet that concerns the pieces of nature. Use yarn to make an arrow from "FIELD TRIP" to "PIECES OF NATURE."



Tell the children that, with their help, you will be adding information to the bulletin board as they study this unit. Say that the bulletin board information will be a good reminder of what they have done and why they have done it. It will also be useful for quick reviews.

Friday (5 minutes)

The children should observe their pieces of nature and record any changes and non-changes in their Record Booklets. Then they should make predictions about what they expect their pieces of nature to look like by Monday. (The page for predicting is opposite their Friday record.)

THIRD DAY (FRIDAY)

Did you notice any changes from yesterday? Yes

Changes in:

SOIL looks about the same

SEEDS a few more sprouted

ROCKS dry on top

MOISTURE about the same

LIGHT no change

TEMPERATURE no change

Other changes

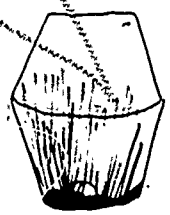
FRIDAY PREDICTIONS FOR SATURDAY AND SUNDAY

What do you think will happen in your Piece of Nature on Saturday and Sunday?

PREDICTION

Changes: The grass will grow more; it might grow 1 more inch

Draw a picture of what you think it will look like on Monday:



Give each child a container to take home. Ask the children to use the containers to catch animals, especially sow bugs and earthworms, to put in their pieces of nature on Monday.

Monday (5 to 10 minutes)

Have the children observe and record changes in their pieces of nature. Hold a brief discussion concerning their predictions and what actually changed. Ask them to put animals in their pieces of nature and to leave them undisturbed in their various locations in the room. Say that early tomorrow you will let them look to see which places in their pieces of nature attracted the animals.

SIXTH DAY (MONDAY)

What happened in your Piece of Nature over the weekend?

Changes: The grass grew quite a bit — almost 2 inches; it didn't grow at all; it grew 1 inch

Where do you think your animals will be tomorrow? Under the rock? Deep in the soil? On the grass?

The worms will be under the rock; the ants will be in the grass

Why? Because that's where I saw them on the field trip

Final observations of the pieces of nature take place in the next lesson.

Lesson 4: INVESTIGATING OUR PIECES OF NATURE (Tuesday)

Yesterday the children placed some small animals in their pieces of nature. Today they will be eager to see where the animals have migrated in each model, so you will probably want to teach this lesson early in the day. First each child will observe his piece of nature and fill out the last page of his Record Booklet. Next he will participate in a class discussion of the results. Keep this discussion open-ended and inconclusive, because the purposes of the lesson are to have the children learn (1) that several conditions may have affected the growth of a plant or the behavior of an animal, (2) that it is impossible for them to decide from this experiment which condition caused a result, and (3) that they need a more scientific method of experimenting -- a method for testing the effects of one condition at a time.

At the conclusion of the lesson, the children may take their completed Record Booklets home. However, if some children wish to continue recording their observations of their pieces of nature, encourage them to do so on their own time.

MATERIALS

- Pieces of Nature
- Record Booklets
- rulers
- chalk of different colors, for your use at the board

PROCEDURE

Have the children observe their pieces of nature and complete their Record Booklets for the seventh day (Tuesday). When they have finished, have them discuss the questions on that page.

WHERE DID YOUR ANIMALS GO IN YOUR PIECE OF NATURE?

Answers will vary. If some of the children had sow bugs or earthworms in their models, the animals probably went under the rocks.

WHY DID THE ANIMALS GO TO THESE PLACES? WAS IT THE MOISTURE THAT ATTRACTED THEM? WAS IT THE LIGHT OR TEMPERATURE? WAS IT SOMETHING ELSE? WHAT DO YOU THINK?

Again answers will vary. Remember to leave the questions open, without settling on any conclusions. Instead keep asking questions that make the children see that there is a great deal of doubt about which condition attracted the animals. Questions you might ask are:

ARE YOU SURE THAT YOUR ANIMALS WENT UNDER THE ROCK BECAUSE OF THE MOISTURE? COULDN'T IT HAVE BEEN THE LACK OF LIGHT THAT ATTRACTED THEM -- OR THE TEMPERATURE?

Tell the children that it seems to be impossible to decide which condition attracted the animals to the various places. Suggest that maybe more conclusive answers about the effects of conditions on living things might be found by concentrating on the growth of the grass. Ask the children to look at their grass.

ALL THOSE WHOSE GRASS GREW QUITE TALL SINCE FRIDAY, PLEASE RAISE THEIR HANDS.

NOW ALL THOSE WHOSE GRASS GREW VERY LITTLE SINCE FRIDAY, PLEASE RAISE THEIR HANDS.

WHAT CONDITIONS DO YOU THINK CAUSED SUCH A DIFFERENCE IN THE GROWTH OF THE GRASS? WAS IT THE MOISTURE, THE TEMPERATURE, OR THE LIGHT? WAS IT SOME OTHER CONDITION?

Let the children speculate. They should mention a number of factors that could have caused differences in the way the grass grew in the different pieces of nature. For example, the children chose a number of different locations where they kept their models. These locations provided different amounts of light and heat. The children also chose different amounts of soil, grass seed and water in setting up their models. Elicit as many of these different conditions as you can. Then say:

WE HAVE TALKED ABOUT A GREAT MANY CONDITIONS THAT COULD HAVE AFFECTED THE GROWTH OF THE GRASS. WHICH OF THESE CONDITIONS DO YOU THINK AFFECTED THE GROWTH MOST?

The children will not be able to decide on any one condition as a satisfactory answer.

SINCE WE HAVE SEVERAL CONDITIONS THAT ALL MIGHT BE EQUALLY IMPORTANT TO THE GROWTH OF THE GRASS, PERHAPS WE COULD FIND A BETTER ANSWER IF WE STUDIED JUST ONE CONDITION. LET'S THINK ABOUT THE DIFFERENCES IN MOISTURE IN OUR PIECES OF NATURE.

Draw a chart on the chalkboard:

Very wet	Wet	Moist	Dry

Ask each child to decide whether the soil in his model is very wet, wet, moist, or dry. If a child is not sure, let other children feel the soil in his piece of nature and reach an agreement about the condition of moisture for him. When everyone has made a decision, write the names in the appropriate columns. Then ask the children to measure the height of their grass to the nearest half-inch with their rulers. Enter each measurement next to the name of the child. The chart should now look something like this:

Very Wet	Wet	Moist	Dry
Mary – 3"	Betty – 2"	John – 1"	Jill – 1"
Sue – 1"	Tom – 2"	Tim – 0"	Jane – 2"
George – 1½"	Mike – 4"	Sam – 3"	Steve – 0"
Gary – 1"	Fred – 1"	Pat – 2½"	Joe – 2½"
	Carol – 0"	Betty – 2½"	
	Rita – 3"	Ann – 4"	
		Bob – 1"	

CAN WE TELL NOW WHETHER OR NOT THE AMOUNT OF MOISTURE AFFECTED THE GROWTH OF OUR GRASS? (Various answers.)

LET'S LOOK AT THE CHART TO SEE WHAT AMOUNT OF MOISTURE WAS BEST FOR GROWING GRASS IN OUR EXPERIMENT.

Draw lines of one color under the names of children whose grass grew zero inches, lines of another color under names with one-inch grass; and so on, until all the names have been underlined. (Expect a variety of measurements in each column and inconsistencies in the results, because this experiment was designed to result in contradictions to show the children the need for a better method of investigation. None of the various conditions was controlled or precisely measured. Thus, in our sample chart, you find Ann with four-inch grass and Tim with zero-inch grass in the same column, and you find one-inch grass in all four columns, etc.)

FROM THIS CHART, CAN WE TELL HOW WET OUR SOIL SHOULD BE TO MAKE GRASS GROW THE FASTEST? (No.) THE SLOWEST? (No.)

WHY DID SOME GRASS GROW BETTER THAN OTHERS EVEN THOUGH THEY HAD ABOUT THE SAME AMOUNT OF MOISTURE? (Other conditions must have affected their growth.)

Elicit all the different conditions that might interfere with drawing a conclusion about the effects of moisture on grass growth in their experiment. Some of these are: the depth at which the seeds were planted, the location in the room (sunny or shady, warm or cool), the amount of soil, and the quantity of seeds. Accept all other answers that seem plausible.

DOES THIS MEAN THAT WE CAN NEVER FIND OUT WHICH AMOUNT OF WATER WE NEED TO MAKE SEEDS GROW BEST?

Have the children speculate about this and try to make suggestions. To help them along, point to your chalkboard chart and ask if it gives them a hint.

THERE MUST BE SOME WAY WE COULD SET UP AN EXPERIMENT TO FIND OUT WHICH AMOUNT OF WATER WE NEED TO MAKE SEEDS GROW BEST. . . BETWEEN NOW AND TOMORROW PLEASE TRY TO THINK OF A WAY WE CAN FIND OUT.

Tell the children they may take their Record Booklets home now, or they may continue to keep a record of their pieces of nature on their own time.

It might be a good idea to keep your demonstration piece of nature for use in the review in Lesson 15 of this unit. You may have to add some water from time to time to keep the animals and the grass alive.

SECTION 2 MOISTURE

In Section 1 the children were introduced to three environmental conditions (moisture, light and temperature) and tried to find out whether or not these conditions affect the growth of plants and the behavior of animals. The results from these studies were inconclusive, and the children could not determine which of the three conditions, or which combination of them, caused the effects. This led to a decision for more controlled experiments, in which the effects of just one condition at a time would be studied.

In this section the children will concentrate on the effects of moisture on plants and animals. This means that only moisture will vary, while all the other conditions will be controlled. Even the soil used in plant experiments should be the same kind in all lessons from here on.

In Lesson 5, the children devise and set up an experiment to find out whether moisture affects the growth of plants. It should take about 40 to 45 minutes for this lesson. However, it will take four or five days for the radish seeds to grow enough for the children to reach any conclusions. They will do this in Lesson 7.

While waiting for the radish seedlings to grow, teach Lesson 6. If you have only mealworm beetles for the experiments, the lesson should take about 30 to 40 minutes. If you also have sow bugs and earthworms, you may want to add another 30 minutes for experiments with them.

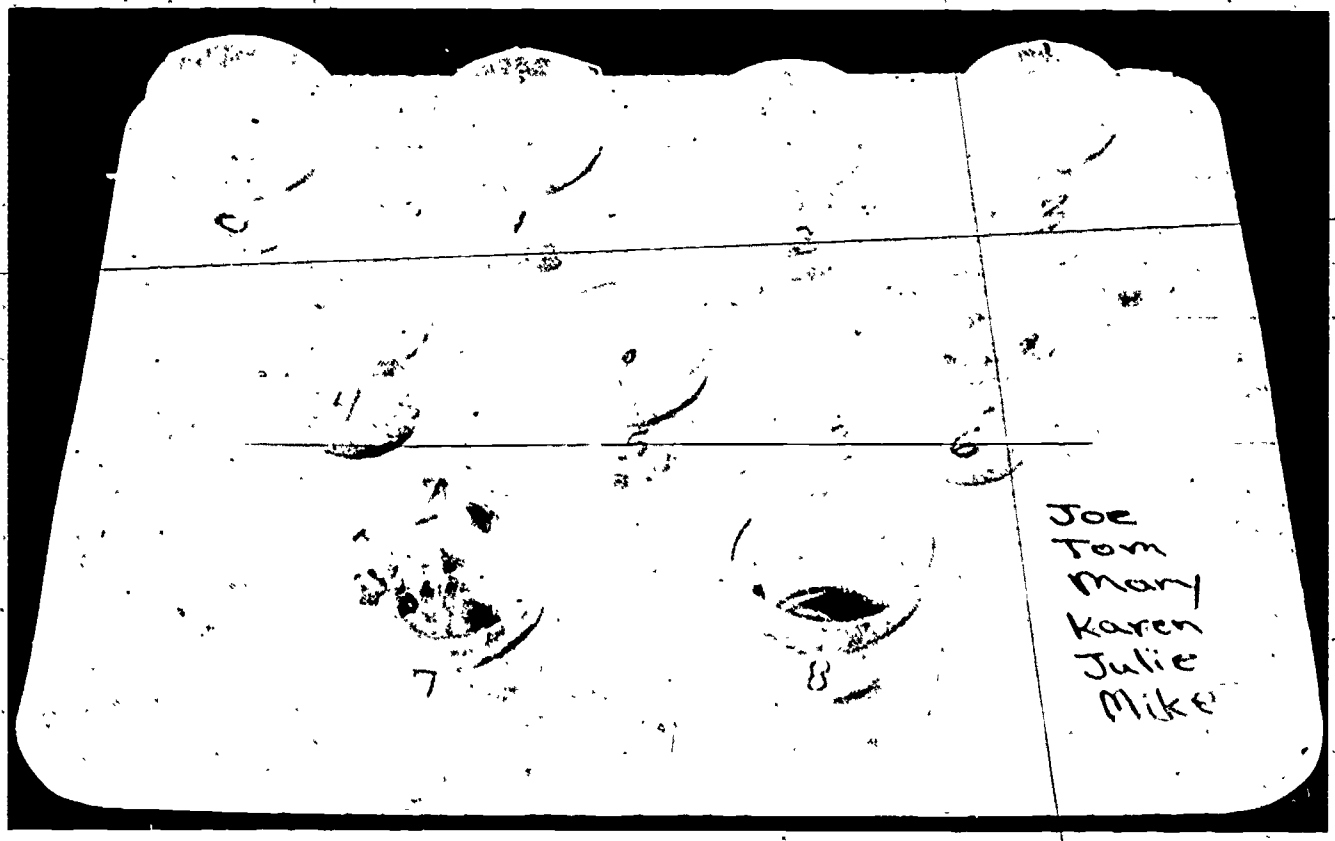
Lesson 7 should be taught when the radish seeds planted in Lesson 5 are ready for observable conclusions. This lesson should take 25 to 35 minutes. Since the lessons of this section are closely related, you may find it helpful to read through all three before you start teaching the section.

Total teaching time for this section should be between one and one-half to two and one-half hours.

Lesson 5: SETTING UP A MOISTURE/PLANT EXPERIMENT

The purposes of this lesson are (1) to have the children set up an experiment that will show whether different amounts of moisture affect the germination and growth of seeds, and (2) to have them do this in such a way that the amount of moisture is the only variable -- all other conditions will be the same in each planting.

The lesson is written for groups of six children, but you may wish to revise it for larger or smaller groups. This lesson should take from 40 to 45 minutes to teach. Four or five days later, in Lesson 7, the children will study the results of this experiment.



This group's moisture/plant experiment was photographed five days after it was set up. It is now ready for Lesson 7.

MATERIALS

- 1 thermometer
- 1 light meter (comes with simple instructions)
- grease pencil

-- for each group of six --

- medicine dropper marked $\frac{3}{4}$" from opening
- 9 one-ounce containers
- soil (same kind for all)
- craft stick or ruler
- quarter-teaspoon
- cup of water
- radish seeds
- plastic wrap to cover containers
- 9 rubber bands
- masking tape (about 12" for labeling containers)
- pencil

PREPARATION

You may wish to have the soil for this lesson brought in by a few children. If so, make sure they all bring in the same kind.

Assemble the materials for the groups on trays, and have ready a tray with materials for only two plantings for your demonstration. Mark all the medicine droppers with a grease pencil about three-fourths of an inch above the open end. Water to this mark will be called "one squirt."

Pre-select a floor space where all the groups can put their trays after they have set up their experiments. This should be a place where the light and temperature will be as nearly the same as possible for all the trays.

PROCEDURE

Conduct a brief review of the bulletin board information. Then ask the children:

WHY COULDN'T WE TELL WHETHER OR NOT THE AMOUNT OF MOISTURE IN OUR PIECES OF NATURE AFFECTED THE GROWTH OF THE GRASS? (There were differences in the amount of light each setup had, as well as in the amount of heat. Some children used one kind of soil and some another kind. Some planted their seeds in the soil, and others sprinkled them on the surface. There were too many variables.)

HOW COULD WE SET UP AN EXPERIMENT TO FIND OUT IF DIFFERENT AMOUNTS OF MOISTURE AFFECT THE GROWTH OF PLANTS?

Let the children discuss this. Gradually guide them to establishing the criteria for a controlled experiment with the following:

WHAT WOULD WE HAVE TO DO ABOUT THE MOISTURE? (We would have to use different amounts of water in each container. Then we could watch to see how the different plantings grew.)

HOW COULD WE MAKE SURE THAT SOMETHING ELSE -- THE LIGHT, THE TEMPERATURE, OR THE SOIL -- DID NOT CAUSE THE DIFFERENCES IN GROWTH? (We would have to keep all these the same for each planting.)

Ask the children to name all the conditions that would have to be the same in every planting. List these on the chalkboard, as the children suggest them. Then ask them to name the one thing that must be varied and put this on the chalkboard, too. Your list should include the following:

Keep the same	Vary
Temperature Light Number of seeds planted Kind of soil used Amount of soil Depth at which seeds are planted Type of container	Moisture used in each planting (amount of water)

It is important to emphasize to the children that the amount of moisture to be used is the only condition that should vary in such an experiment.

Bring out the demonstration tray and tell the children that, using the conditions they have specified above, you are going to do two plantings. Have them watch closely, because they will be doing the same experiment, but with more plantings. Before demonstrating, ask:

HOW CAN I MAKE SURE THAT MY TWO SETUPS WILL HAVE THE SAME AMOUNT OF SOIL, SEEDS, LIGHT AND TEMPERATURE? (By measuring.)

When it has been established that everything in this experiment will be carefully measured, whereas in the pieces of nature there was no quantification, show the children what they are going to do.

Step 1. Place two level quarter-teaspoons of soil into each of your two containers. Show the children how to use a craft stick or ruler for leveling.

WHAT CONDITION IS TO BE DIFFERENT FOR EACH PLANTING? (The amount of moisture.)

HOW MUCH WATER SHOULD WE USE IN EACH SETUP? (Let the children make suggestions, but lead them to the realization that if they put measured amounts of water from "no water" to "lots of water" and keep all other conditions the same, they may be able to find out what amount of moisture is best for the radish seeds they are going to plant.)

Step 2. Show how to fill the medicine dropper to the "1 squirt" mark, and how air sometimes enters the dropper after it is taken from the water, pushing the water up. Say that this is no problem, since the amount of water in the dropper remains the same. Say that the different setups will have different numbers of squirts.

Step 3. After adding no squirt (zero squirts) to one of your containers and one squirt to the other, stir the soil in each to distribute the water. Then smooth the surface of the soil. Label each container with the number of squirts (0 and 1). Tell the children that each group will have nine containers which should be labeled 0 through 8 according to the number of squirts in each.

Step 4. Count out ten radish seeds and spread them out on the soil in one container. Then count out ten more seeds and spread them on the soil in the second container. Tell the children that they will plant ten radish seeds in each of their containers. The seeds are to be pressed down even with the soil.

Step 5. When you have pressed the seeds even with the soil, cover each setup with a small piece of plastic wrap and secure it with a rubber band. Ask the children if they can tell you why each container should be so carefully covered. (To keep the moisture in.)

Step 6. Ask the children to tell you how to measure the temperature. When they suggest using a thermometer, show them how to measure the temperature beside each container with the thermometer. Tell them they must read the thermometer at eye level.

Step 7. Ask the children how you might measure the light that each container is receiving. If they don't suggest a light meter, show them yours and how it works. Tell them that all groups will measure the light with this meter when their plantings are set up.

Divide the class into groups of six and have a tray of materials distributed to each group. Assign a letter (A, B, C, etc.) to each child in every group, then list the duties on the chalkboard:

Child A: Puts 2 level quarter-teaspoons of soil in each container.

Child B: Puts measured squirts of water in the containers, as follows:

Container	Number of squirts
1	0 - no water at all
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8

Child C: Writes the number of squirts on each container.

Child D: Stirs up the soil to distribute the water evenly and smooths the surface.

Child E: Spreads 10 radish seeds in each container and presses them down until they are level with the soil.

Child F: Covers the top of each container completely with plastic wrap and a rubber band. He places the containers in order on the tray.

Have the children carry out their tasks. When they are finished, show them the place on the floor where they are to put their trays. When all the trays are in place, have one child measure the temperature and another the light to make sure that these are as nearly the same for all trays as possible.

Explain to the children that it will take four or five days for the seeds to grow enough for conclusions to be drawn about the effects of different amounts of moisture, but that they should make daily observations to see which seeds germinate first, which seem to be growing best, etc.

Conclude the lesson by spending a few minutes on predicting.

Ask:

HOW MANY OF YOU THINK THE SEEDS WILL GROW BEST IN THE 0 TO 2-SQUIRT CONTAINERS?

IN THE 3 TO 5-SQUIRT CONTAINERS?

IN THE 6 TO 8?

Write on the board the number of children who responded to each prediction. Tell the class that, when observable growth has taken place in the containers, these predictions will be checked. Say that, in the meantime, the children will be doing some experiments with the effects of moisture on small animals.

Lesson 6: EFFECTS OF MOISTURE ON ANIMALS

In this lesson the children set up experiments to find out if moisture affects the behavior of mealworm beetles. They discover that these beetles are attracted to dry areas. If the children have the opportunity to do another experiment with either earthworms or sow bugs, they will discover that these kinds of animals are attracted to wet areas.

The lesson begins with a brief review at the bulletin board to show the children how the present work is related to previous work. Then the children work in pairs to set up their experiments. Each pair has two or three mealworm beetles to put in a petri dish, after preparing the dish with a wet and a dry area. (A petri dish is a shallow, round, covered container about three and one-half inches in diameter.) The children prepare the petri dish for the animals by cutting a round piece of blotter into two halves and taping them in place. The center tape prevents water from the wet half from being absorbed into the other half. The beetles are placed in the dishes, covered, and then set aside for about an hour, undisturbed. After that, the children observe the animals and find out which condition -- moisture, or the lack of it -- attracted the animals.

If you did not buy sixty or more mealworm larvae before beginning this unit, please do so now, because you will need them for future lessons. It takes from one to three weeks for the larvae to develop into beetles. It is important to conduct this lesson, however, even if you do not have the mealworm beetles. Substitute either sow bugs or earthworms. Both are plentiful in the damp, dark areas under rocks, logs, etc., and sow bugs can sometimes be found in basements. The children could collect the animals for you, if you do not already have colonies of them. Directions for maintaining all three species are in the appendix to this manual.

Kindergarten teachers may wish to borrow a few of your mealworm beetles for an optional activity in MINNEMAST Unit 2, Curves and Shapes.

If the children experiment only with mealworm beetles, teaching time for this lesson should be from 30 to 40 minutes. If they use several kinds of animals, it will probably take another 30 minutes.

Mealworm beetles in this petri dish soon chose the dry area.

MATERIALS

-- for the bulletin board --

- 1 new heading, "MOISTURE," and 2 new subheadings, "Plants" and "Animals"
- information sheet
- pieces of yarn
- felt-tip pen

-- for each pair of children --

- petri dish and cover
- $3\frac{1}{2}$" square of blotting paper
- 2 or 3 mealworm beetles in 1-ounce plastic container
- 2 or 3 sow bugs
- 2 or 3 earthworms
- $3\frac{1}{2}$" piece of masking tape, two 1" pieces
- scissors
- pencil
- tray

-- for the class --

- mealworm colony (at least 30 to 40 beetles)
- sow bug colony (30 to 40)
- earthworm colony (30 to 40)
- medicine dropper
- glass of water
- thermometer
- light meter
- pencil

PREPARATION

Look at the completed bulletin board in the introduction to see where the new heading and subheadings are placed. Prepare these headings.

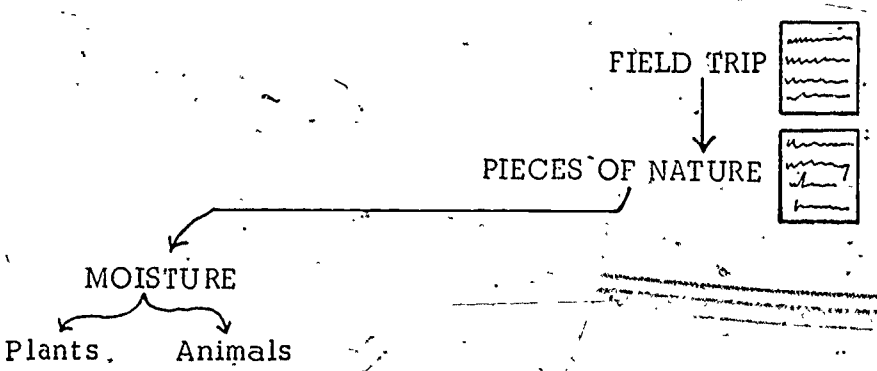
With a paper cutter, make a three and one-half inch square of blotting paper for each pair of children.

Ask a child to put two or three mealworm beetles in a one-ounce plastic container for each pair of children.

Assemble on trays the materials needed for each pair, and one for your demonstration.

PROCEDURE

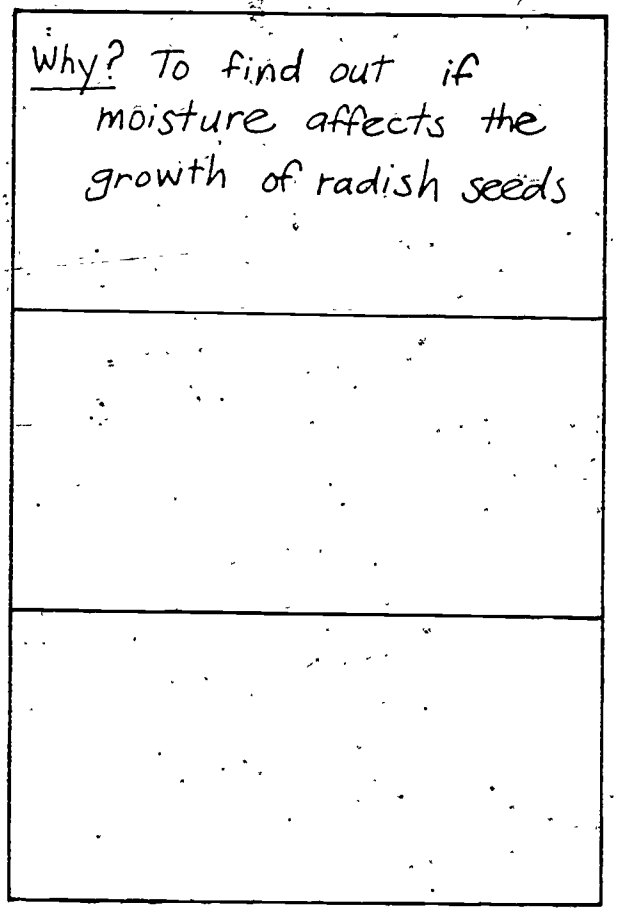
Have the children gather in front of the bulletin board. A little below, but at the extreme left of the PIECES OF NATURE heading, pin the new MOISTURE heading. Connect the two headings with a piece of yarn. Beneath MOISTURE, place the subheadings "Plants" and "Animals." Connect each of these to MOISTURE with yarn, as shown:



Briefly review the information (especially the results) from the field trip and the pieces of nature with the class. Then ask:

WHY DID WE SET UP THE RADISH SEED EXPERIMENTS YESTERDAY? (Because we want to find out if moisture affects the growth of seeds.)

With a felt-tip pen, divide a large piece of paper into three spaces to make a new information sheet. Write "Why?" in the top space and, after it, the children's reason for the experiment.



Next ask:

HOW DID WE SET UP THE EXPERIMENTS SO THAT WE COULD FIND OUT IF DIFFERENT AMOUNTS OF MOISTURE AFFECT THE GROWTH OF RADISH SEEDS? (Lead the children to the generalization that they tried to keep everything the same except the amount of moisture in each setup.)

In the second space of the information sheet, write "HOW SET UP?" and quickly fill in this generalization.

Why? To find out if moisture affects the growth of radish seeds
How Set Up? Everything the same except the amount of water in each container
Result:

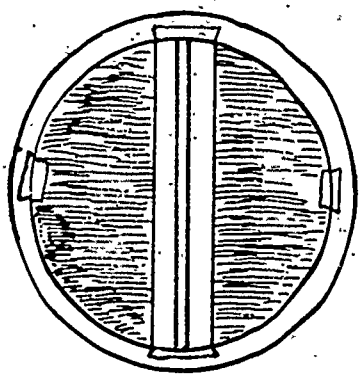
Tell the children that in a few more days they will finish filling in this information sheet with the results of their moisture/plant experiment. Pin this information sheet below the subheading "Plants" on the bulletin board.

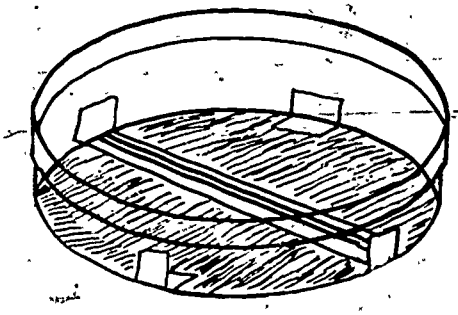
Direct attention to the words "MOISTURE" and "Animals" on the bulletin board. Ask:

CAN ANYONE THINK OF AN EXPERIMENT WE CAN SET UP THAT WILL SHOW US IF MOISTURE AFFECTS THE BEHAVIOR OF SOME ANIMALS -- LIKE MEALWORM BEETLES?

Bring out your demonstration tray and show the children several beetles. Ask the children to make suggestions. In the discussion bring out the idea that all the conditions in such an experiment would have to be the same, except the amount of moisture.

Show the children a petri dish and ask them to watch as you place it on the square piece of blotting paper and draw a circle around the bottom of the dish with a pencil. Say that you are going to cut a little inside this circle so that the blotter will fit inside the dish. Do this. Then cut a strip (about the width of a pencil) from the center of the blotter, so that the two half-circles do not touch when placed in the dish. To keep the blotters from moving around and touching, fasten them to the bottom and sides of the dish with masking tape, as shown here:





Ask:

CAN ANYONE THINK OF A WAY WE COULD USE THIS SETUP TO GIVE THE MEALWORM BEETLES A CHOICE BETWEEN A WET AND A DRY AREA? (We could wet one of the blotter pieces and leave the other piece dry, then put the beetles in and see where they go.)

WOULD THE TEMPERATURE AND LIGHT BE THE SAME FOR BOTH PIECES OF BLOTTER? (Let the children speculate.)

With a medicine dropper, wet one piece of the blotter thoroughly. Have a child take a thermometer reading for both pieces. Have another child take a light meter reading for both pieces. (The amount of light and temperature should be about the same for both pieces.)

IN THIS SETUP WHAT CONDITION WOULD NOT BE THE SAME IN EVERY PLACE? (The amount of moisture.)

IF I PUT SOME MEALWORM BEETLES IN MY DISH, WHICH AREA DO YOU THINK WOULD ATTRACT THEM? HOW MANY THINK THE BEETLES WOULD GO TO THE WET AREA? (Write the number on the board.) HOW MANY THINK THE DRY AREA WOULD ATTRACT THE BEETLES? (Write the number on the board.) HOW MANY THINK THE BEETLES WOULD BE ATTRACTED TO BOTH PLACES ABOUT EQUALLY?

Write this number on the board also, and leave these predictions for later checking:

The beetles will go to the wet area 12

to the dry area 10

equally to both areas 8

Now have the children pair off and take a tray of materials to a work area. Remind them, if necessary, how to prepare the petri dishes. When all the blotters are cut properly and taped in place, go about and wet one blotter piece for each pair. (Be careful not to wet the other piece.)

Ask the children to put their beetles in the petri dishes very carefully, some putting them in the dry area, some in the wet. Then have the children cover the dishes and observe the beetles for a few minutes. Ask each pair to put their setup in a place where the animals will not be disturbed for at least an hour. Teach another subject during this period.

When the time is up, have the children observe where the beetles are located. Call on each pair to report how many beetles are in each area. Write the data on a chalkboard chart.

On WET Area	On DRY Area
𝍸	𝍸 𝍸 𝍸 𝍸 𝍸

The children can now check the results of the experiment with their predictions.

If some children ask why all the beetles didn't go to a dry area, ask them how they could find out. (They would have to do more experiments, because many factors could be involved -- old age, sickness, injury, fright, etc.)

Tell the children that, when working with living things, there are usually exceptions that are difficult to explain. This is one reason why you did not set up just one beetle experiment, but many. To draw any valid conclusions a scientist would repeat his experiments many, many times. Say that if the children set up two experiments and two beetles went to the dry area, and two to the wet area, no conclusions could be drawn. But if 25 go to the dry area and only 5 to the wet area, it appears that most mealworm beetles are attracted to a dry area.

Ask the children to discuss how this conclusion relates to the usual habitat of mealworm beetles. (The mealworm beetle culture is a dry area. Mealworm beetles are usually found in grain storage areas -- and grain is stored in dry places.)

If sow bugs and earthworms are available, have the children use the same procedure to find out how moisture affects the behavior of these little animals.

NOTE: Maintain the colonies of animals for use in other lessons and for experiments by individual children. Also save one petri dish setup (without the beetles) for display in Lesson 15.

Lesson 7: EFFECTS OF MOISTURE ON PLANTS

This lesson concludes the work with the moisture/radish seed experiments set up in Lesson 5. It should be taught when there are definite variations in the growth of the seedlings (about four or five days after the seeds were planted). None of the plants will have grown enough during this time to look like those at the top of the Radish Growth Chart on the next page.

In Activity A the children observe and graph the results of their radish seed experiments and discover that there is a functional relation between the amount of moisture and the growth of the plants.

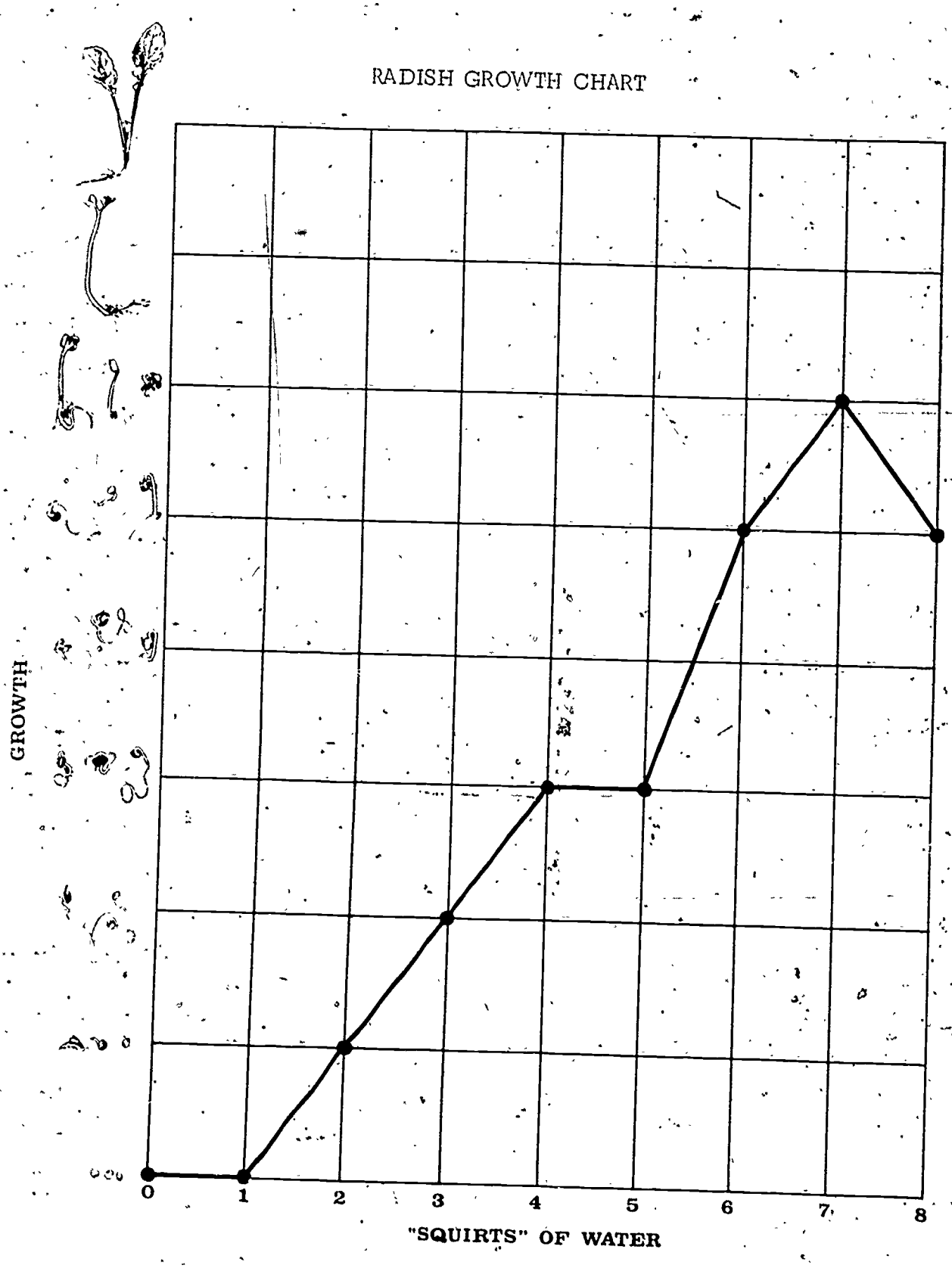
In Activity B the children provide information about the effects of moisture on plants and animals for the bulletin board, and are led to see the similarities of experimental procedures between both the plant and the animal experiments.

In Activity C the children are encouraged to devise and carry out independent moisture experiments, using the procedures they have learned.

Teaching time for this lesson should be about 25 to 35 minutes.

MATERIALS

- moisture/radish seed experiments from Lesson 5
- Radish Growth Chart, 1 for each group of six (see small facsimile on next page)
- transparency of chart
- overhead projector
- 2 information sheets for bulletin board
- Living Things in Field and Classroom



Graph of one group's results

PREPARATION

After arranging for the use of an overhead projector, prepare for Activity C by looking up some experiments in the MINNE-MAST Handbook. Also take stock of what materials in the room could be lent to the children to encourage their independent experiments.

PROCEDURE

Activity A

Have the same groups of children who worked together in Lesson 5 take their trays to their work areas. Allow a few minutes for them to observe their setups. Then give each group one large Radish Growth Chart. Show the transparency of this chart on the overhead projector. Demonstrate how the children can graph the amount of water against the growth of the radish seeds. (You may wish to use the plottings from the completed chart on the preceding page for this.)

Ask the children to work as teams to decide which picture of radish growth on the chart best matches the growth in each of their setups. Have them graph each setup.

When this work is completed, choose one group's graph to copy on the transparency. Project this, and have the groups discuss the similarities and differences between their graphs and the projected one. Ask the children to decide which amount(s) of moisture seem to be best for growing radish seeds. If the seeds with the most moisture did not grow best, ask the children to discuss this. (This amount of water was enough to produce a drowning effect, shutting the seeds off from air.)

Collect the graphed charts and display them, so the children can compare their results with the others.

You may wish to save some of the healthiest-looking radish plants for the independent experiments of Activity C.

Activity B

Have the class gather in front of the bulletin board and complete the information sheet for Plants (under MOISTURE), with the help of the class.

WHY?

HOW SET UP?

RESULTS: Different amounts of moisture do affect the growth of radish seedlings.

With information from the children, quickly fill out a sheet for Animals (under MOISTURE). A completed information sheet for Animals might look like this:

WHY? To find out if moisture affects where mealworm beetles will go.

HOW SET UP? All conditions the same except the amount of moisture. Animals given the choice between a dry area and a wet area.

RESULTS: Different amounts of moisture affected where the animals went. Mealworm beetles went to the dry area, sow bugs and earthworms to the wet area.

Pin this information sheet on the bulletin board below MOISTURE and Animals. Then discuss with the class the similarities between the experiments done to find out whether moisture affected plants and animals:

(1) All conditions were the same, except the amount of moisture.

(2) The amount of moisture did affect both the plants and the animals the class experimented with -- radish seeds, mealworm beetles, sow bugs, and earthworms.

Activity C

Ask the class:

DO YOU THINK DIFFERENT AMOUNTS OF MOISTURE WOULD AFFECT OTHER PLANTS AND ANIMALS IN THE SAME WAY IT AFFECTED THOSE WE TESTED? (Let the children speculate.)

Encourage suggestions of how other plants and animals could be used for experiments, for example: trying other seeds, putting leafy twigs in water while others are left out, watering potted plants with different amounts of water, giving frogs or grasshoppers a choice of a wet or dry area.

HOW COULD WE FIND OUT WHETHER THE AMOUNT OF MOISTURE AFFECTS SOME OTHER PLANTS OR ANIMALS? (Set up experiments as we did in class, with all the conditions the same except the amount of moisture.)

COULD WE PUT A FROG IN THE DISH SETUP WE USED FOR MEALWORM BEETLES? (No, the frog wouldn't fit.)

Have the class give suggestions of possible equipment that could be used to give the frog a choice of a wet or a dry area. Be alert to suggestions that involve more than just moisture as a variable. Point out these other variables to the children.

HOW MANY OF YOU WOULD LIKE TO SET UP, ON YOUR OWN, EXPERIMENTS THAT WOULD FIND OUT IF OTHER PLANTS AND ANIMALS REACT TO DIFFERENT AMOUNTS OF MOISTURE?

Suggest that a few children might like to continue the radish experiments in pots, carefully controlling all conditions and varying the amount of moisture in each pot.

Tell the children they may work on these projects either at home or during their free time at school. Encourage them to use any of the MINNEMAST materials they need. (You may find it necessary to appoint a monitor to keep track of borrowed materials and see that they are brought back in good condition and placed where you want them kept.)

The desirability of having children do many independent experiments has been mentioned before in this unit. It is reiterated here to remind you of the importance of encouraging it throughout all MINNEMAST studies. It is vital to give the children plenty of praise when they first start experimenting on their own, and to remain interested and enthusiastic when they give their progress reports.

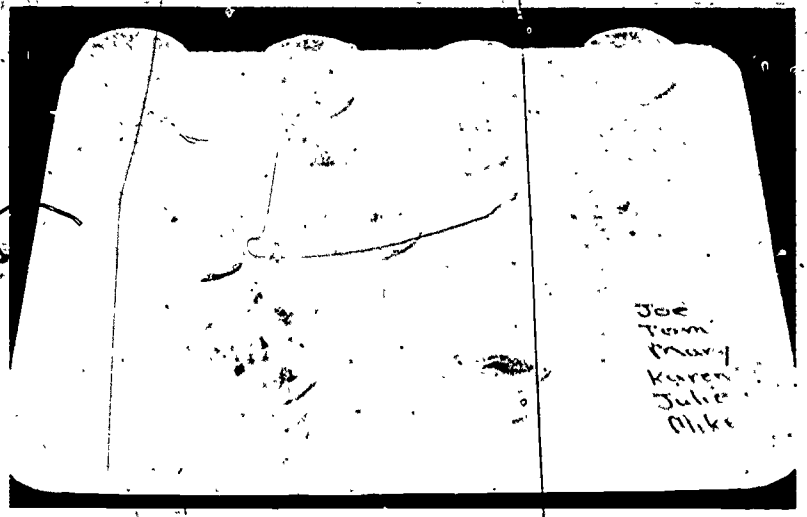
Children in the third grade lose interest in projects that do not show results for a long time. In this regard you may find it helpful to examine the germination chart on page 183 of this unit, and to acquaint your class with this chart. It tells, for example, that an orange seed takes about thirty days to germinate. Probably this makes the planting of orange seeds unsuitable for children of this age.

Photographic Review of Sections 1 and 2

Field Trip

Piece of Nature

Effect of Moisture on Animals



Effect of Moisture on Plants

SECTION 3 LIGHT

PURPOSE

— To have the children find out, by experimentation, if light affects plants and animals.

COMMENTARY

In Section 2 the children set up experiments to find out if moisture affects the growth of plants and the behavior of animals. In this section they set up experiments to find out how light affects the growth of plants and the behavior of animals.

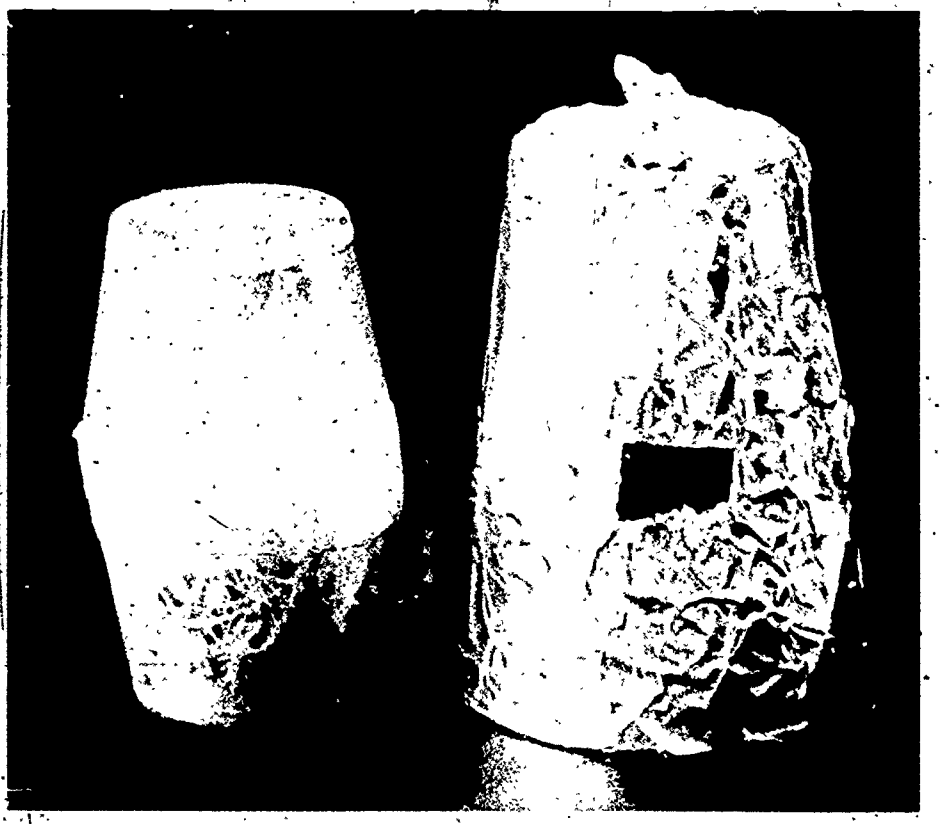
Lesson 8 should take from 45 to 60 minutes. In this lesson the children plant grass seeds with controlled amounts of light. They must wait about seven days before they can draw their conclusions about this experiment.

Lesson 9, which is concerned with the effect of light on animals, should be taught during this waiting period. If you have only mealworm beetles for the experiments, the lesson should take from 40 to 45 minutes. If you also use sow bugs and earthworms, allow for another 30 minutes.

Lesson 10 should be taught when the light/grass setups are ready for observable conclusions. It should take from 30 to 45 minutes.

Since all three lessons are closely related, you will find it helpful to read through all of them before starting this section.

Total teaching time for this section should be between three and four class periods.



These photographs show how each light/grass experiment is set up in Lesson 8. The amounts of soil, water and grass seed are carefully measured and placed in a four-ounce plastic container. To retain the moisture, another container is taped on as a cover. The light is controlled by means of a window cut in a foil-covered styrofoam cup placed over the plastic containers. The setups are placed on the floor in such a way that all windows are facing an electric light, but each setup is at a different distance from the light. These photographs were taken about a week after the grass seeds were planted.

Lesson 8: SETTING UP A LIGHT/PLANT EXPERIMENT

The purpose of this lesson is to give the children the opportunity to participate in planning and setting up an experiment that will show them how different amounts of light affect the growth of grass. In this experiment the children plant grass seeds in such a way that all the conditions, except the amount of light, are the same for each setup. It should take from 45 to 60 minutes to teach this lesson, but it will take about seven days for the grass to grow enough for conclusions to be reached. The children will study the results of this experiment in Lesson 10. During the waiting period, teach Lesson 9.

MATERIALS

-- for the class --

- bulletin board
- small lamp with 75-watt bulb (borrow from custodian)
- 3 sheets of newsprint (enough to cover 4' x 8' floor space)
- transparent tape and masking tape
- grease pencil for marking medicine droppers
- 2 thermometers
- 1 light meter
- single-edge razor blade (for your preparations)
- 3" x 5" index card (for your preparations)

-- for each group of four --

- tray
- 4 four-ounce plastic cups
- 2 twelve-ounce styrofoam cups, each with window cut to same size and at the same height
- 2 sheets of aluminum foil, about 12" x 9"
- cup of soil (same kind for all groups)
- craft stick or ruler

— 1-ounce container of grass seeds (same kind for all groups)

— piece of transparent tape about 1" long

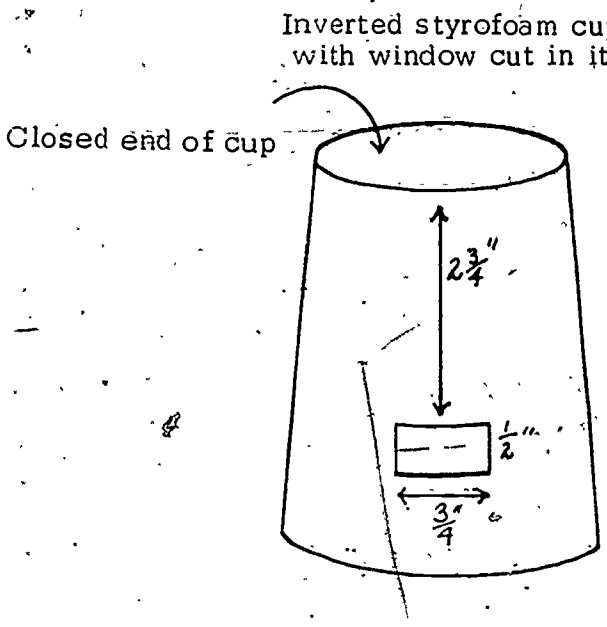
— container of water

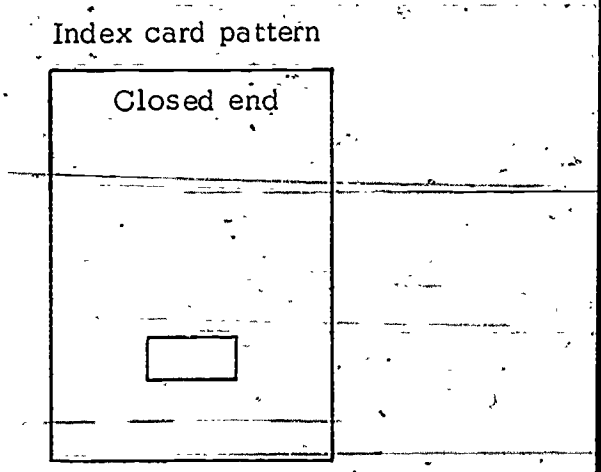
— medicine dropper marked 2" from open end

— plastic teaspoon

PREPARATION

Each styrofoam cup that the children use must have a window cut in it. This window should be three-fourths of an inch wide and one-half inch high. The top of the window should be two and three-fourths inches from the closed end of the cup. You can put a window in the first cup you prepare by measuring everything carefully and then cutting out the window with a razor blade. After that, you can make a pattern by inserting an index card behind the window, and drawing the outline of the window with a pencil. Cut the window from the index card and use it as a template (pattern) to draw windows on the other cups. Cut these out, too. Be sure to mark your index-card pattern to indicate which represents the closed end of the cup.





Use a grease pencil to mark each medicine dropper at a point two inches from the open end (not three-fourths inch, as previously). Make sure the marks are at the same place on all droppers.

Have some children help you assemble the materials on trays. Choose a place on the floor that is out of the sunlight and near an electric outlet. Tape newsprint to cover an area about 4 feet by 8 feet on the floor, in this place. Have a lamp with an unshaded 75-watt bulb ready to put in the center of the paper. Notify the custodian that the lamp is to be left burning day and night.

Prepare one tray with materials for just one setup -- 2 plastic four-ounce cups, 1 styrofoam cup, etc. -- for your demonstration.

PROCEDURE

Activity A

Go through the information sheets on the bulletin board, emphasizing the moisture/plant experiments. Then say:

WE SET UP EXPERIMENTS TO FIND OUT IF MOISTURE AFFECTS PLANTS. WE FOUND OUT THAT DIFFERENT AMOUNTS OF MOISTURE AFFECT RADISH GROWTH.

Relate these findings to the growth of grass in the different pieces of nature by suggesting that different amounts of moisture in those setups may have been one of the reasons why the grass grew differently in several pieces of nature. Remind the children that results were inconclusive because conditions in the pieces of nature were not controlled. Then ask:

WERE WE ABLE TO TELL IF LIGHT AFFECTED THE GROWTH OF THE GRASS IN OUR PIECES OF NATURE? (No.) WHY? (There were too many conditions. Moisture, light, soil, or temperature could have caused the results.)

WHAT WOULD WE HAVE TO DO TO FIND OUT IF DIFFERENT AMOUNTS OF LIGHT AFFECT THE GROWTH OF GRASS SEEDS? (We would have to set up experiments in which the grass seedlings all have the same conditions, except the amount of light they receive, and then see how the grass grows.)

HOW COULD WE MAKE SURE THAT SOMETHING ELSE -- THE MOISTURE, TEMPERATURE, SOIL, AND SO ON -- WOULD NOT CAUSE THE DIFFERENCES IN GROWTH? (We should keep all the other conditions the same. Only the light should vary.)

WHAT THINGS SHOULD WE KEEP THE SAME, AND WHAT SHOULD WE VARY?

List the suggestions on the chalkboard:

Keep the same	Vary
Moisture (water)	Amount of light
Temperature	
Kind of seeds	
Amount of seeds	
Kind of soil	
Depth where seeds are planted	
Size of container	
Type of container	

It is important for the children to notice that the amount of light is the only thing that is different from setup to setup.

After you have listed the criteria for the experiment on the chalkboard, ask the class:

HOW CAN WE TELL IF ALL THE SETUPS HAVE THE SAME AMOUNT OF SOIL, SEEDS, MOISTURE, AND TEMPERATURE? (Measure each thing as we set up the experiment.)

Tell the children that they will be working in groups of four, and that each group will prepare two light/plant setups. Say that each member of a group will be assigned a certain job, so they should watch and listen closely as you demonstrate what they are going to do. Bring out a tray of materials, and go through the following steps. Write a brief instruction describing each step on the chalkboard.

Step 1. Put 5 level teaspoons of soil in one 4-ounce container. Level the soil with a craft stick or ruler. Remind the children that each group will be preparing two containers like this.

Step 2. Draw up water to the grease-pencil mark in the dropper and squeeze the water out over the soil. Do this seven times. Measure and count carefully. (Change the number of dropperfuls if the type of soil you use requires it.)

Step 3. Sprinkle one level teaspoon of grass seed over the soil.

Step 4. Press the seeds down so they are level with the soil. Do not cover them with soil.

Ask:

HOW CAN I MAKE SURE THE AMOUNT OF MOISTURE IN THIS SETUP WILL REMAIN THE SAME DURING THE EXPERIMENT? (Cover the container.)

Step 5. Cover the container with another 4-ounce container.

Step 6. Tape the cover to the bottom container with a piece of transparent tape. (Explain that later you will put transparent tape all the way around the cups, so that no water can escape.

NOW THAT I HAVE CAREFULLY MEASURED THE AMOUNTS OF SOIL, SEED AND MOISTURE IN MY SETUPS, WHERE SHOULD I PLACE THEM SO THAT EACH SETUP RECEIVES A DIFFERENT AMOUNT OF LIGHT?

The most obvious suggestion from the children will probably be to put one setup in a light area and another in a dark area. Explain that at night both setups will be in a dark area -- the sun will not be shining, and the lights will be turned off in the classroom.

Show the lamp and ask if anyone can think of any way to use it so that a certain setup will get the same amount of light all the time, and so that another setup will also get a different amount of light all the time. Place the lamp on the newsprint (which you have taped to the floor) and turn on the lamp. Turn off all the other lights and pull the shades. The children should be able to see that the farther you get from the lamp, the less light you receive.

Ask:

> HOW CAN WE MEASURE THE DIFFERENT AMOUNTS OF LIGHT AS WE MOVE FARTHER AND FARTHER AWAY FROM THE LAMP? (Measure the amount of light with the light meter. Record several different readings on the newsprint as you move away from the lamp.)

The children should now be able to tell you that their setups should be placed at different distances from the lamp in order to receive different amounts of light, and that the lamp should be left on day and night.

Now turn on the lights and raise the shades. Put your demonstration setup on the floor near the lamp. Ask the children to observe closely both the lamp and the setup. Ask them to raise their hands when they think of something that is wrong with the setup. (They should notice that the light from the lamp is not the only light shining on the setup.)

Tell the class that there must be a way of making sure that the only light the plants will receive is from the lamp. Show the styrofoam cup with the window in it.

> COULD WE USE THIS CUP IN SOME WAY TO MAKE SURE THE SETUPS RECEIVE ONLY THE LIGHT FROM THE LAMP?

Place the styrofoam cup over the grass setup, with the window toward the lamp.

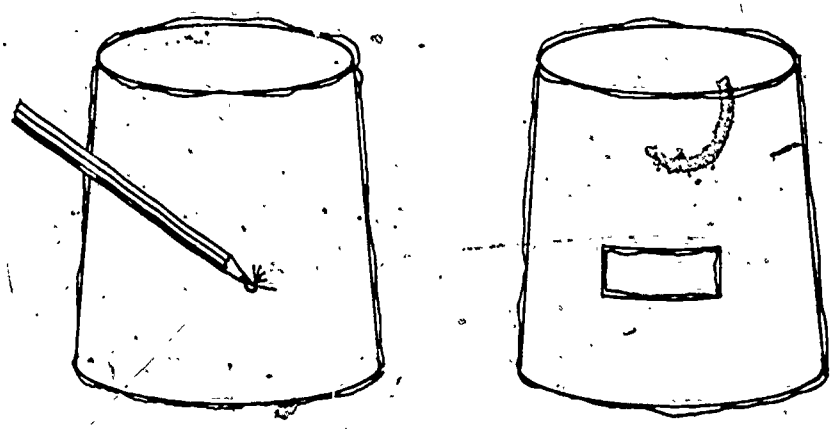
DO YOU SUPPOSE THESE STYROFOAM CUPS ARE COMPLETELY LIGHTPROOF?

Have a few children hold cups toward a light source, and look into them. (The cups are not lightproof.)

COULD WE USE THIS PIECE OF ALUMINUM FOIL TO MAKE THIS CUP LIGHTPROOF?

Have a child cover the cup with foil. Have him fold the foil over the lip of the cup and press it firmly, so that it fits neatly. Ask a few children to look into the cup now, while holding it toward the light. (The cup will now be completely lightproof.)

Show the children how to pass their fingers over the foil and feel for the window. Then show them how to poke a hole through the window and fold all the edges of the foil inside the cup.



Step 7. Put foil on the cup and poke hole through window. Tell the class that one of the groups can make one setup that is completely dark -- with no foil poked through the window. Say that the same group could leave the other setup completely in the light -- without the styrofoam cup over it.

Step 8. Place the setup and cup cover on the newsprint. Explain that the setups should be placed at various distances from the lamp, anywhere from one-half foot to five feet away, with each window facing the lamp.

Step 9. Each group will be assigned a name (A, B, C, D), and this name should be written on the newsprint beside each of their setups.

Step 10. Draw a circle around the bottom of the setup and the styrofoam cup cover. Explain that this will help the children put their experiments back in the right places after they observe them each day. Further explain that after picking up a setup, the children will not know which side of the setup should face the window. Show them how to put a small piece of masking tape near the base of each setup, so that they can align it directly below the window each time a setup has to be put back in its place.

Diagram shows where to place tape on the setup directly beneath the window. This is then lined up with tape on the floor.

Step 11. Put tape on setups.

Activity B

Divide the class into groups of four. Have the children of each group letter themselves -- A, B, C and D. Then list the duties for each child on the chalkboard.

Child A -- Puts in soil and water.
(Steps 1 and 2)
Cleans up.

Child B — Puts in grass seed.
Presses down grass seed.
(Steps 3 and 4)
Cleans up.

Child C — Puts covers on containers with small piece of transparent tape as hinge.
Puts foil on cups and pokes hole through window.
(Steps 5, 6, and 7)

Child D — Puts setups on floor, each at a different distance from the lamp, and writes group name at each place.
Draws circles around setups and cup cover.
Puts tape on setup.
(Steps 8, 9, 10 and 11)

Have the children of each group take their tray of materials to their work area. If the children in each group work together as a team, it should not take them more than 15 minutes to do this activity -- from start to clean-up.

When all the groups have finished placing their setups on the floor, call the children together for a brief discussion. Stress the fact that all the conditions have been controlled except the amount of light each setup will receive. Ask the class:

WHAT CONDITION HAVE WE NOT CHECKED TO MAKE SURE IT IS THE SAME FOR ALL THE SETUPS? (Temperature.)

Take two thermometers and cut the backing from the bottom of them, just below the scale. Check these thermometers to make sure their readings are the same. Then cut slits in the tops of two styrofoam cups (one that is near the lamp, and one that is farther away). Place a thermometer in each slit, making sure the base of the bulb touches the setup inside.

The temperature readings for both setups are generally found to be about the same, as the styrofoam cup acts as an insulator against the heat radiated from the light bulb. When the thermometers are removed, cover the slits with more foil.

Ask the children what they think will happen to the grass seeds that receive the most light, to the seeds that receive the least light, to the seeds that are completely in the dark, and to those that are completely in the light.

Tell the children that it will take about six or seven days for their grass seeds to grow enough for them to come to some conclusions. Encourage the children to examine their setups each day. (This could be done as soon as they arrive at school each morning.) Remind them to be sure to replace the setups just as they found them by lining up the small piece of tape on the bottom container with the window in the styrofoam cup cover. The window, of course, is to be lined up with the lamp.

Conclude this lesson by saying that the children will finish their work with these light/plant experiments in Lesson 10. In the meantime, they will be doing a light/animal experiment.

Lesson 9: EFFECTS OF LIGHT ON ANIMALS

In Lesson 8 the children set up a controlled experiment in order to find out the effects of different amounts of light on the growth of grass. In this lesson they set up controlled experiments to observe the behavior of small animals when the animals are given a choice between dark and light areas.

Activity A brings the bulletin board up to date. In Activity B the children do the experiment with mealworm beetles. In Activity C, which could be done on the same day, the children do the same kind of experiment with sow bugs and earthworms. Activity D is optional, but the showing of the film is highly desirable. This lesson should take from 40 to 45 minutes if only mealworms are used. Add another 30 minutes if sow bugs and earthworms are also used.

MATERIALS

-- for the class --

- 1 new heading, "LIGHT" and 2 new subheadings, "Plants" and "Animals" for the bulletin board; also 1 new information sheet, yarn, and felt-tip pen
- mealworm, sow bug and earthworm colonies
- light meter
- thermometer
- 12" x 14" piece of aluminum foil; another piece 4" x 6"
- film, Desert Community, Encyclopedia Britannica Films, 1 reel, color

-- for each pair of children --

- 1 petri dish and cover
- $3\frac{1}{2}$" x $3\frac{1}{2}$" square of construction paper
- 4" x 6" piece of aluminum foil
- 2 or 3 mealworm beetles in 1-ounce plastic cup
- tray
- scissors
- pencil

PREPARATION

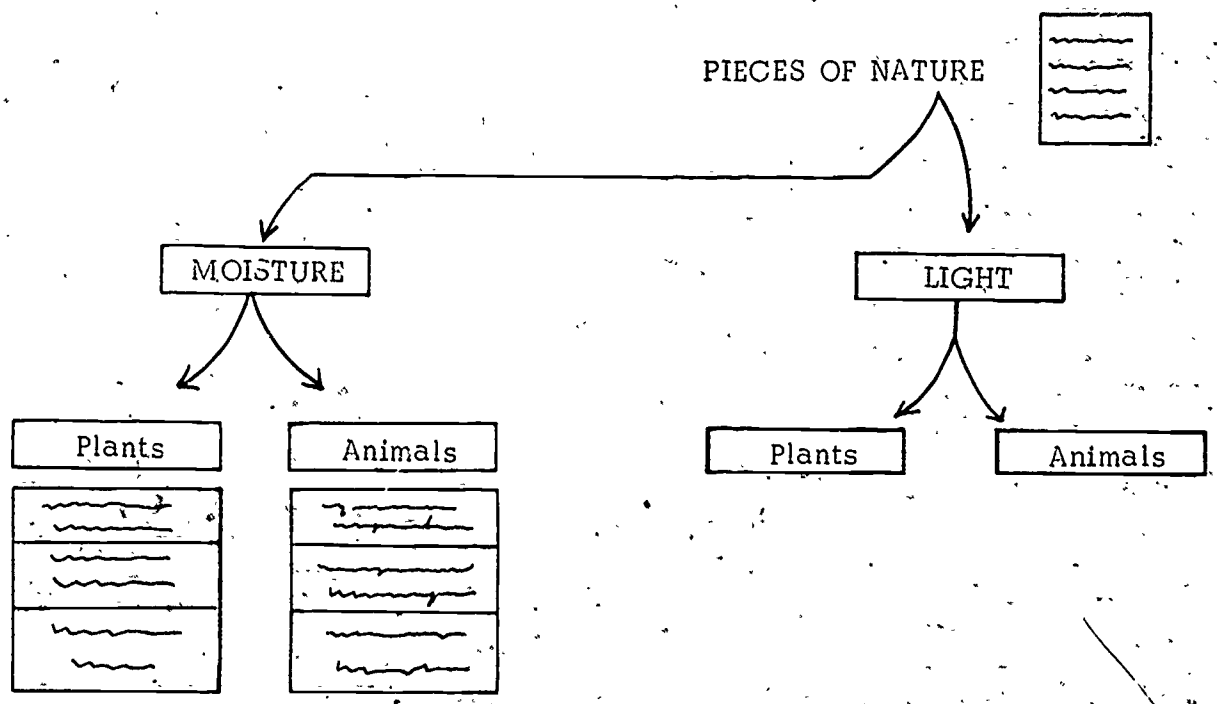
Have the materials for the bulletin board ready for Activity A. Ask a child to help you assemble the materials for each pair of children on trays. Also prepare one tray for your demonstration. If possible, obtain the film for use at the end of the lesson.

PROCEDURE

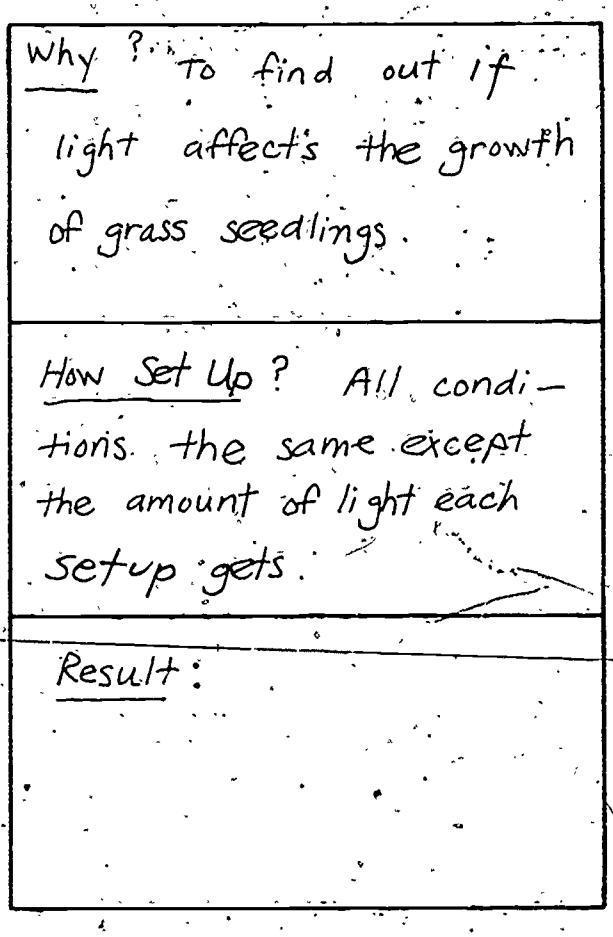
Activity A

Have the class gather in front of the bulletin board. Briefly review the information sheets already there. Discuss with the class the reasons for setting up light experiments. (On the field trip there were too many conditions affecting the plants and animals. It was necessary to set up experiments where just moisture, or just light, or just temperature could be shown to affect the plants and animals.)

Pin the new heading "LIGHT" on the bulletin board below "PIECES OF NATURE." Connect these two headings with a piece of yarn. Then pin the subheadings "Plants" and "Animals" below "LIGHT", and connect with yarn, as shown:



Review the light/plant setup from Lesson 8 with the children. With their help, fill in the "Why?" and "How Set Up?" spaces of a new information sheet for this experiment, and pin it in the appropriate place.



Remind the children that they will have to wait a few more days for the grass to grow before they can fill in the results of this experiment.

Activity B

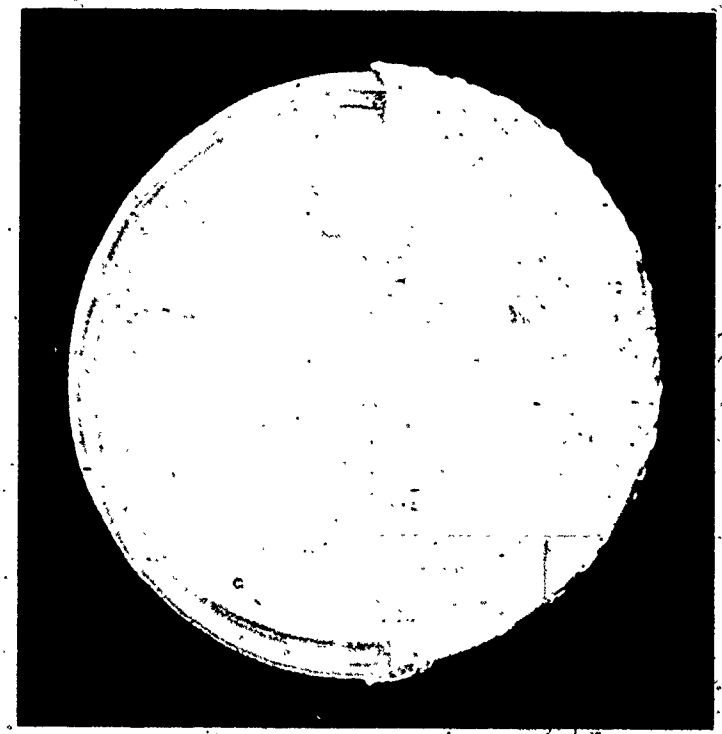
Bring out a tray of materials and have the class gather in front of your demonstration table. Then ask:

SUPPOSE WE WANTED TO FIND OUT IF DIFFERENT AMOUNTS OF LIGHT AFFECT MEALWORM BEETLES -- HOW COULD WE DO IT?

Remind the class of the setup used to find out if moisture affected these animals. In that setup they gave the animals a choice between a wet area and a dry one. Ask the children if they could use this same apparatus (show petri dish with construction paper in bottom) to give the beetles different amounts of light (say, a light area and a dark area) to choose from.

If the children can't think of a way to darken half the petri dish, show them a piece of aluminum foil and ask if they could use it to make half the dish darker. Let them make suggestions and try out their ideas. Then fold a small square of aluminum foil over half the petri dish, pressing the foil firmly together on the bottom.

Show the class the completed setup:



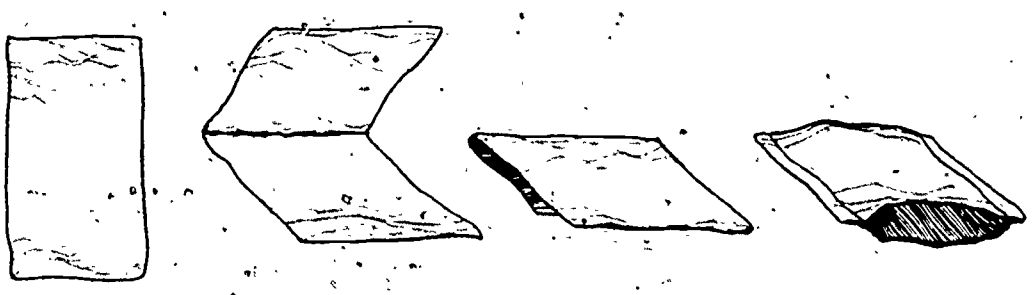
Photograph shows how aluminum foil is used to cover half of the petri dish.

Ask:

CAN WE USE OUR LIGHT METER TO SHOW THAT THERE IS LESS LIGHT IN THE HALF OF THE DISH THAT IS COVERED WITH FOIL? (No, it will not fit inside the dish.)

HOW CAN WE BE SURE THAT THE ALUMINUM FOIL IS KEEPING SOME LIGHT OUT OF THIS HALF OF THE DISH? (Have the children make suggestions.)

Take a large piece of aluminum foil and fold in half and around two open edges. This will make a bag with one open end.



Have a child take a light meter reading inside the foil bag and outside it. Say that the foil bag can be thought of as a larger model of the foil-covered half of the petri dish. The children should be able to see that it is darker under the foil. (The reason for using the light meter is to give the children a rough measure of the amount of light.)

NOW IF WE HAVE DIFFERENT AMOUNTS OF LIGHT IN OUR SETUPS, WHAT CONDITIONS MUST WE KEEP THE SAME? (The amounts of moisture and temperature.)

WILL THE MOISTURE BE THE SAME EVERYWHERE IN THE DISH? (Yes, the construction paper will be dry in both the dark and light areas.)

WILL THE TEMPERATURE BE THE SAME IN BOTH AREAS? (Let's check it and see.)

Remove the foil and the cover from the petri dish and slip the foil back over half the uncovered dish. Ask a child to take temperature readings in both the light and dark areas. (The temperature is generally found to be about the same in each half of the dish.)

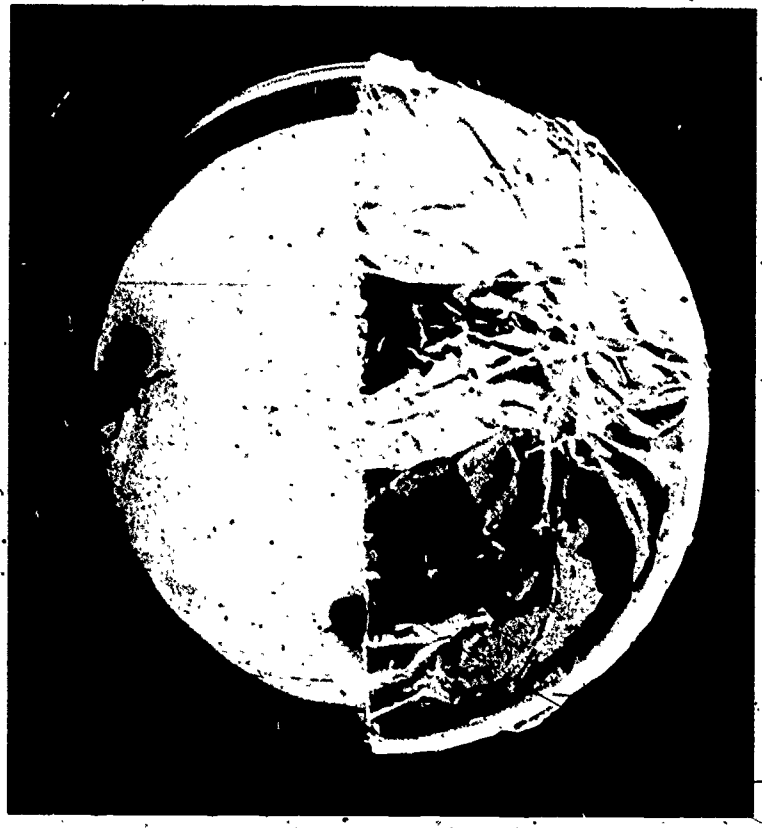
Explain to the children that, working in pairs, they are going to set up light experiments to find out how mealworm beetles react to different amounts of light. Ask all who think the beetles will go to the light area to raise their hands. Write that count on the board. Then ask all of those who think the beetles will be attracted to the dark area to raise their hands. Write that count on the board also. Finally ask for a show of hands by all children who think the beetles will be equally attracted to both areas, and write that count on the board:

Beetles will be attracted to the light area 10
to the dark area 17
to both areas 3

Quickly show the children how to draw a circle on the construction paper square around the bottom of the petri dish. Remind them to cut in from the circle a little so the paper will fit in the dish. Then show them again how to cover the dish with foil, and how they can slip the foil off when the beetles are put in.

Have one child from each pair pick up a materials tray and take it to the work area. Let the children set up their experiments and observe the responses of the beetles. Most mealworm beetles will react within 30 to 90 seconds, when given a choice between a dark or light area (they tend to go to the dark area), but you may wish to have the children set them aside for a while to make sure the beetles have time to settle down.

When mealworm beetles are given a choice between a light and a dark area, they soon choose the dark one. When you consider their natural habitat (grain storage bins, etc.), the choice of the dark area seems predictable enough.



When the class is ready to draw conclusions, write the results of the experiments on the chalkboard:

Light Area	Dark Area
II	𝍸 𝍸
	𝍸 𝍸
	𝍸 III

Then ask:

> HOW DID MOST OF THE BEETLES REACT WHEN GIVEN THE CHOICE BETWEEN A LIGHT AND A DARK AREA? (Most of them went to the dark area.)

You may want to discuss with the children the reasons why all the beetles did not go to the dark area. As in the experiments with moisture, the children should see the reasons for setting up many experiments rather than just one or two. Relate the responses of the mealworm beetles to their habitat. Elicit that mealworm beetles are not found running around on the surface of the mealworm colony, but are found under the cereal where it is darker. This could be one of the reasons why they went to the darker area of the petri dish.

Activity C

If sow bugs and earthworms are available, have the children use the same experimental equipment and procedure that they used with the beetles to find out how these other animals are affected by different amounts of light. (Both sow bugs and earthworms will be attracted to the dark areas.) In discussing the results, you might ask the children:

> COULD THE DARKNESS UNDER ROCKS, LOGS AND BOARDS BE ONE OF THE REASONS WHY SOW BUGS AND EARTHWORMS ARE ATTRACTED TO THOSE PLACES?

Activity D—

The film, Desert Community, deals with the effects of unrelenting sunlight on the plants and animals of the desert. It shows how the few day-roving animals adapt to the heat produced by the sun, and how most of the desert's inhabitants carry on their activities in the cool darkness of the night. This film also emphasizes the adaptations made by both plants and animals to the desert's lack of moisture. It is strongly recommended that you show the film, because it deals not only with the two conditions the children have already studied, but also with the effects of temperature -- a topic they will explore in the next section of the unit.

Lesson 10: EFFECTS OF LIGHT ON PLANTS

Activity A of this lesson should be conducted whenever the grass planted in Lesson 8 has reached a height somewhere between two and three inches. (This should take about six or seven days.) In this activity the children observe the effects that different amounts of light have had on the growth of their plants.

In Activity B the children provide information to bring the bulletin board up-to-date. They are also asked to note the similarities of procedure between the experiments with light and those previously done with moisture.

In Activity C you again invite and encourage the children to set up independent experiments, using the procedures they have learned to find out the effects of light on plants and animals other than those already tested.

Teaching time for this lesson should be 30 to 45 minutes.

MATERIALS

- light/plant setups from Lesson 8
- rulers
- new information sheet for bulletin board
- Living Things in Field and Classroom

PROCEDURE

Activity A

Have the children gather around the light/plant experiment. Ask one child from each pair to describe the grass in the setup placed closest to the lamp and the other to describe that in the setup placed farther away from the lamp. Ask them to tell which setup got more light and which got less, how long the grass is in each, what color it is, and how much it bent toward the lamp. Ask them to judge whether the grass is healthy-looking or not. You may want to record the results on a chalkboard chart, like this:

Results of our Light / Grass Experiment:

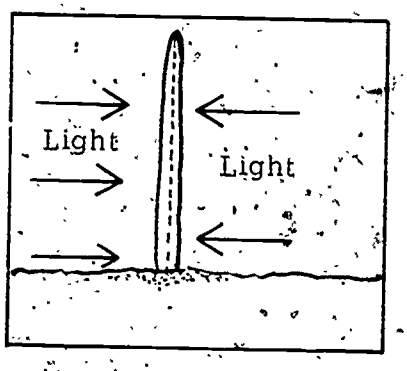
Amount of Light	Height	Color	Bent?	Healthy?
Setups completely in light	about 3"	very green	Yes, bent the most	very
Setups nearest to lamp	about 3"	very green	Yes, bent next to most	Yes
Setups about halfway from lamp	about 3"	green	yes, a little	yes
Setups farthest from lamp	about 3"	pale green	Very little	thin
Setups with no light	about 3¾"	yellow, white	Droopy	Sickly

Discuss the results with the class, asking them to come to some conclusion about the effects of different amounts of light on the growth of grass. The children should be able to see that the amount of light the plants received affected the way they grew. To have the children draw an analogy from their previous experiences, ask if anyone can remember and describe the grass they saw growing under rocks, logs and boards. Then ask if the lack of light in those places could have been one of the reasons it grew that way.

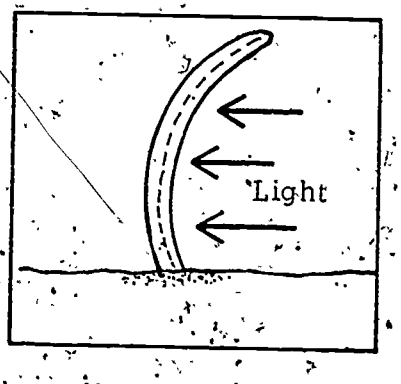
In case some child would like to know why the grass bends toward the light, we have provided you with the following information:

The bending of a plant occurs when the cells grow faster on the dark side of the plant than they do on the light side. When the light is the same on both sides, the plant grows straight, without bending.

Light the same on both sides



Light from one side only



There is a chemical substance in the cells of the plant that stimulates growth. Light interferes with the action of the chemical. Consider what would happen to a plant that does not respond by turning toward the light, but instead continues to grow straight up. Green plants need a certain amount of light. The bending of the plant results in the plant obtaining this minimum of light.

Activity B

Gather the children in front of the bulletin board and have them provide the information for the RESULT part of the light/plant information sheet. An example of the results might be stated like this:

RESULT: Different amounts of light affect the growth of grass.

With the help of the children, quickly fill out an information sheet for the light/animals experiments. The completed sheet might contain information something like this:

WHY? To find out if light affects the behavior of mealworm beetles, sow bugs, and earthworms.

HOW SET UP? All conditions the same except the amount of light. Animals given choice of light or dark area.

RESULT: Light affected all the animals. Mealworm beetles, sow bugs and earthworms were attracted to the dark area.

Pin this information sheet below "LIGHT" and "Animals".

Ask the children to discuss the similarities between the light experiments done with plants and those done with animals. Elicit these two similarities:

1. All conditions were the same, except the amount of light.

2. The amount of light did affect both the growth of plants and the behavior of animals that were studied (grass seeds, beetles, sow bugs, earthworms).

Also elicit the parallelism between the light experiments and the moisture experiments -- all conditions, except one, were the same in each case.

Activity C

Ask the children if they think different amounts of light would affect plants and animals, other than those studied, in just the same ways. Let the children speculate. Then encourage suggestions of other plants and animals they could use for similar experiments. Have a few suggestions ready, in case the children have difficulty in thinking of things to try:

1. Plant other kinds of seeds than those already used.

2. Place one of two identical plants in a dark area, and one in a light area.

3. Cover a spot of the schoolyard with cardboard.

4. Put one of two coleus plants in bright sunlight and one in the shade.

5. Darken half of the aquarium to see which half attracts the goldfish.

6. Give other animals a choice of a light or dark area.

7. Give mealworm beetles a choice among three areas (light, shady, and very dark).

When the children have selected experiments they want to do, ask how they should go about it. (They should set up their experiments as they did in class --- with all the conditions the same, except the amount of light.)

Remind the children of MINNEMAST materials they may borrow, and again say that these experiments may be done either at home or during free time in school. Ask the children to keep records like the information sheets, saying why they are doing the experiments, how they set them up, and what the results were. They might also like to record their predictions.

Save the apparatus for one light/grass and for one light/animal setup for display in Lesson 15.

SECTION 4 TEMPERATURE

In Section 2 the children set up experiments to find out if moisture affects plants and animals. Section 3 dealt with the effects of light on plants and animals. In this section the children will set up experiments to find out if temperature affects plants and animals.

Unlike the previous two sections, the lessons of this section should be taught on consecutive days. For example, on Monday teach Lesson 11 (40 to 45 minutes), on Tuesday teach Lesson 12 (60 to 70 minutes), on Wednesday teach Lesson 13 (35 to 45 minutes), and on Thursday teach Lesson 14 (30 to 40 minutes).

In Lesson 11 the children set up temperature/plant experiments. In three or four days they can draw conclusions about this experiment (Lesson 14).

In Lesson 12 the children set up an experiment to see whether temperature changes affect the breathing rate of goldfish. You will need one goldfish for every group of four children. If you have no aquarium in your room, you may be able to borrow the fish from other teachers in your school.

In Lesson 13 the children observe the effects of temperature changes on mealworm beetles.

Lesson 14 should be taught whenever the temperature/plant setups from Lesson 11 are ready for observable conclusions. Then the children should again be given the opportunity to set up independent experiments.

The four lessons of this section are closely related, and you may find it helpful to read through all four of them before starting to teach Lesson 11.

Total teaching time for this section should be about four class periods taught on four consecutive days.

Lesson 11: SETTING UP A TEMPERATURE/PLANT EXPERIMENT

In this lesson the children will set up an experiment to show the effect of different temperatures on the germination of seeds. As in previous lessons, all other conditions in the experiment are the same (light, type and number of seeds, type of soil, etc.), but the setups will be placed under a number of different temperature conditions.

The seedlings will be ready for conclusive observations in about three or four days. The results will be considered in Lesson 14. This lesson should take approximately 40 to 45 minutes.

MATERIALS

-- for each child --

- Worksheet 1 (in Student Manual)

-- for each group of four --

- tray
- 3 one-ounce containers
- quarter-teaspoon
- medicine dropper marked $1\frac{1}{2}$" from opening (squirt level)
- soil (all the same kind)
- radish seeds (all the same kind)
- water
- 3 pieces plastic wrap (3" x 3")
- 3 rubber bands
- 3 pieces aluminum foil (5" x 5")

-- for the class --

- grease pencil
- lamp with 25- to 45-watt bulb
- box, at least 3" taller than top of bulb in lamp
- 4 or 5 thermometers
- masking tape for labeling

PREPARATION

Most schools have a refrigerator somewhere in the building. Check the freezing and chill compartments to see whether there is enough room for a small tray in each. If the only refrigerator available is in the school kitchen, be sure to ask the cooks for permission to use it. Notify the custodian that you will be putting a small lamp under a box in your room and that this lamp is to be kept on day and night for three or four days.

Use a grease pencil to mark the squirt level on the medicine droppers, one and one-fourth inches from the open end. Then have some children help you arrange, on trays, the materials for each group of four.

PROCEDURE

Activity A

Have the class gather in front of the bulletin board. Quickly go through the information sheets, emphasizing the reason why separate experiments had to be set up in order to find out if different amounts of moisture and light affected the behavior of plants and animals: it was not possible to find out the effects of any one condition by studying plants or animals on the field trip or in the pieces of nature, because many conditions were affecting the plants and animals at the same time. Therefore experiments had to be set up where only one condition at a time was varied.

SO FAR WE HAVE EXPERIMENTED WITH MOISTURE AND LIGHT. HOW CAN WE FIND OUT IF DIFFERENCES IN TEMPERATURE AFFECT PLANTS AND ANIMALS? (Set up experiments, using just plants or just animals, in which every condition is kept the same except the temperature.)

WHEN WE DID OUR MOISTURE/PLANT EXPERIMENTS WE FOUND OUT THAT DIFFERENT AMOUNTS OF MOISTURE AFFECTED THE GROWTH OF RADISH PLANTS.

Review the graphs showing the results, pointing out that some of the seeds did not grow at all, while others grew very well. The amount of moisture affected the growth of the radish seeds.

WHAT WOULD WE HAVE TO DO TO FIND OUT WHAT EFFECT DIFFERENT TEMPERATURES HAVE ON THE GROWTH OF RADISH SEEDS? (Set up experiments in which radish seeds are planted under different temperature conditions.)

IF WE FIND DIFFERENCES IN HOW THE SEEDS GROW, HOW WOULD WE KNOW THAT SOMETHING ELSE -- MOISTURE, LIGHT, SOIL, ETC. -- DID NOT CAUSE THE DIFFERENCES? (We should keep all other conditions the same.)

WHAT THINGS SHOULD WE KEEP THE SAME?

List the various things on the chalkboard as the children suggest them.

Keep the same	Vary
Moisture	Temperature
Light	
Number of seeds in a container	
Kind of seeds	
Kind of soil	
Amount of soil	
Depth seeds are planted	
Type and size of container	

It is important that the children notice that the temperature is the only thing that is different from setup to setup.

Tell the children that they will be working in groups of four, and that each group will prepare three temperature/radish-seed setups. Ask them to watch carefully while you demonstrate the steps of the experiment, so that they will know how to do jobs that will be assigned later.

Bring out a tray of materials and demonstrate to the class how to set up the experiment. (The following steps are in the Student Manuals on Worksheet 1, so it is not necessary to write them on the chalkboard.)

Step 1. Put two level spoonfuls of soil in a one-ounce container. Remind the class that each group will be preparing three setups.

Step 2. Put two squirts of water into each container. One "squirt" describes water drawn up to the mark on the dropper. (You may want to remind the children how to use the dropper.) Two squirts of water should saturate the soil in the container, but there should not be any water standing on the surface. If there is, lay a piece of paper towel on the surface to draw off the excess.

Step 3. Put ten radish seeds in each setup.

Step 4. Press seeds down so their tops are level with the soil.

Step 5. Cover the container with plastic wrap and secure with a rubber band. Discuss the reason why the plastic wrap is put on the container (To keep the moisture in.)

Step 6. Wrap the container in aluminum foil. Ask the children to tell you why you did this. (To keep the amount of light in each setup the same. No matter where you put the setups, they will all be in the dark because of the foil.)

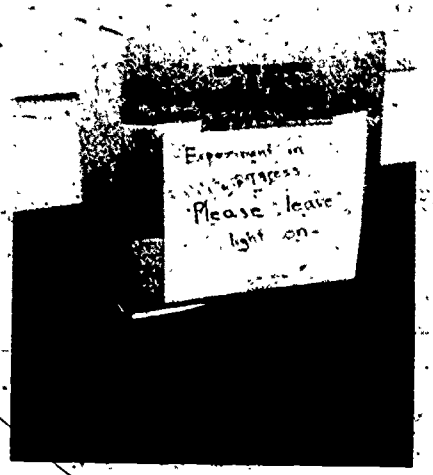
NOW THAT I HAVE MADE ALMOST EVERYTING THE SAME -- MOISTURE, LIGHT, SEEDS, ETC. -- WHAT SHOULD BE DIFFERENT? (The temperature.)

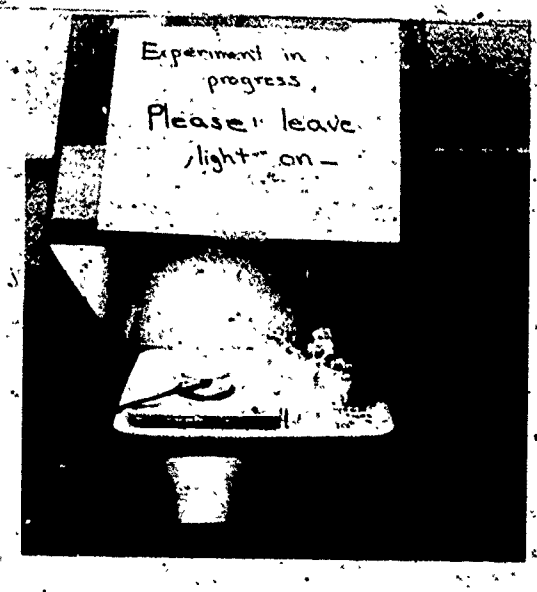
Ask the children to suggest how you can provide different temperatures for the setups. They will probably suggest putting some of the setups in the sun and others in the shade. Help the class to see that at night all setups would be in areas where there is no heat from the sun. Therefore, all would have approximately the same temperature.

Ask the children what they do at home if they want to keep something cold. Some should think of refrigerators. Ask for other suggestions of areas that would keep setups at certain, but different, temperatures for a few days. List the suggestions on the chalkboard:

Freezing compartment of refrigerator
Chilling compartment of refrigerator
Room temperature
Heated area

There are few heated areas that maintain a constant temperature, but you can make a fairly suitable one by putting a box over a lamp with a 25- to 45-watt bulb. Be sure that the box is at least 3" higher than the bulb, to avoid fire hazard. The bulb will be kept on throughout the experiment.





HOW CAN WE BE SURE THE TEMPERATURES ARE REALLY DIFFERENT IN THESE LOCATIONS? (Place a thermometer in each area and check the temperature readings daily.)

The readings can be recorded daily on a classroom chart. You may want to assign one child to do this job. He should record the temperature when he comes in the morning and before he leaves in the afternoon.

Divide the class into groups of four. Assign each child in the group a letter, A through D. Write the jobs for each child on the chalkboard. (They are also given on Worksheet 1.)

Child	Job
A	Step 1
B	Step 2
C	Steps 3 and 4
D	Step 5
A	Step 6
B	Cleans up
C	Cleans up

Have the children in each group take a tray and work in an assigned area.

When the groups have completed their setups, have them brought to a certain location. Divide the setups according to the number of locations you will be using. Keep about nine setups in the room temperature location and divide the remaining ones among the other three locations. A class of 32 children will have 8 groups and will prepare a total of 24 setups. If there are 3 locations in addition to the room temperature location, you will have enough for 5 each in the freezing, chilling and heated areas.

You will need the nine setups that were kept at room temperature for Lesson 14. These should be kept out of the sun at all times, and should be kept in one group to insure that they have uniform temperature.

Place all the setups for each temperature location on a small tray or other container. Use masking tape to label the tray and each setup with the name of the location. Put the tape label on the plastic container.

You may want to emphasize the variability of living things as the reason why you don't put just one setup in each location.

Put the trays of setups in the different temperature zones. The trays should be left undisturbed for 3 or 4 days, when there should be a noticeable difference in the germination of the radish seeds from location to location. At that time conclusions can be drawn, according to procedures described in Lesson 14.

When the temperature is established for each zone, you may want to tape a record of the reading on each tray. (The temperature in the refrigerator freezing compartment will be about -15° C or 5° F. The chill compartment temperature will be about 5° C or 41° F. Room temperature is about 25° C or 74° F, and in the inverted box with the lightbulb, the temperature may be 40° C or 104° F.)

Lesson 12: EFFECTS OF TEMPERATURE ON ANIMALS (GOLDFISH)

In Lesson 11 the children set up temperature/plant experiments to find out the effects of different temperatures on radish growth. In this lesson they will set up an experiment to observe the effects of different temperatures on the breathing rate of goldfish. The children gather data from this experiment which they convert into a bar graph. From this graph they discover the functional relation between the temperature of the water and the breathing rate of the goldfish.

It is important to follow the procedure of this lesson carefully -- not omitting any of the preparatory steps -- as trials of this lesson have shown that the children need practice in learning to count irregular rhythms (such as the breathing of the goldfish) and in counting for a specified time duration (such as 20 seconds). The children also need the step-by-step explanation of what they are going to do and why they are going to do it.

Activity A, at the bulletin board, should take from 5 to 10 minutes. Activity B, the experiment, should take from 45 to 50 minutes. Activity C, the graphing of data, should take approximately 5 to 10 minutes. Total teaching time for the entire lesson ought to be between 60 to 70 minutes.

MATERIALS

-- for the class --

- yarn, magic marker, 1 new information sheet, 1 new heading, "TEMPERATURE", and 2 new subheadings, "Plants" and "Animals", for the bulletin board
- aquarium with goldfish (1 fish for each group of 4)
- fish net
- light meter
- clock with second hand
- paper shaped like a piece of pie to cover time duration of 20 seconds on the clock, masking tape
- measuring cup

-- for each group of four --

— 1 goldfish and 1 cup of water from the aquarium in 16-ounce plastic container

— 2 ice cubes in 4-ounce container

— thermometer

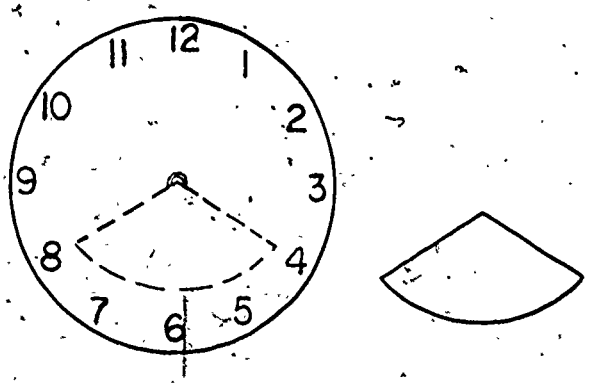
— tray

-- for each child --

— Worksheet 2 in Student Manual

— pencil

PREPARATION



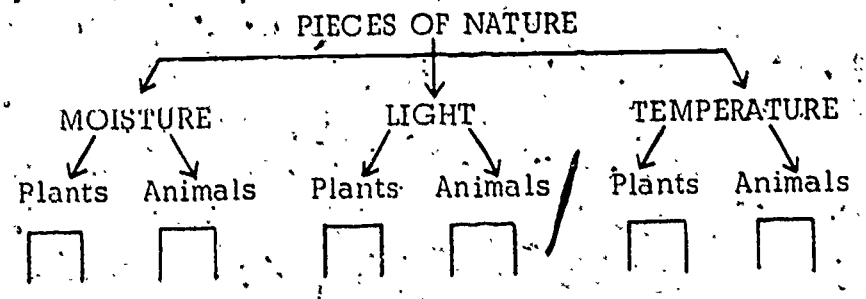
Make the new heading and two subheadings for the bulletin board, and have ready a large sheet of paper for new information, yarn, pins, etc. Then cut out a piece of red construction paper in a wedge that will cover a 20-second sweep of the clock. Since this will be taped to the clock later, a wedge covering the area between 8 and 4 (but not the numerals) at the bottom of the clock would probably be most convenient. Put loops of masking tape on one side of this wedge so that it will be ready when you need it.

Have a child help you assemble the materials for each group on trays. Be sure each 16-ounce container has only water from the aquarium (one cup) and that the fish are treated gently as they are being netted and transferred from the aquarium to the containers.

PROCEDURE

Activity A

Have the children briefly review the information on the bulletin board. Discuss with the class the reasons for setting up experiments where just moisture, or just light, affected the plants and animals. Remind the children that yesterday they set up experiments which would show only the effects of temperature on the plants. Pin the heading "TEMPERATURE" below "PIECES OF NATURE" and to the right of "LIGHT." Connect with yarn. Then pin the subheadings "Plants" and "Animals" below the heading, "TEMPERATURE." Connect these with yarn.



Review with the class the temperature/plant experiments set up in Lesson 11. Fill in the "WHY" and "HOW SET UP" spaces of the information sheet, with the help of the class:

> WHY? To find out whether different temperatures affect the growth of radish plants.
>
> HOW SET UP? All conditions the same except the temperature at the locations of various setups.

Remind the children that they will have to wait a few days to fill in the results on this information sheet. Then pin it to the bulletin board below the new subheading, "Plants."

Activity B

Take one goldfish to a demonstration table and have the children gather around it. Then ask:

> SUPPOSE WE WANTED TO FIND OUT HOW DIFFERENT TEMPERATURES AFFECT SMALL ANIMALS LIKE THIS GOLDFISH -- HOW COULD WE DO IT? (Set up experiments and observe what the goldfish does.)
>
> WHAT THINGS SHOULD WE REMEMBER TO DO IF WE WANT AN EXPERIMENT WHERE WE CAN BE SURE IT IS ONLY THE TEMPERATURE THAT IS AFFECTING THE BEHAVIOR OF THE FISH? (We will have to keep all conditions the same, except the temperature.)

List on the chalkboard the criteria suggested by the children for the fish experiment.

Keep the Same	Vary
Kind and amount of water	Temperature
Amount of light	
Type of container	
Type of fish	

HOW COULD WE PROVIDE DIFFERENT TEMPERATURES FOR THIS FISH?

The children may suggest temperature locations such as those used in the temperature/plant experiments, but remind them that they will have to observe the behavior of the fish -- something impossible to do in a refrigerator.

CAN ANYONE THINK OF A WAY WE COULD COOL THE WATER AROUND THE FISH?

By now, some child will probably suggest using an ice cube, so tell the class that the temperature of the water could be regulated by placing zero, one, and then two ice cubes in the water and measuring each change in temperature with a thermometer. They could observe the behavior of the fish in each of these conditions.

WHAT BEHAVIOR CAN WE OBSERVE?

The children may suggest the following:

(a) We could see if the fish eats differently. (Explain that the fish do not eat for long enough periods to detect any differences in behavior.)

(b) We could see if the fish swims differently in warm and in cold water. (The difficulty with this is that the fish is in a small space. It might not be possible to judge whether it was swimming in a different way from normal.)

(c) We can observe how it drinks. (Some children will say that the fish is not drinking -- it is breathing. Ask what makes them think so. Then say that if the fish were drinking all that water, it would soon expand like a balloon and burst.)

WHY DOESN'T THE FISH FILL UP AND BURST? (Because the water comes out again through the slits on the sides of its head -- its gills.)

WHAT EVIDENCE DO YOU SEE THAT THIS IS WHAT IS HAPPENING? (The gills open and close in rhythm with the drinking movements of the mouth.)

WHAT IS THE FISH REALLY DOING? (It is breathing.)

Call on a child to place his hand on his cheeks and imitate the breathing of a fish.

IF YOU WANTED TO FIND OUT HOW FAST OR HOW SLOWLY A FISH IS BREATHING, WHAT WOULD YOU COUNT? (Either the openings of the mouth or the movements of the gills.)

SUPPOSE WE COOLED THE WATER AROUND THE GOLDFISH -- HOW MANY OF YOU THINK THE FISH WOULD BREATHE FASTER? HOW MANY THINK THE FISH WOULD BREATHE MORE SLOWLY? HOW MANY THINK ITS BREATHING WOULD REMAIN THE SAME?

Record the hypotheses and the number of children who responded to each on the chalkboard:

In colder water, the fish will breathe faster. 10

In colder water, it will breathe slower. 15

Colder water will not change its breathing rate. 5

BEFORE WE CAN DO AN EXPERIMENT WHERE WE OBSERVE HOW QUICKLY OR HOW SLOWLY A FISH BREATHES, THERE ARE SOME THINGS WE HAVE TO LEARN.

Ask the children to return to their seats. Explain that you are going to give them some practice in counting your hand-claps so that they will be able to count the breaths of the fish more easily. Ask the children to pay close attention, because as soon as they can do this counting exercise well, they can start their experiments.

I AM GOING TO CLAP IN TWO DIFFERENT WAYS AND I WANT YOU TO TELL ME WHICH TIME I CLAPPED FASTER.

Clap five times with a slow, steady rhythm. Do it again at about the same speed. Ask:

WHICH TIME DID I CLAP FASTER -- THE FIRST TIME OR THE SECOND?

The children will disagree. They should perceive that this has not been a very accurate method of judging the rate of your clapping.

IS THERE ANOTHER WAY WE COULD TELL WHICH TIME I CLAP FASTER?

The children may suggest watching your hands, as well as listening. At this point, if no child brings up the idea, suggest counting the number of claps in each series.

NOW I WILL CLAP AGAIN. COUNT THE NUMBER OF CLAPS EACH TIME AND TELL ME WHICH TIME I CLAPPED FASTER.

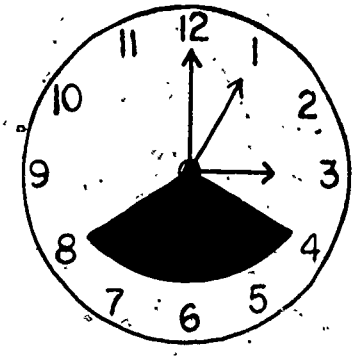
Make your first series five very slow, steady claps. Make the second series five very fast, steady claps. Ask:

HOW MANY TIMES DID I CLAP EACH TIME? (Five times.)
WHICH TIME DID I CLAP FASTER?

Probably every child will say you clapped faster the second time. Then make the statement that, since everyone said you clapped five times each time, you must have clapped at the same speed. The children will quickly disagree.

IF WE ARE GOING TO COMPARE THE SPEED OF ONE ROUND OF CLAPS WITH THE SPEED OF ANOTHER ROUND, WE WILL HAVE TO DO SOMETHING BESIDES COUNTING. WHAT SHALL WE DO?

The children should suggest the need for timing each round of claps. If they do not, ask them if the clock could be used in some way. Then tape the red paper wedge to the clock so that it covers a distance that the second hand would travel in twenty seconds. Tell the children that the second hand will be their timing device.



Then say:

WHEN THE SECOND HAND ENTERS THE RED AREA, WE WILL START COUNTING. WHEN THE SECOND HAND LEAVES THE RED AREA, WE WILL STOP COUNTING.

Write the following on the chalkboard:

Counts in 20 seconds

Trial 1: _____

Trial 2: _____

Now tell the children that, when you start clapping again, you may start before the second hand enters the red area of the clock, and you may continue to clap after it has left the red area -- but they are only to count while the second hand is in the red area.

Trial 1. Clap with a regular, slow beat. Ask the children how many times you clapped in 20 seconds. If the range is greater than 6 to 8 counts, discuss why this happened. (Some must have started counting too soon. Others may have continued counting too long.) Repeat the clapping. The range this time should be not more than four counts, with maybe one or two children very much off. Record the closest count in the space after Trial 1 on the chalkboard.

Practice in counting your claps during 20-second time periods prepares the children for more accurate counting of the breaths of the goldfish.

Trial 2. Advise the children that you may play a little trick on them this time, so they had better watch the clock very closely. Start out with a regular beat, but change to an irregular rhythm. Ask how many times you clapped. Record the range; but if it is too great, repeat the clapping. Record the final count on the chalkboard.

Counts in 20 seconds

Trial 1: 32

Trial 2: 40

IMAGINE THAT THE NUMBER OF CLAPS I RECORDED FOR TRIAL 1 ARE THE NUMBER OF TIMES A FISH BREATHED DURING TWENTY SECONDS, AND THAT THE NUMBER OF CLAPS RECORDED FOR TRIAL 2 REPRESENT THE NUMBER OF TIMES THE SAME FISH LATER BREATHED IN TWENTY SECONDS. HOW WOULD YOU DESCRIBE THE CHANGE IN THE WAY THE FISH BREATHED? (The fish's breathing changed from 32 times in 20 seconds to 40 times in 20 seconds.)

Divide the class into groups of four children and assign a work area to each group. Give each group a tray (goldfish, ice cubes, thermometer) and tell the children they will need Worksheet 2 from their Student Manuals, and pencils, to record data about the goldfish. Show them the connection between the drill they have just had in counting your claps and the breathing of the goldfish by asking:

OBSERVE HOW YOUR GOLDFISH BREATHES, AND TELL ME WHETHER IT BREATHES STEADILY -- THE WAY I CLAPPED IN TRIAL ONE -- OR WHETHER IT BREATHES SOMETIMES FASTER AND SOMETIMES SLOWER -- THE WAY I CLAPPED IN TRIAL TWO.

Discuss the need for observing the breathing of the fish very closely because the rhythm may change.

WHAT ARE WE GOING TO TRY TO FIND OUT IN THE EXPERIMENT WITH THE GOLDFISH? (Whether it breathes faster or slower as the water becomes colder.)

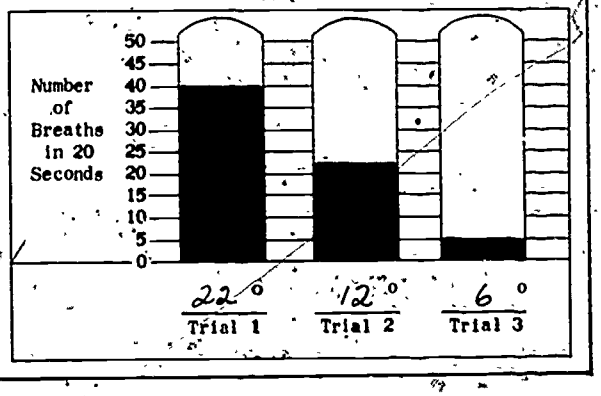
Next remind the children how to read a thermometer correctly -- at eye level.

Worksheet 2.
Unit 23 Name_____

Data

Trial	Temperature of water	Breaths in 20 seconds
1	22	40
2	12° C	23
3	6° C	5

Graph



Now ask the children to look at the upper part of Worksheet 2 and ask:

HOW MANY TRIALS ARE WE GOING TO DO? (Three.) HOW MANY ICE CUBES ARE WE GOING TO USE FOR THE FIRST TRIAL? (None.) FOR THE SECOND TRIAL? (One ice cube.) FOR THE THIRD TRIAL? (Two ice cubes.)

Tell the children that each goldfish is swimming in one cup of water from the aquarium. The kind and amount of water is the same for all the setups. Have the children compare the water levels in the containers.

Then have the children check the amount of light at each work area with the light meter. The amount of light should be about the same at each place.

Briefly describe the procedure to be used for the experiment:

Trial 1. The goldfish is in a container of water. The water is at room temperature. The temperature of the water is taken and recorded. Counters count the number of times the fish breathes in 20 seconds at this temperature. The number of breaths in 20 seconds is recorded on the worksheet. (Have everyone note the proper place for the data.)

Trial 2. One ice cube is put gently into the water with the fish. When the water gets to 12°C, the number of breathing movements the fish makes in 20 seconds is again counted and recorded.

Trial 3. Now a second ice cube is placed gently in the water with the fish. When the water gets to 6°C, the number of breathing movements the fish makes in 20 seconds is counted and recorded for a third time.

WHAT IS THE FIRST THING WE SHOULD RECORD ON OUR WORKSHEET? (Temperature of the water.)

Each group will do this. They should then carefully remove the thermometer so they can see the goldfish better.

Assign two people to be counters for Trial 1 in each group, two for Trial 2, two for Trial 3. (There may be some who count more than once.) Discuss the reason for having 2 counters at a time. (If the counts are not very close, there should be a recount.)

ARE THE COUNTERS GOING TO BE ABLE TO WATCH THE CLOCK AND, AT THE SAME TIME, COUNT THE NUMBER OF TIMES THE GOLDFISH BREATHES? (No.)

WHAT SHOULD THE OTHER PEOPLE IN THE GROUP DO? (They should watch the clock and tell the counters when to start and when to stop counting. They should speak softly so other groups will not be disturbed.)

ARE THERE ANY QUESTIONS BEFORE WE START? (Make sure everyone understands the procedure before starting, because the experiments can not be repeated. A fish will endure this experiment nicely once, but should not be used for a repeat until several weeks have passed.)

Trial 1. All the groups should complete Trial 1, making sure each one in the group records his data.

Trial 2. Trial 1 counters should be instructed to pass the goldfish carefully to Trial 2 counters. Trial 2 counters should carefully place one ice cube in the container with the fish. They should then carefully place the thermometer in the container. Instruct all groups to wait until the temperature lowers to 12°C, before they make their count. When the temperature reaches 12°C, the counters should remove the thermometer, and tell the timers they are ready. When the second hand enters the red area on the clock, the timers should tell them to start counting. Later, when the second hand leaves the red area, the timers should tell them to stop. The entire group should then record the count for Trial 2.

Trial 3. The fish is passed to the counters for Trial 3. They add a second ice cube and wait until the temperature lowers to 6°C. Then they follow the same procedure as Trial 2.

Cleaning up: One person from each group should return the fish and equipment to the teacher as soon as Trial 3 is completed. The ice should be removed quickly. Then the fish should remain in their plastic containers until the water has reached the same temperature as when the experiment was started. Then they should be put back into the aquarium.

Activity C

Have the children use Worksheet 2 to convert the data at the top to the bar graph beneath the data. The amount of help your class will need for this activity will vary. You may want to introduce this as a group activity and then have the children complete their individual graphs. (You may even want to make a transparency of the worksheet to help the children.)

When the children have completed their graphs, discuss the results. Refer to the hypotheses made earlier. Most of the groups should have found that their fish breathed slower as the water got colder. (See completed worksheet.) Collect a representative graph from each group. Display these graphs in the room. Have the children compare their group's graph with the graphs of other groups in their free time.

Lesson 13: EFFECTS OF TEMPERATURE ON ANIMALS (MEALWORM BEETLES)

In Lesson 12 the children found out that different temperatures affected the breathing rate of goldfish. In this lesson they will set up an experiment to find out how different temperatures will affect the behavior of mealworm beetles. In the experiment three beetles become immobile when placed in a cup under which there is another cup containing crushed ice. Then one beetle is removed and placed in a cup heated by a cup of water at room temperature, and another is placed in a cup heated over a cup of warmer water. The third beetle is placed in the chill part of a refrigerator to see what will happen to it there. By counting the swings of a pendulum the children measure the time duration it takes for the beetles to start moving again. The time is recorded and graphed. A functional relation between the temperature and the activity of mealworm beetles is discovered. This lesson should take from 35 to 45 minutes.

MATERIALS

- mealworm beetle colony
- one-fourth cup of salt
- crushed ice cubes
- pitcher of water at room temperature
- pitcher of water warmer than 30°C

-- for each group of four --

- 6 four-ounce plastic containers
- 3 thermometers with plastic backing cut off just above the bulb
- 12" pendulum

-- for each child --

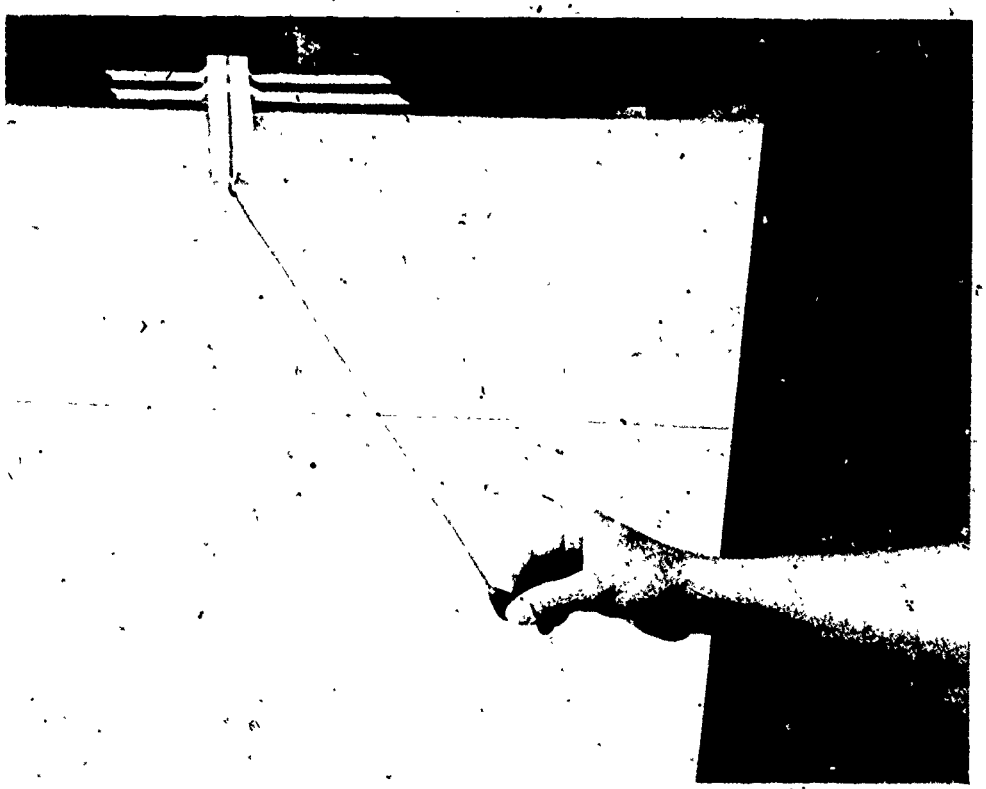
- Worksheets 3 and 4
- pencil

PREPARATION

Let a pitcher of water stand overnight so that the water will be at room temperature when you want to use it. Cut away a small part of the plastic backing on each thermometer behind the bottom part, so that the bulb extends beyond the backing. (In the experiment, the bottom of the bulb must touch the bottom of the cup in order to obtain a reading.) However, do not cut off too much or the thermometers will break too easily.

Just before the lesson, crush a tray of ice cubes. Also have on hand a pitcher of hot water.

Ask a child to assemble one pendulum for each group. The necessary materials are: tape, a ruler, a twelve-inch piece of thread, a paper clip and a nut or sinker for a bob.



Have another child put three beetles in a one-ounce cup for each group. Another child could also put about one teaspoon of salt in a one-ounce container for each group.

Assemble on trays the materials for each group.

PROCEDURE

YESTERDAY WE DID AN EXPERIMENT WITH GOLDFISH. WHAT DID WE FIND OUT FROM THAT EXPERIMENT? (That different temperatures affected the breathing rate of goldfish -- the colder the water, the slower the fish breathed.)

WHEN WE DID EXPERIMENTS WITH MOISTURE AND LIGHT, WE USED MEALWORM BEETLES AS OUR EXPERIMENTAL ANIMALS. WHAT DID WE FIND OUT FROM THOSE EXPERIMENTS? (Different amounts of light affected the beetles -- they went to the darker area. Different amounts of moisture affected the beetles -- they went to the dry area.)

WHAT COULD WE DO TO FIND OUT IF DIFFERENT TEMPERATURES AFFECT THE BEHAVIOR OF MEALWORM BEETLES? (Set up experiments where everything is the same except the temperatures and then observe the behavior of the beetles.)

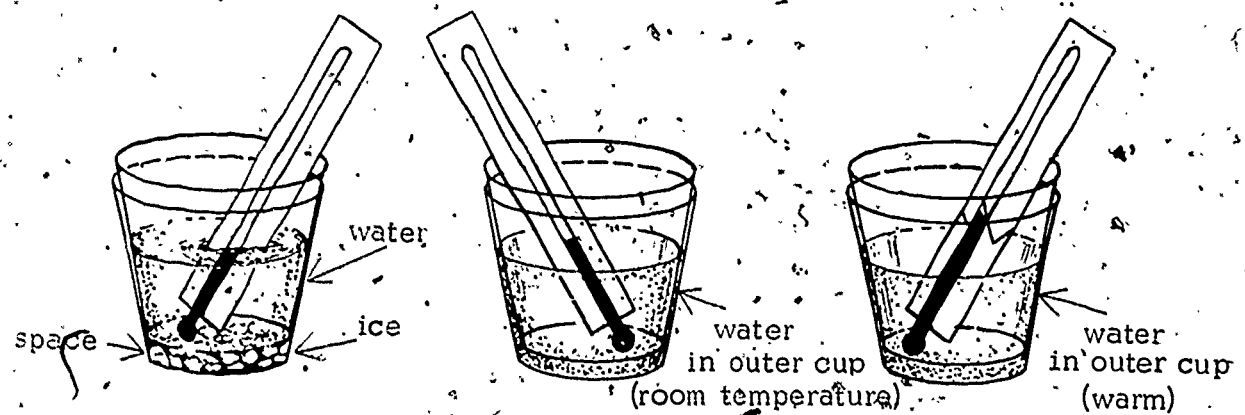
WHAT CONDITIONS SHOULD WE KEEP THE SAME, AND WHAT CONDITION SHOULD VARY? List the criteria for the experiment on the chalkboard:

Keep the same	Vary
Number of beetles	Temperature
Type of container	
Light	
Moisture	

I HAVE HERE ON THE DEMONSTRATION TABLE SOME MATERIALS THAT MIGHT MAKE IT POSSIBLE FOR US TO OBSERVE THE BEHAVIOR OF BEETLES WHEN THEY ARE EXPOSED TO DIFFERENT TEMPERATURES.

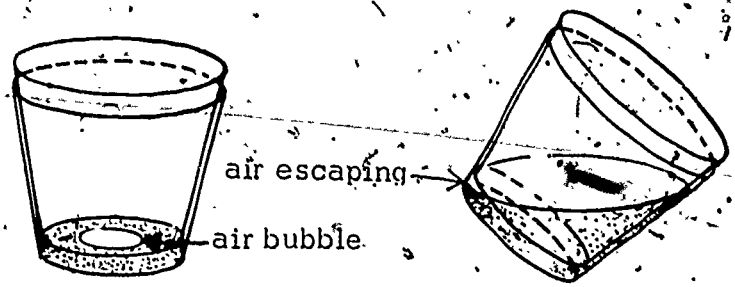
Gather the class near the demonstration table so that everyone can see clearly. Assemble a cup apparatus in front of the class.

Use water at room temperature. (See diagrams and instructions below.) Let the children identify what they see. (Two containers, one inside the other, water in the lower cup, and a thermometer in the upper one.)



The plastic cups are assembled as shown above. Note that when one cup is placed in another, there is a space between the bottoms of the two cups. This space can accommodate water at different temperatures. The inside of the upper cup remains dry and can accommodate a thermometer and a beetle. The thermometer shows the temperature of the bottom of the upper cup where the beetle is placed.

Note that all air must be allowed to escape from the space between the cups. When water is placed in the space formed between the upper and lower cups, an air bubble usually is seen. This bubble can interfere with the passage of cold from the water in the space to the bottom of the upper cup. By picking up both cups and tilting them, the air bubble can be made to escape. This should be done before the apparatus is used.



Elicit from the class where the beetle might be placed, how the temperature in the upper cup could be changed, and how the temperature in the upper cup can be measured.

Briefly discuss with the class this common phenomenon: on a warm day in late fall or early spring, insects appear -- flying, crawling, jumping. When the days get cold, they disappear. Also, on cold spring mornings, insects appear sluggish. By noontime they become quite active. Could temperature have something to do with this?

Transfer some beetles into the upper cup.

WHAT IS THE TEMPERATURE OF THE BOTTOM OF THE UPPER DISH WHERE THE BEETLES ARE?

Have a child read the thermometer and report.

WHAT DO YOU SEE THE BEETLES DOING? (Moving around.) I AM NOW GOING TO LOWER THE TEMPERATURE IN THE UPPER CUP.

Remove the upper dish, place ice water and salt in the bottom dish and replace the upper dish. Ask one child to call out the fall in temperature while the class observes the beetles becoming immobile.

ARE THE BEETLES DEAD OR JUST SLEEPING? HOW CAN WE FIND OUT?

Children will say that the temperature should be raised or the beetles should be put in a warm place to see if they will move again.

Now take out a second assemblage, with water at room temperature in the lower cup. You now have two on the table. Call on a child to read the thermometer in the second assemblage and report to the class. (It should read approximately room temperature.) Have a child calculate on the chalkboard the difference in temperatures of the two upper cups. Transfer half the beetles from the first apparatus into the second cup. The children will see the beetles become active again.

Bring out a third assemblage and have its thermometer register more than thirty degrees by using warm water. Then pose this problem:

IF WE HAD THREE SLEEPING BEETLES IN A CUP AND WE TRANSFERRED ONE TO ROOM TEMPERATURE AND ONE TO HIGHER THAN ROOM TEMPERATURE, WHICH WOULD WAKE UP FIRST? HOW MANY WOULD LIKE TO DO THIS EXPERIMENT?

Divide the class into groups of four. Assign a letter (A, B, C, D) to the children in each group. Assign responsibilities to members of the groups as follows:

Child A This child is in charge of the cold setup. He will get water and crushed ice for the ice water and salt mixture in the lower cup. When the upper cup temperature falls to 10° C, A will put the three beetles in his upper cup. He should record the temperature on his worksheet.

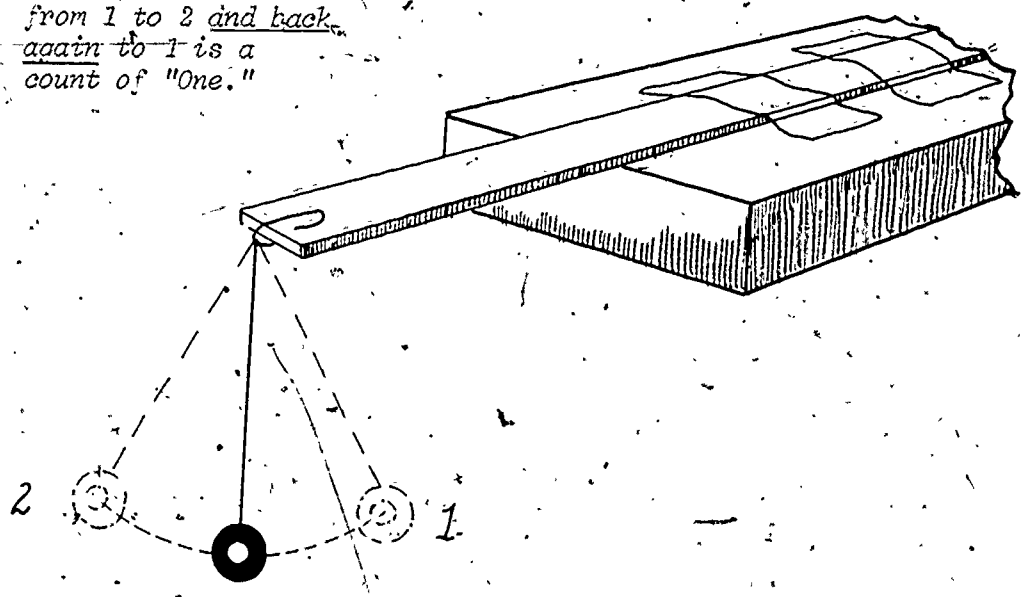
Child B This child is in charge of the setup at room temperature. He will put the water in the lower cup of his apparatus. He will read the upper cup's temperature and record it before the beetle is put in.

Child C This child is in charge of the warm water setup. He will put warm water in his lower cup, read the temperature in the upper cup, and record it before a beetle is put in.

Child D This child is the timekeeper. He will tape the pendulum ruler to a desk (see diagram on next page) so the bob can swing freely.

He brings the bob up to position #1 (not too high up) and lets the bob go. Then he says, "Ready." When the bob returns all the way to position #1 he calls out, "Set." On the second return to position #1 he says, "Go."

A swing of the bob from 1 to 2 and back again to 1 is a count of "One."



When child A hears "Go," he slides a "sleeping" beetle from his cup into each of the other two cups with a pencil. Child D continues to call out the returns of the pendulum bob, counting ONE, TWO, THREE, etc. A, B, and C watch their beetles. When an observer sees his beetle awaken, he records the count of the pendulum he hears. (See Worksheet 3.)

Have the children of each group take their materials tray to their assigned work area and perform the experiment. When the children have completed their experiment, they should complete Worksheet 3 with the appropriate data from their team members. These data should then be graphed on Worksheet 4.

Worksheet 3
Unit 23

Name_____

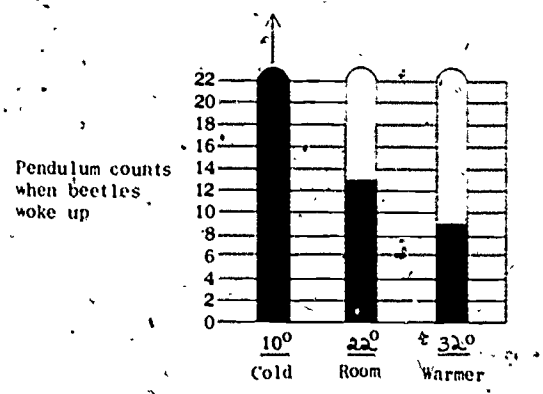
Temperature Data for Mealworm Beetle Experiment

	Temperature of upper cup	Pendulum count when beetles woke up
Child A Setup with crushed ice and salt	10° C	22+
Child B Setup with water at room temperature	22	13
Child C Setup with water warmer than room temperature	32	9

Worksheet 4
Unit 23

Name _____

Graph of Data from the Temperature and Beetle Experiment



Note: On this graph there is an arrow extended above the 10° bar graph beyond 22 counts. If the temperature in the lower cup could be kept at 10°C, the beetle would not wake up. This is why we did not extend the graph farther up. If the ice melts in the lower cup, the temperature will rise above 10°C and the beetles will awaken.

Some children may now wish to place a few beetles in the chill compartment of a refrigerator to see if they will remain immobile or if they will waken.

Have the groups discuss and compare results. (In most cases, warm water will revive the beetles faster.)

RESULT: Different temperatures do affect the behavior of mealworm beetles.

Lesson 14: EFFECTS OF TEMPERATURE ON PLANTS AND ANIMALS

This lesson completes the work begun in Lesson 11 on the temperature/radish seed experiments. It should be taught as soon as there is a noticeable difference between the radish setups at room temperature and the setups in other temperature locations. This should be on the fourth day after planting.

In Activity A the radish seedlings that were grown at room temperature are used to find out whether or not different temperatures will affect growth, once the plants have started growing. It will take a few days for results to be observed.

In Activity B the children provide information for bringing the bulletin board up-to-date.

Activity C provides still another opportunity for the children to set up experiments of their own, in which to test responses by plants and animals other than those already used in class experiments.

Teaching time for this lesson should be about 30 to 40 minutes.

MATERIALS

- temperature/radish seed setups from Lesson 11
- 2 new information sheets for the bulletin board
- the same 4 temperature locations used in Lesson 11
- Living Things in Field and Classroom

PROCEDURE

Activity A

Have four children get the trays of radish seed setups from the various temperature locations. Place these trays on a demonstration table around which the children can gather.

Ask four children to remove the foil covering from the radish setups carefully. While they are doing this, discuss with the class the reason for the foil covering (to keep the amount of light the same from setup to setup).

One by one, have children remove the plastic covers and show the setups from each location. As the children comment on their observations of the setups, write the results of the setups from each of the temperature locations on the chalkboard in the form of a chart. A completed chart may look like the following:

Location	Results
Freezer ($-15^{\circ}C$)	Seeds did not germinate
Chill ($5^{\circ}C$)	Seeds did not germinate
Room ($25^{\circ}C$)	Seeds germinated and grew
Heated ($40^{\circ}C$)	Seeds did not germinate

The class should come to the general conclusion that different temperatures affect the sprouting (germination) of radish seeds.

Discuss with the children what the importance is of these effects of temperature on the sprouting of radish seeds. For example, why wouldn't it be good for radish seeds to start growing under a snow bank in the winter? Would it be good for a radish plant to start growing in the middle of July when it's very hot? Why not?

In the course of this discussion, a natural question to be raised is the following:

> WE FOUND THAT DIFFERENT TEMPERATURES AFFECTED THE SPROUTING OF RADISH SEEDS, BUT DO WE KNOW WHETHER OR NOT DIFFERENT TEMPERATURES WILL AFFECT THE RADISH SEEDLINGS, ONCE THEY HAVE STARTED GROWING? (No.) HOW COULD WE USE THESE RADISH SEEDLINGS TO FIND OUT? (Put some of the setups in each of the locations we used before.)

Divide the setups as evenly as possible among the four areas. In the first experiment there were nine setups at room temperature which would be about two setups for each location. Have the children wrap the setups as before and place them on trays in the proper locations.

Ask the children to predict what will happen to the radish seedlings in the various locations. You may wish to record the predictions so the children can refer to them when the experiment is ready for observation.

After two or three days have the class observe setups. The extremely cold and very hot temperatures will probably retard the growth of the seedlings. Discuss the implications of this experiment with the class.

Activity B

Have the children gather in front of the bulletin board and provide answers for the information sheet for "Plants" under the heading, "TEMPERATURE." Example:

> WHY? To find out if different temperatures affect the germination of radish seeds.
>
> HOW SET UP? All conditions the same except the temperature locations of various setups.
>
> RESULT: Different temperatures affect the germination of radish seeds.

Then, with the help of the class, complete an information sheet for "Animals" under the heading, "TEMPERATURE." Example:

> WHY? To find out if different temperatures affect the behavior of goldfish and of mealworm beetles.
>
> HOW SET UP? All conditions were the same, except the temperature. We counted the fish's breathing for 20 seconds at 3 different temperatures. We cooled beetles until they were immobile, then found out at which temperature they woke up most quickly.
>
> RESULT: Temperature differences affected the behavior of goldfish and mealworm beetles.

Pin these information sheets in the proper places on the bulletin board.

Discuss with the class the similarities between the methods used in the temperature experiments with the plants and animals:

1. All conditions were the same except the temperature.
2. Different temperatures did affect the behavior of the plants and animals tested.

Also discuss the similarities between the moisture, light and temperature experiments--all the conditions were the same, except one.

Activity C

Ask the children:

DO YOU THINK DIFFERENT TEMPERATURES WOULD AFFECT OTHER PLANTS AND ANIMALS? WOULD THEY BE AFFECTED IN THE SAME WAY AS OUR TEST ANIMALS? (Let the children discuss this.)

Encourage questions that could be answered through experiments:

1. Would all seeds respond to different temperature locations exactly the way the radish seeds did?
2. What would happen to a plant that had been in a cooled or heated area for several days if it were placed at room temperature again?
3. Is room temperature the best temperature for plant growth? What about a temperature location just 5°, 10°, or 15° higher or lower than room temperature?
4. Would the responses of other small animals to various temperatures be the same as those of our test animals?
5. Will low temperature retard mealworm larvae from developing into beetles?

(Living Things in Field and Classroom provides ideas about other plants and animals that could be tested.)

HOW SHOULD WE SET UP EXPERIMENTS TO FIND OUT IF DIFFERENT TEMPERATURES AFFECT OTHER PLANTS AND ANIMALS? (Set up experiments as we did in class, with all the conditions the same, except the temperatures.)

HOW MANY OF YOU WOULD LIKE TO SET UP SOME OF THESE EXPERIMENTS ON YOUR OWN?

As in Lessons 7 and 10, tell the children that they may work on these projects at home or during their free time at school. Encourage the children to use any of the MINNEMAST materials they need and have them report to the class from time to time about their projects. Such individual projects should be encouraged and continued throughout the remainder of the unit.

This picture shows the results of one child's independent experiment on the effects of temperature on the growth of grass after germination.

SECTION 5 REVIEW AND NEW APPLICATIONS OF OUR LEARNINGS

This section consists of only two lessons. Lesson 15 is a discussion lesson reviewing all that the children have learned in the first fourteen lessons. The bulletin board that you have been developing with the children is used as a means of showing them how it was necessary to keep narrowing down their investigations so that they could do experiments that tested the effects of just one condition at a time. A flow chart -- even simpler than the bulletin board -- reemphasizes how the narrowing down process came about. A display of experimental setups that the children have used helps them remember what they have done, and how and why they have done it. Then the children are asked to apply what they know to new, hypothetical problems. For example, if the children needed to know the effect of moisture on rats, what system would they devise to solve the problem? What techniques would they use? What would they carefully control? How would they simplify the experiment -- narrow it down -- so that just the effects of the one condition could be considered? This lesson should take between 35 and 45 minutes.

Lesson 16 consists of a number of worksheets picturing the kinds of conditions the children have been studying in this unit. By the way they perform the various tasks of selecting which conditions best suit various plants and animals, you are able to evaluate how much the children have learned about the effects of moisture, light and temperature on living things. This lesson should take from 40 to 50 minutes.

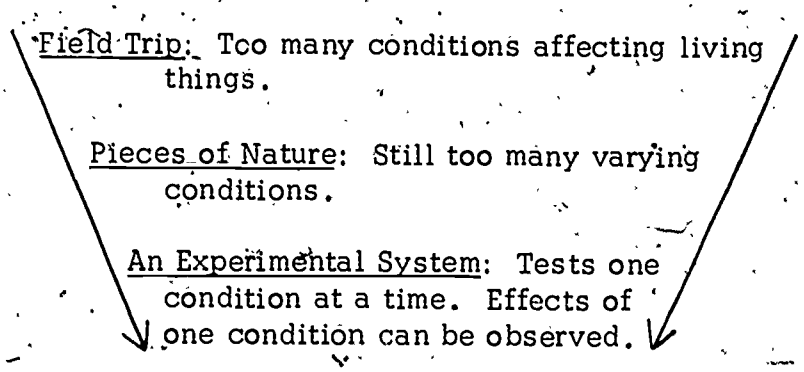
LESSON 15: HOW WE DEVELOPED OUR EXPERIMENTAL SYSTEMS

This lesson briefly summarizes and generalizes the methods and results involved in the experiments that the children have performed in this unit. It should take from 35 to 45 minutes to teach. A display of some of the experimental setups used in the moisture, light and temperature experiments should be available for reference throughout the lesson.

In this lesson the children should become aware that every setup for an experiment is a system that enables the experimenter to control the conditions in the system. The children should learn that each system was designed to answer one question, and that in each case the system simulated and simplified conditions found in the natural environment.

The bulletin board used throughout the unit illustrates how the various systems were developed. This development can also be represented by a flow chart that demonstrates the necessity of narrowing down the experimental environment and simplifying the apparatus, until the system used is effective in isolating the effects of only one condition.

CHART DEMONSTRATING THE NARROWING DOWN PROCESS



This narrowing down process, a basic principle in developing a test system, is discussed in terms of examples. It is essential to the development of the systems thread in the MINNEMAST curriculum that the children see the advantage of this narrowing down process in developing a system that answers a question. Units containing the systems thread are:

Unit 15, Investigating Systems
Unit 19, Comparing Changes
Unit 23, Conditions Affecting Life
Unit 24, Change and Calculations
Unit 29, Natural Systems

Throughout the discussion of this lesson, you will be able to evaluate what the children have learned about scientific methods.

MATERIALS

- moisture/plant setup from Lesson 5
- moisture/beetle setup from Lesson 6
- light/grass setup from Lesson 8
- temperature/plant setup from Lesson 11 or temperature/animal setup from Lesson 13
- other experimental setups, including your demonstration piece of nature, if available

PROCEDURE

Have on display some of the experimental setups the children have used in this unit. Ask the children to gather in front of the bulletin board so that you can refer to it whenever it is pertinent to the discussion.

Start by asking the children why they took the field trip at the beginning of this unit. (To find out if light, moisture and temperature affect living things.)

DID THE FIELD TRIP ANSWER OUR QUESTION? (No.) WHY NOT? (There were too many variables affecting the living things. We couldn't isolate the effect of any single condition.)

THEN WHAT DID WE DO TO TRY TO ANSWER OUR QUESTION? (We set up models of a piece of nature.)

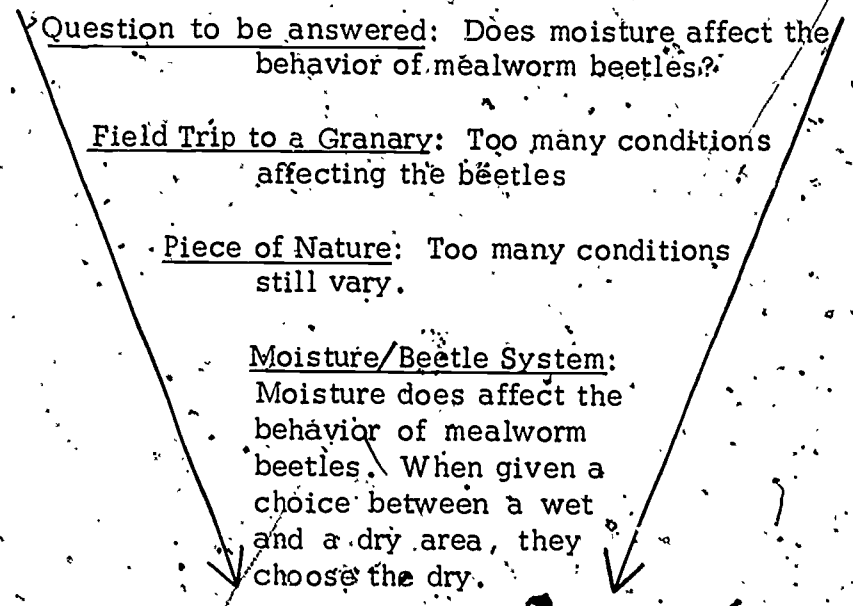
DID OUR PIECES OF NATURE ANSWER OUR QUESTION? (No.) WHY NOT? (There were still too many varying conditions.)

HOW DID WE EVENTUALLY ANSWER OUR QUESTION ABOUT WHETHER MOISTURE, LIGHT AND TEMPERATURE AFFECT LIVING THINGS? (We set up experiments that would find out whether just moisture, or just light, or just temperature affected a certain plant or animal. We kept everything the same except the amount of moisture, the amount of light, or the temperature.)

THESE EXPERIMENTAL SETUPS CAN BE THOUGHT OF AS SYSTEMS.

Have someone show the class the moisture/beetle setup and tell how it was used to answer the question of whether moisture affected the behavior of mealworm beetles. Tell the class that this moisture/beetle setup can be thought of as a system. To clarify this, discuss the narrowing down process involved in arriving at an answer to the question of whether moisture affects the behavior of mealworm beetles.

With the help of the children, draw the following flow chart on the chalkboard, as the discussion progresses:



The children should see the similarity between the flow chart and the "Conditions Affecting Life" bulletin board -- that it was necessary to narrow down the conditions affecting living things until there was just one condition that varied or had an observable effect.

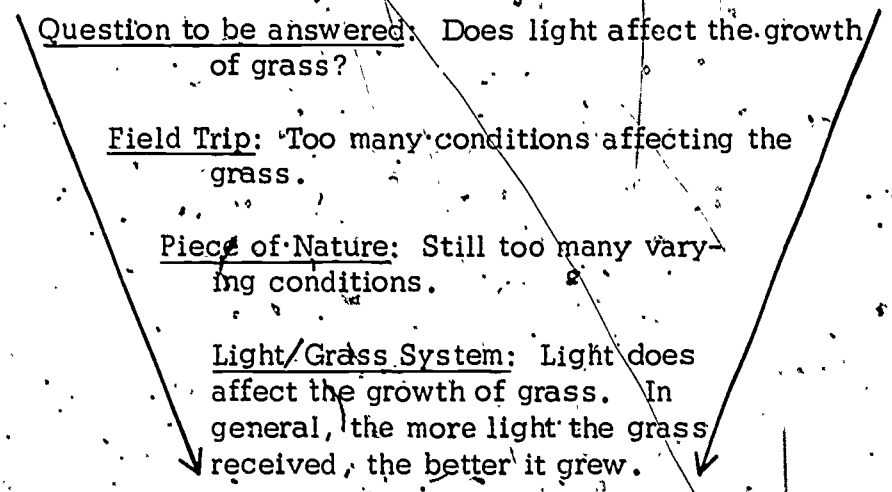
WHY COULDN'T WE HAVE ANSWERED OUR QUESTION BY GOING ON A FIELD TRIP TO OBSERVE THE MEALWORM BEETLES IN THEIR NATURAL SURROUNDINGS, SUCH AS A GRAIN STORAGE AREA? (Too many conditions would be affecting the beetles at the same time.)

COULD WE HAVE ANSWERED OUR QUESTION BY TAKING A PIECE OF THESE SURROUNDINGS, WHERE THE MEALWORMS WERE FOUND, INTO THE CLASSROOM? (No, too many conditions would still be affecting the beetles at once.)

Hold up the moisture/beetle setup.

FINALLY WE SET UP A SYSTEM WHERE JUST MOISTURE WAS VARIED. WITH THIS SYSTEM WE WERE FINALLY ABLE TO ANSWER OUR QUESTION. WE FOUND THAT MOISTURE DOES AFFECT THE BEHAVIOR OF MEALWORM BEETLES.

Have another child show the class the setup used in the light/grass experiment and tell how it was used to answer the question, "Does light affect the growth of grass seedlings?" Again, this setup can be thought of as a system. Discuss the narrowing down process involved in arriving at an answer to the question, following a procedure similar to the one used in the moisture/plant discussion. A flow chart for the light/grass question may look like the following:



Again it was necessary to narrow down the conditions affecting life until only one condition varied and an effect was observable.

If you feel your class is still having difficulty with the narrowing down process used in developing a system, go through the process with some of the other systems used in the unit.

Activity B

In this activity the class transfers the narrowing down process to a discussion of the development of systems in new situations. Tell the children that they are going to be thinking of ways to develop some systems, but first they must have a question to be answered. Suggest the following hypothetical situation:

EVERY YEAR RATS CAUSE GREAT AMOUNTS OF DAMAGE. IMAGINE THAT THE GOVERNMENT HAS ASKED YOU TO LEARN MORE ABOUT THE BEHAVIOR OF RATS. GOVERNMENT OFFICIALS COULD THEN FIGURE OUT A WAY TO GET RID OF ALL THE RATS IN THE COUNTRY.

WE COULD START BY ASKING THE QUESTION: HOW DO RATS BEHAVE?

Discuss with the children the problems that may arise if they start with such a broad question. They should see that their questions should be simplified so they can concentrate (experiment) on one condition at a time. A simpler question would be:

DOES MOISTURE AFFECT THE BEHAVIOR OF RATS? HOW COULD WE ANSWER THIS QUESTION? WE COULD GO AROUND THE WORLD OBSERVING THE BEHAVIOR OF RATS IN DRY AREAS, WET AREAS, ETC. WOULD THIS BE A GOOD IDEA? WHY OR WHY NOT? (Too many other things may be affecting the rats' behavior.)

The children should see that to find out what effect moisture alone has, it is necessary to narrow down the number of variables affecting the behavior of rats. It would then be possible to set up a system that would answer the question. You may want to discuss with the children how this system could be set up.

Following is a list of other possible examples that you can discuss with the class in the same manner. In each case the children should see that it is necessary to narrow down the experimental surroundings until they develop a system that is effective in isolating the effect of only one variable.

1. Does the color red make bulls angry?
2. Does the length of a burning candle depend on how long it was burning?
3. Does the amount of salt in the water affect the behavior of guppies?
4. Do different kinds of soil affect growth of dandelions?

Lesson 16: APPLYING OUR LEARNINGS

In this lesson the children are given an opportunity to apply to pictures of natural situations the things they have learned about the effects of light, temperature and moisture on living things. The worksheets are made up of pictures and discussion questions that should prove very enjoyable to the children. You can use the worksheets in several different ways, according to the needs and abilities of your students. Some are best suited to class discussions, some to independent work, and all should be useful in evaluating how well the children have understood the concepts taught in the unit.

You may wish to have the children do the worksheets in connection with their social studies. Teaching time should be from 40 to 50 minutes.

MATERIALS

- Worksheets 5 through 11
- pencils, crayons, scissors and paste
- world globe (optional)

PROCEDURE

The procedure is given worksheet by worksheet, rather than by separate activities. Feel free to use the worksheets in ways other than those suggested.

Worksheets 5a and 5b

Call on the children to describe what they see on Worksheet 5a. (Woods, open field, sunny and shady areas, plants, etc.) Then have them look at the pictures of specific living things at the bottom of the worksheet. Ask them to find each of these things in the top picture and mark it with the appropriate letter. When they have done this, say that a freeway is soon going to be built through this area.

Have the children look at Worksheet 5b. Say that a boy named Tom lives in this house. Tom's mother has told him that he can go to the area shown on 5a before the bulldozers arrive,

and bring back as many of the living things as he wishes, to put in the yard. Have the children discuss what differences they notice between various parts of the yard. (Some areas are sunny and some are shady.) Ask the children to think about what place in the yard would be best for each living thing. Then ask them to cut out each item from the bottom of Worksheet 5a and paste it in the picture of the yard in whatever place they think most appropriate. You may wish to give the children a choice between cutting and pasting, marking with appropriate letters, or drawing their own pictures. Finally, ask each child to explain, on the blank provided on Worksheet 5b, how he made his decisions. (By the condition of the light.)

Worksheet 6

This picture emphasizes the difference in the conditions of moisture in the environment. The star and triangle indicate the most obviously dry and wet areas, but there are other areas along the shore that would be moist and suitable for such things as cattails and frogs. Have the children indicate where each living thing shown at the bottom of the page would live. To do this, they may use either letters or drawings.

Worksheet 7

This worksheet is concerned with different amounts of moisture. In a prairie, trees will grow along the banks of a river, but away from it there is usually only enough moisture to maintain grass and other small plants. This distinction that some plants require more moisture than others was not made in previous lessons, but let the children try to arrive at their own answers from their experiences or from deduction. When they figure out that there should be a river in the picture, have them draw it in with blue crayon.

Worksheet 8

Have the children study the picture and identify the polar bears, the mountains, the iceberg and the open water. They should then try to answer the questions. The picture shows an arctic scene in the northern hemisphere. (Polar bears are not found in the southern arctic.) Since light and moisture

are in good supply, the children should be able to deduce that the temperature does not support the growth of bushes or trees. There is no indication in the picture of food for the bears, but the children may be able to guess that there is food (fish) for them in the water.

Worksheet 9

Have the children identify such things as sand dunes, date palm trees, camels, and the irrigated field. Some children may be familiar with scenes of the Sahara or some other desert, and they could point these out on the globe. The condition of special interest in this desert scene is moisture. The trees grow in the small area shown in the picture because that is where the water supply is. The children might enjoy speculating on ways to get water from an oasis to the irrigated field.

Worksheets 10a and 10b

The cross-section of a pond shows the effects of different amounts of light on plants and animals. It should be easy for the children to see that moisture conditions are uniform in the pond, but see if any of them notice that there is less light at the deepest part of the pond, even though there are no lily-pads above this part. See if any child notices that the smallest plants toward the center of the pond are of the same variety as the taller ones. Ask the children why the plants growing nearer the surface are larger. (These plants receive more light.) Have the children do the tasks pertaining to Worksheet 10a on 10b.

Worksheet 11

On this worksheet the children should draw their own pictures of a jungle -- a hot, moist place. They should feel free to put in any people, plants or animals they think might live in the jungle.

Conclude the lesson with a discussion leading to the generalized statement that different areas contain different kinds of plants and animals because the conditions vary from one area to another.

Worksheet 5a
Unit 23

Name _____

Find these living things in the picture of the woods.

Write the correct letter on each one you find.

A. ferns 

B. salamander 

C. daisies

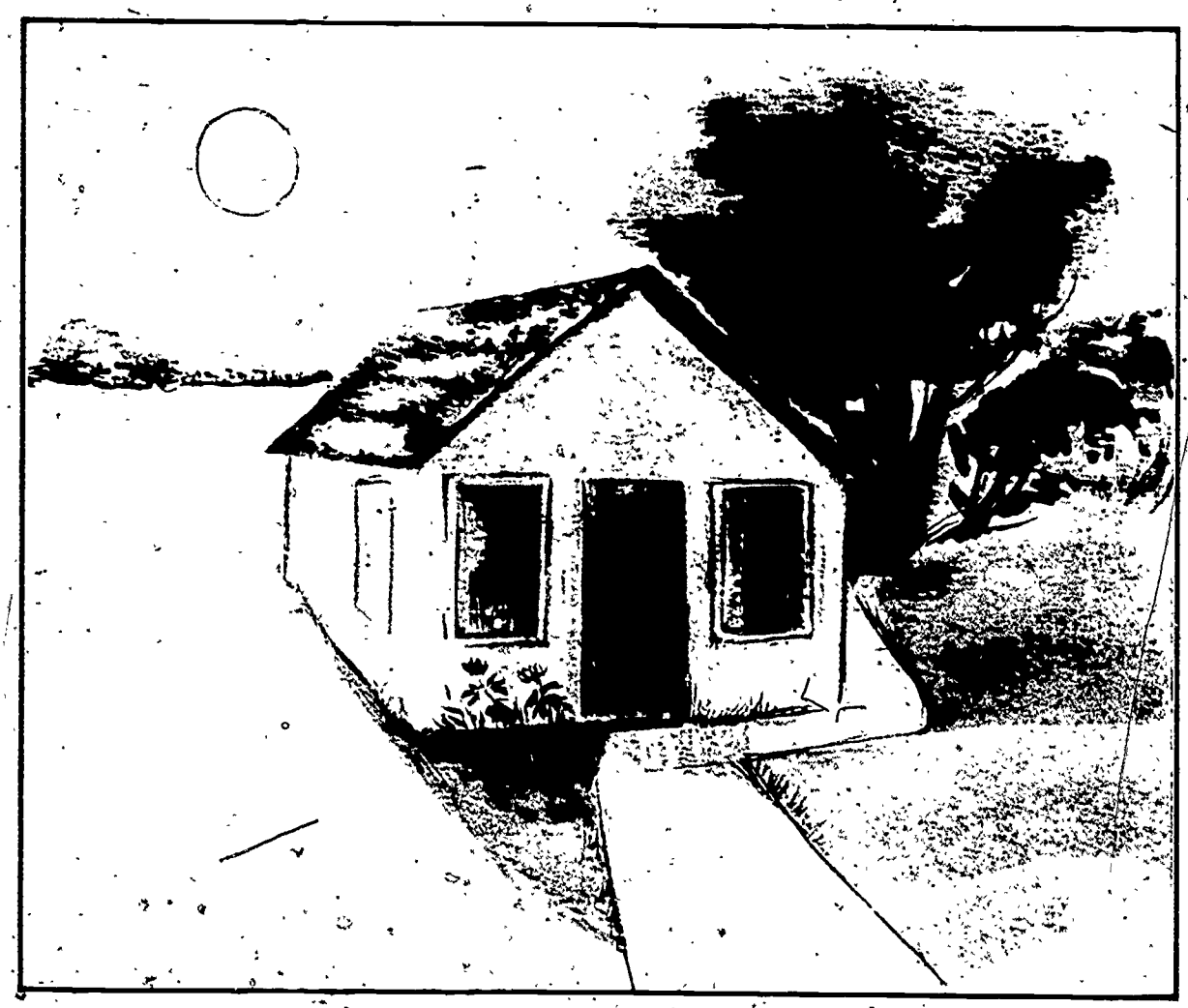
D. jack-in-the-pulpit 

E. ants in an anthill 

F. strawberry plant 

Worksheet 5b
Unit 23

Name _____



Find the place in the yard you think is best for each living thing in the woods.

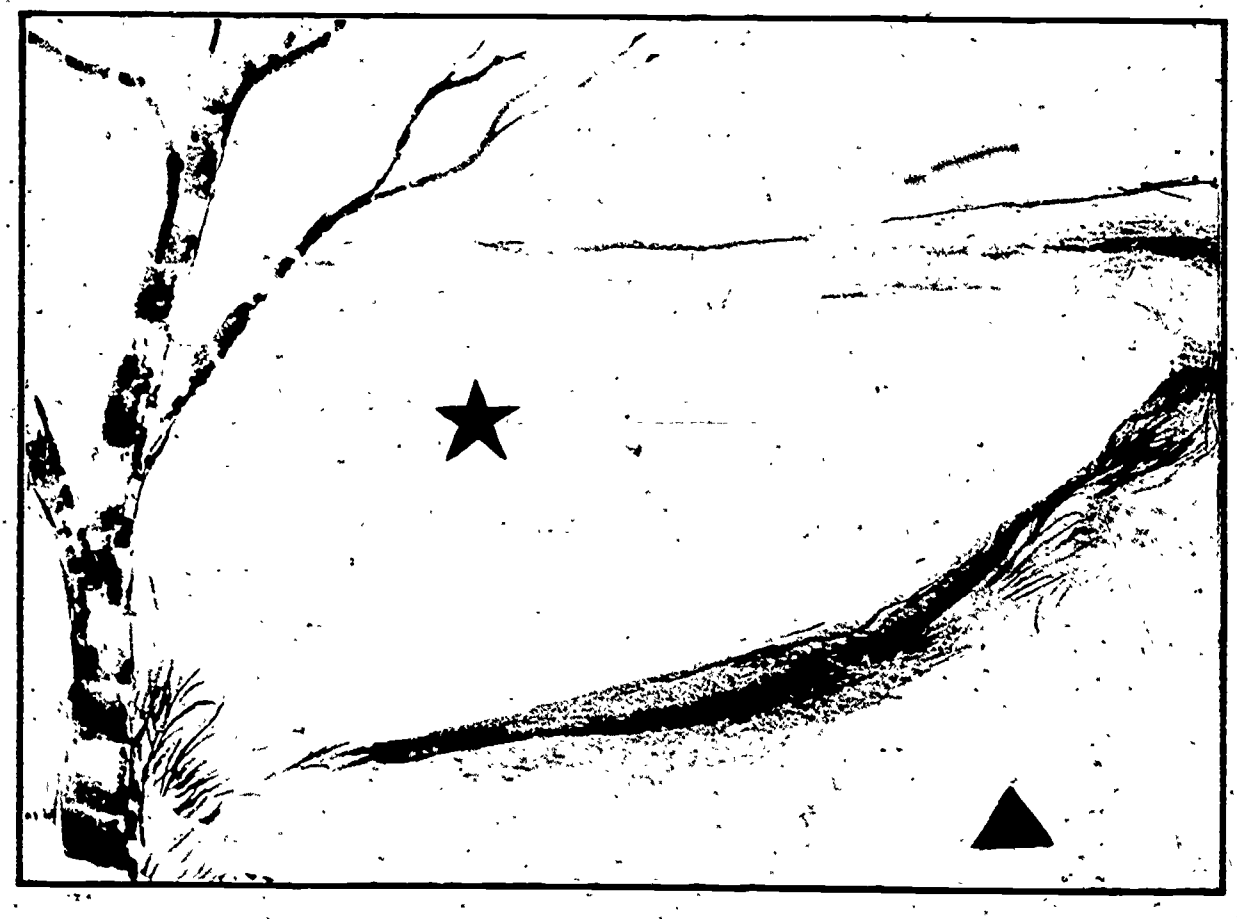
Show where you think each thing should go.

Why did you choose the places you did?

Because of the light or some things live best in the light and some in the shade.

Worksheet 6
Unit 23

Name _____



Locate the star and the triangle in the picture.

What differences in conditions do you think there are between the two locations?

Some places are wetter than others.

Show in the picture where you think these living things would live best:

A. frog 

B. fish 

C. clover 

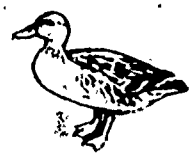
D. clam 

E. squirrel 

F. robin 

G. cattail 

H. earthworm 

I. duck 

Worksheet 7
Unit 23

Name _____

Ben has climbed a lookout tower in South Dakota.
He sees both grass and trees.
Are the trees growing everywhere? No.
There must be a reason why trees are growing in some places. What do you think the reason is?
Water
Was something left out of the picture? Yes, a river.
Use crayons to complete the picture.

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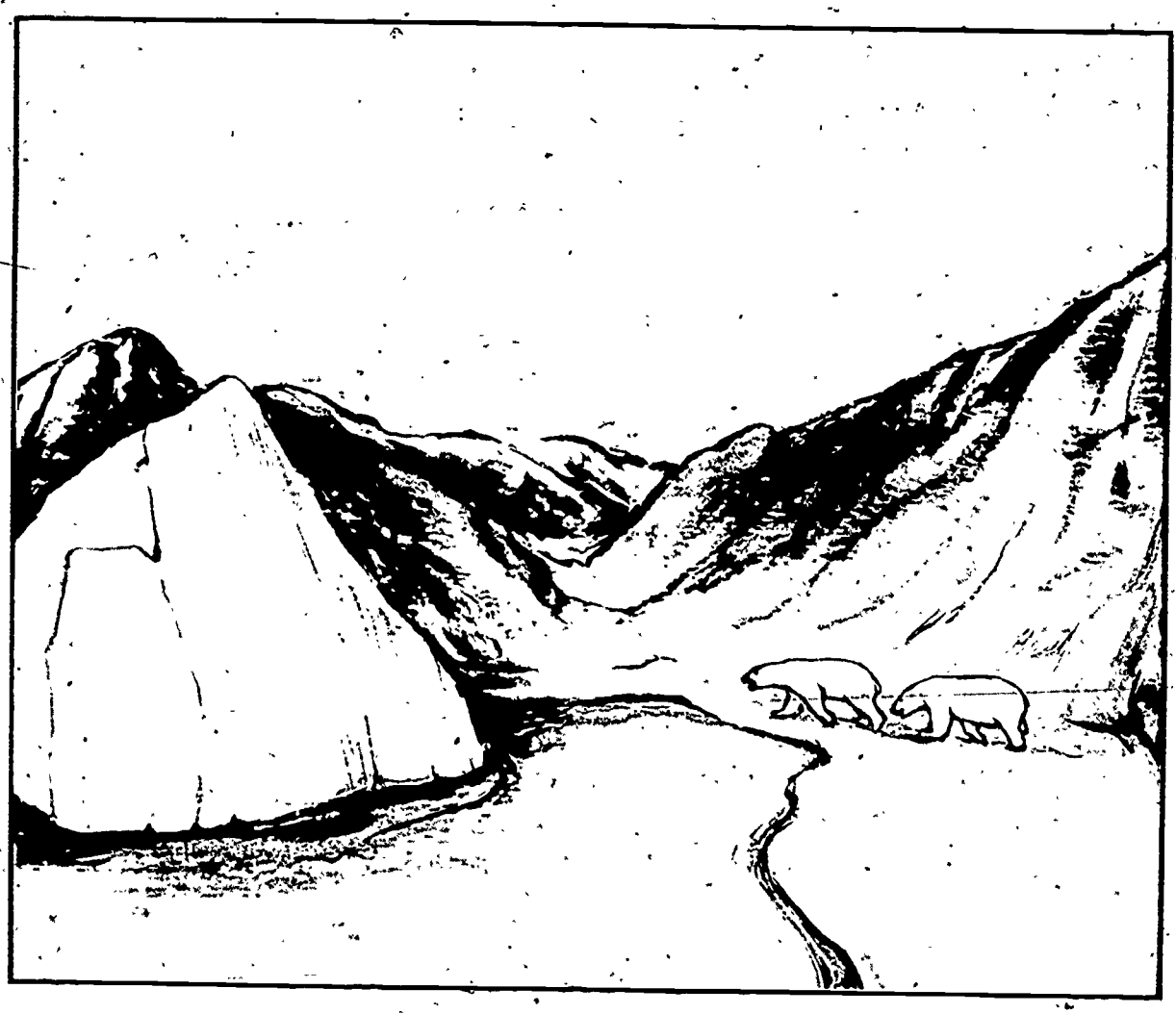
Worksheet 8
Unit 23

Name _____



What part of the world do you think this is?

Northern arctic region

Why do you think there are no bushes or trees?

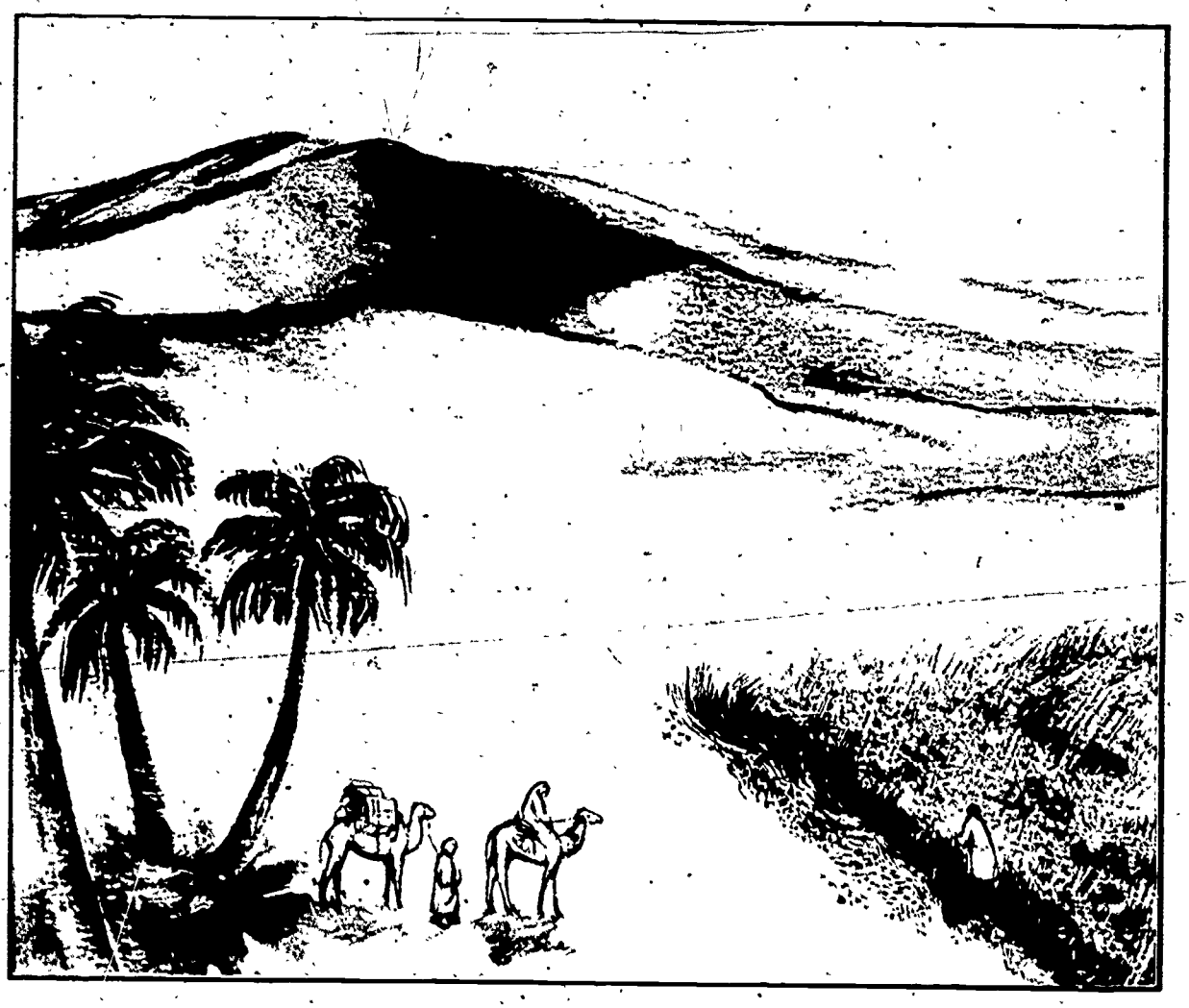
It's too cold there.

What do you think the bears eat?

Fish

Worksheet 9
Unit 23

Name _____



What part of the world do you think this is?

A desert

Why are the trees growing in only a small area?

There must be water there.

What must the farmer do to get things to grow in his field? He must water it some way.

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Worksheet 10a

Worksheet 10b
Unit 23

Name _____

This is a cross section of a pond.

Notice that parts are sunny and parts are shady.

Put an "X" on the water lily leaves.

Are any other plants growing under them?

No

What condition is different where the other plants are growing?

There is more light.

Why do you think there are no plants in the deepest part of the pond?

There is not enough light.

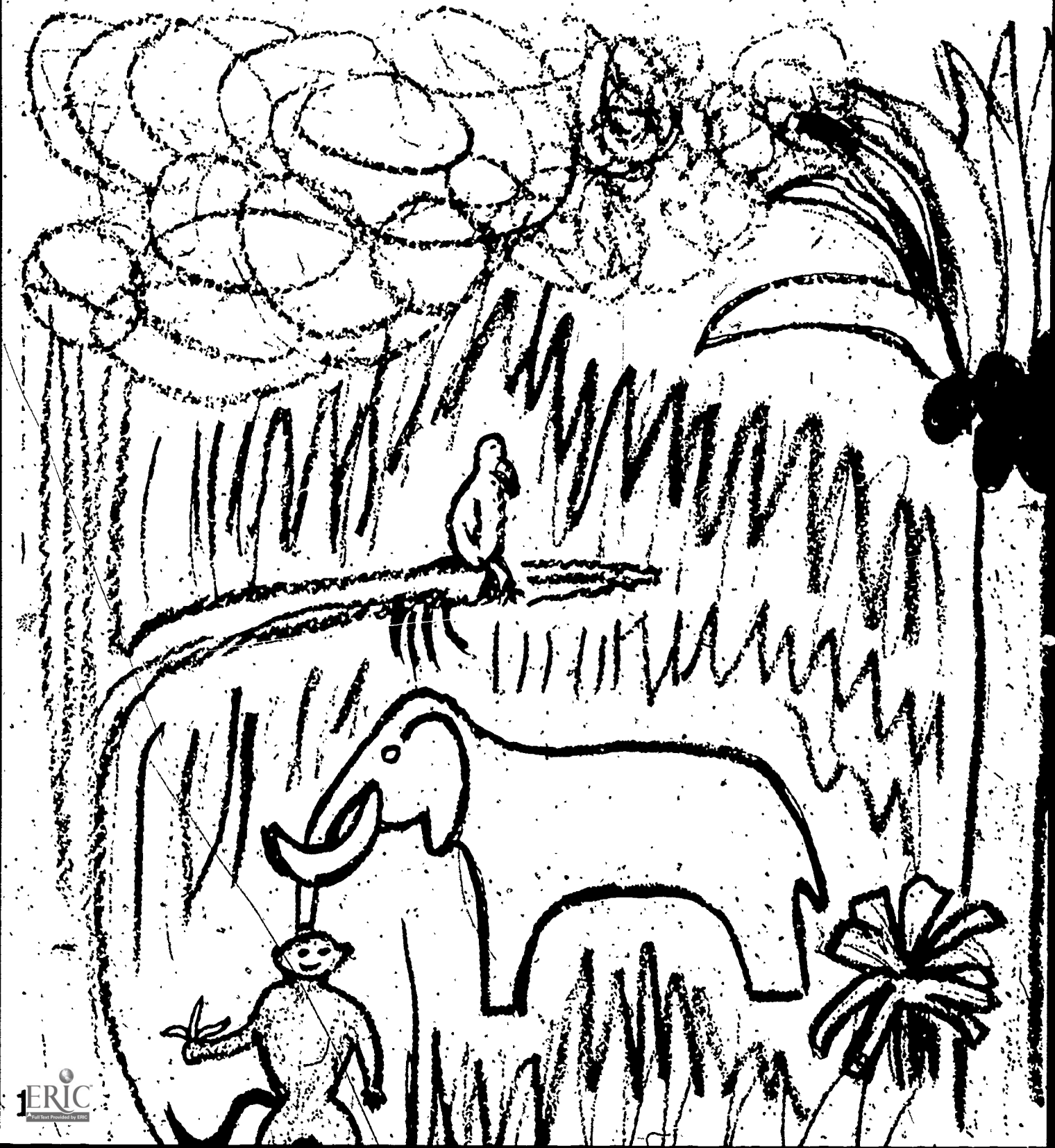
Find the fish in the picture. Why do you think they are in those places?

Fish go where it is cooler.

Worksheet 11
Unit 23

Name Tammy

My Picture of a Jungle



SECTION 6 - SEASONAL CHANGES

This is the last section of the unit. Many of the activities in this section can be continued throughout the year as the seasons change.

In Lesson 17 (35 to 45 minutes), the children read and illustrate the story, "A Camp Adventure." This story focuses the children's attention on the changes from summer to winter.

In Lesson 18 (70 to 80 minutes), studies are based on a series of pictographs and line graphs showing changes in moisture, light and temperature that take place from June to December.

In Lesson 19 the children observe and discuss the responses of plants and animals as these living things react to seasonal changes.

Total teaching time for this section should be about 4 to 5 class periods.

Lesson 17: A CAMP ADVENTURE (A Story Lesson)

A story, "A Camp Adventure," and the discussion of it, make up this lesson. In the story a city boy goes to camp toward the end of the summer. At the camp he learns a great deal about how various plants and animals react to seasonal changes, a subject that the children will be studying in the remaining lessons of this unit. Besides introducing the class to the reactions of living things to seasonal changes in moisture, light and temperature, the story should enhance the children's appreciation of a country environment by seeing it from the point of view of a city child. It should also provide the children with some initial understanding of the oneness of nature, as the boy in the story notices that a tree in the city reacts to the changing season in the same way as the trees in the forest near the camp. By giving some clues about what to look for, the story should motivate the children to observe seasonal changes that affect living things in their own neighborhoods.

The story need not be used just as a science lesson. It could, for example, be used as a reading lesson or as the basis for an art lesson. Such uses would in no way detract from the purposes of the lesson. They would, in fact, serve to reinforce the purposes.

The procedure can be modified to suit the reading and artistic abilities of your particular class.

Teaching time should be about 40 to 50 minutes.

MATERIALS

- the story, "A Camp Adventure," provided in this lesson and in the Student Manuals
- yarn, string or brass fasteners
- crayons, paints, colored chalk or pencils

PROCEDURE

Activity A

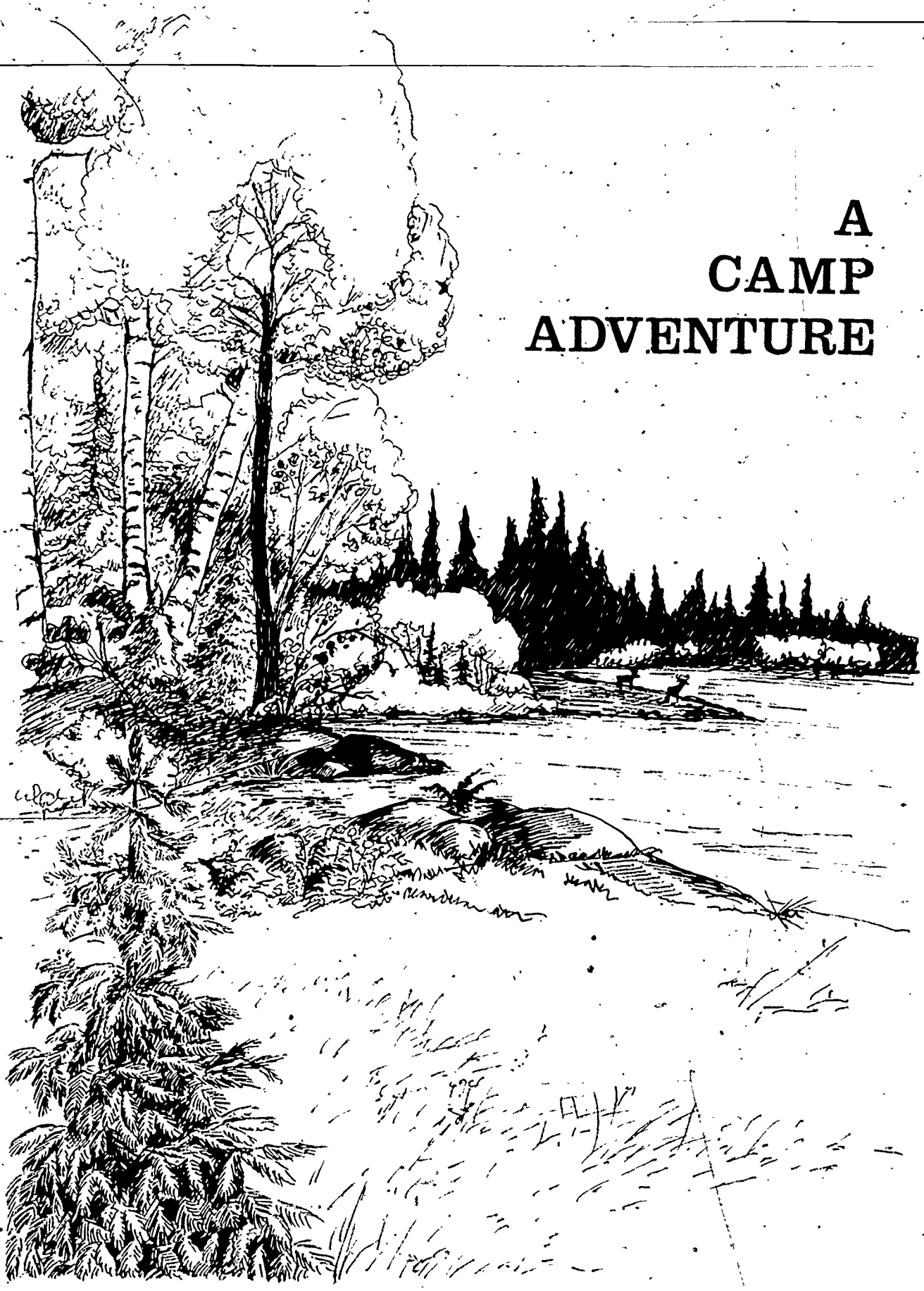
Have the children carefully remove the story pages from their Student Manuals and put them together with yarn or other fastening device so that each child has a story booklet.

Read the story to the children. Have them follow the text in their own copies, if you think this would be helpful to them.

After the children have had the story read to them, let them discuss, for a few minutes, anything in it that is of special interest. Then ask the class to speculate about how the changes in moisture, light and temperature will be affecting some of the plants and animals mentioned in the story. Get the children to consider how the change from summer to winter will affect their own behavior. (They will wear warmer clothing, probably spend more time indoors or engage in different sports or games when outdoors.) At the end of the discussion, remind the children to observe as many plant and animal reactions to the changing season as they can, whenever they are outdoors.

Activity B

Suggest that each child read the story for himself and think about what illustrations he wants to draw in the blank spaces provided. Let the children know that they need not draw all (or any) of the suggested pictures, but may draw any pictures they wish that pertain to any part of the story. Distribute whatever art materials you want the children to use, and have them draw the pictures they have decided on.



A CAMP ADVENTURE

A CAMP ADVENTURE

Sid lived on a busy street in the heart of the city. His house was four stories high and he considered himself lucky to be living on the first floor so he could go in and out of the house without climbing three flights of stairs as his friend Tony had to do.

On the street in front of his house, cars were always parked on one side of the street or the other. When Sid and his friends played ball, the parked cars were always in the way. When the boys ran across the street after a ball, they had to squeeze between the parked cars and watch out for any car that might be speeding along. Nevertheless Sid and his friends managed to have fun playing softball and other games in the city.

Sometimes, while Sid and a few of his friends were waiting for enough children to show up for a ball game, they played hide-and-seek. The boy who was "it" would lean against the only tree that grew on Sid's street. It was not a large tree, and like anything that has been in the same place for a long time, hardly anyone but the children ever noticed it.

One day in the springtime, when Sid was walking home from school, he was thinking how good it would be to get his clothes changed, and go out to play. But when he went into the house, he saw a strange man and a strange woman talking to his mother. When his mother saw Sid, she said, "Here he is now."

Sid's mother pointed to a chair and asked him to sit down. Sid became a little nervous. He wondered what trouble was ahead. But then he noticed that all of the grownups were smiling. His mother said, "Sidney, how would you like to go to camp this August for two weeks -- way out in the country, a hundred miles from here?"

Sid's face lit up. "Can my friends come along, too?"

"Some other time," the man said. "This time it is your turn. I am sure you will make friends with the boys you meet in our camp."

Well, all through May, June and July, Sid wondered what camp was going to be like. Toward the end of July, he noticed that his mother was washing, mending, and getting ready to pack the clothes he was going to take to camp.

Finally, August arrived. Sid's mother took him to the bus station. There he found four other boys waiting, three with their mothers and one with his father.

The man Sid had seen in his house in the springtime was there, too. He introduced the boys to each other, and they talked for a while. Then the bus arrived. The boys said goodbye to their parents and climbed into the bus. More and more boys came, and soon the bus was full. Now it began to move, and the boys and their parents waved to each other. The bus turned several corners, picked up speed, and soon was rolling along past houses and trees, and over bridges. Sid was on his way to camp.

On the bus the boys got acquainted and played some guessing games. There were many interesting things to see as the bus slowed down in the towns along the way. All these things made the time pass very quickly, so it didn't seem like three hours had really gone by when the bus turned off on a side road. Then, a few minutes later, it pulled into a parking lot near a lake, and stopped. The boys saw several cabins nearby and wondered which one they would be living in. They got off the bus and noticed some campers coming up from the lake where they had been swimming. In the distance they saw a fine baseball field. They felt very happy, but hungry.

The camp counselor showed them to their cabins, and told them where to wash up. Then off to the dining room they all went. How good the food tasted in the pure fresh air of the country! As Sid looked around, he was enchanted with everything he saw -- with the trees, with the lake, and with the green hills across the lake. You see, this was the first time in his life that he had ever been in the country!

The first week was a busy one for Sid. He swam, he played baseball, and he even learned to play tennis. He had a wonderful time, and he enjoyed every minute of it.

During the second week, the camp counselor made an announcement: "Tomorrow you boys are going on an overnight hike beyond the green hills across the lake. This is Mr. Kelly who will be your hike leader."

What excitement followed this announcement! The boys took out tents, and blankets, and things to cook with -- everything they needed to get ready. They asked Mr. Kelly all sorts of questions about where they were going. But all he would say was, "To a great forest."

And, sure enough, that is where they went. They had to hike for a whole day, but they did finally come to the forest. The trees there were so huge that Sid didn't think, at first, they could be real.

"They are real enough, all right," Mr. Kelly said. "Look at this tree, though, and notice how its leaves are already changing color. A few weeks from now, every time the wind blows, a shower of leaves will fall from the trees. When winter comes, the trees will not be able to get water, so they will cut off their leaves and let them fall."

"Will that kill the trees?" Sid asked.

"Not at all. Look closely at this branch and notice the buds. These buds will grow into new leaves next spring."

Then the boys continued their hike. Here and there they stepped on a few leaves that had already fallen. Sid began to wonder about the little tree on his street. Would it cut off its leaves and let them fall before winter, too. He would try to remember to look at it and find out when he got home.

That night the boys slept under some big pine trees by a beautiful lake. Early in the morning they looked out over the lake and saw dragonflies hovering near the water. In the distance, they saw fish jumping out of the water. Nearer the shore, they chased some frogs who went "ge-plump" as they leaped into the lake.

Mr. Kelly said, "Be sure to take a good look at everything, boys, because summer is ending and things will not look like this very much longer. In a few months, winter will be here. The lake will freeze over, and everything will be changed."

"What will happen to the fish and the frogs and the dragonflies then?" Sid asked.

"The fish will stay alive in the water under the ice," the hike leader said. "The big dragonflies will all die, but their babies -- which do not look like dragonflies at all -- will live at the bottom of the lake. When spring comes, they will crawl out of the lake onto a rock or plant, and develop into dragonflies, and fly away."

"What about the frogs?" Sid asked.

"They will dig themselves into the mud and sort of sleep until spring. When the ice melts, they will go into the water again, and lay their eggs."

"What makes all of this happen?" one of Sid's new friends asked.

"Well, perhaps you have noticed how cold it's getting. And how the days are getting shorter, so there is less light, too. And think of the kind of moisture we will soon be seeing -- nothing but snow and ice. Until the snow and ice melt, neither the plants nor the animals can use the water."

The boys thought that the overnight hike and the things they saw were the greatest imaginable. But a few days later, they had to start home.

When Sid got home, he had lunch with his mother and told her all about the forest. Then he went out to the street. And what do you think was the first thing he did? You're right, he went straight to the tree and looked at it carefully. Sure enough, it too was cutting off its leaves and already he could see little buds on the branches from which the new leaves would grow the next spring.

He began to think of the next summer. It seemed a very long time to wait. "Oh," he thought, "how I would like to be back in the forest right now!"

Lesson 18: SEASONAL CHANGES IN MOISTURE, LIGHT AND TEMPERATURE

This lesson is based on a series of graphs designed to make the children aware of seasonal changes in moisture, light and temperature. Information for these graphs was supplied by the U. S. Weather Bureau in Minneapolis. If you teach in another area, you may wish to obtain corresponding information from your local weather bureau and use the data to prepare charts and graphs reflecting conditions there.

The children are given the opportunity to extract information from graphs and see the relation between different types of graphs.

In Activity A the children act out a skit dealing with the changes in length of daytime and nighttime from June to December. This activity should take 25 to 30 minutes.

The children study the changes in the highest and lowest temperatures from June to December in Activity B (20 to 25 minutes). They are also asked to transfer information from one type of graph to another.

In Activity C (20 to 25 minutes) the children study monthly changes in rainfall from June to December, again using graphs.

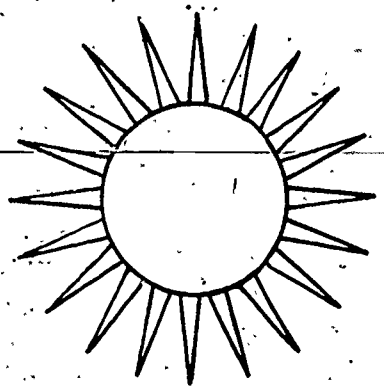
This lesson should take a total of 70 to 80 minutes teaching time.

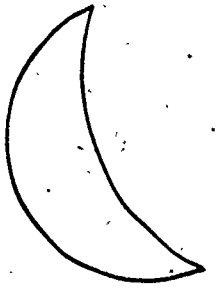
MATERIALS

- large cutouts of sun and moon (one of each)
- Worksheets 12 through 25 from Student Manuals
- clock with second hand (or 12-inch pendulum from Lesson 13)

PREPARATION

Cut out a sun and a moon from yellow construction paper for the skit in Activity A.





PROCEDURE

Activity A

Ask the children to discuss what they have observed about the difference in sunset time between summer and winter. Ask questions that will help them remember, such as:

ARE THE DAYS LONGER IN WINTER OR IN SUMMER? HOW DO YOU KNOW?

IS IT DARK WHEN YOU EAT SUPPER IN THE SUMMERTIME? CAN YOU PLAY OUTDOORS AFTER SUPPER IN THE SUMMERTIME?

HOW ABOUT THE WINTER? CAN YOU USUALLY PLAY OUTDOORS IN THE WINTER? DOES MOTHER USUALLY HAVE TO TURN ON THE LIGHTS IN THE HOUSE BY SUPPER TIME? ABOUT WHAT TIME DOES THE SUN SET IN THE SUMMERTIME? (Approximate answers are acceptable here, or such remarks as "The sun sets much later in the summer," and "The sun sets much earlier in the winter.")

After the children have made whatever contributions they can to the subject of sunset times, say:

YES, IN THE SUMMERTIME THE SUN DOES NOT SET UNTIL 9 O'CLOCK AT NIGHT, OR EVEN LATER. YOU MAY HAVE TO GO TO BED WHILE IT IS STILL LIGHT.

IN THE WINTER IT GETS DARK MUCH EARLIER, SOMETIMES EVEN BEFORE SUPPER. BUT IS IT SUMMER ONE DAY, WITH THE SUN SETTING LATE, AND WINTER THE NEXT DAY, WITH THE SUN SETTING EARLY? (No, there are many days in between when the sun sets a little earlier each day.)

When the children understand that the sun gradually sets a little earlier each day from summer to winter, ask:

IF A GROUP OF BOYS AND THEIR COUNSELOR WERE GIVEN PERMISSION TO REMAIN IN CAMP UNTIL WINTER SO THEY COULD FIND OUT JUST HOW QUICKLY OR HOW SLOWLY THE LENGTH OF DAYTIME AND NIGHTTIME CHANGES, HOW COULD THEY DO IT?

Let the children speculate, make their own suggestions, and discuss whether or not the suggestions are practical.

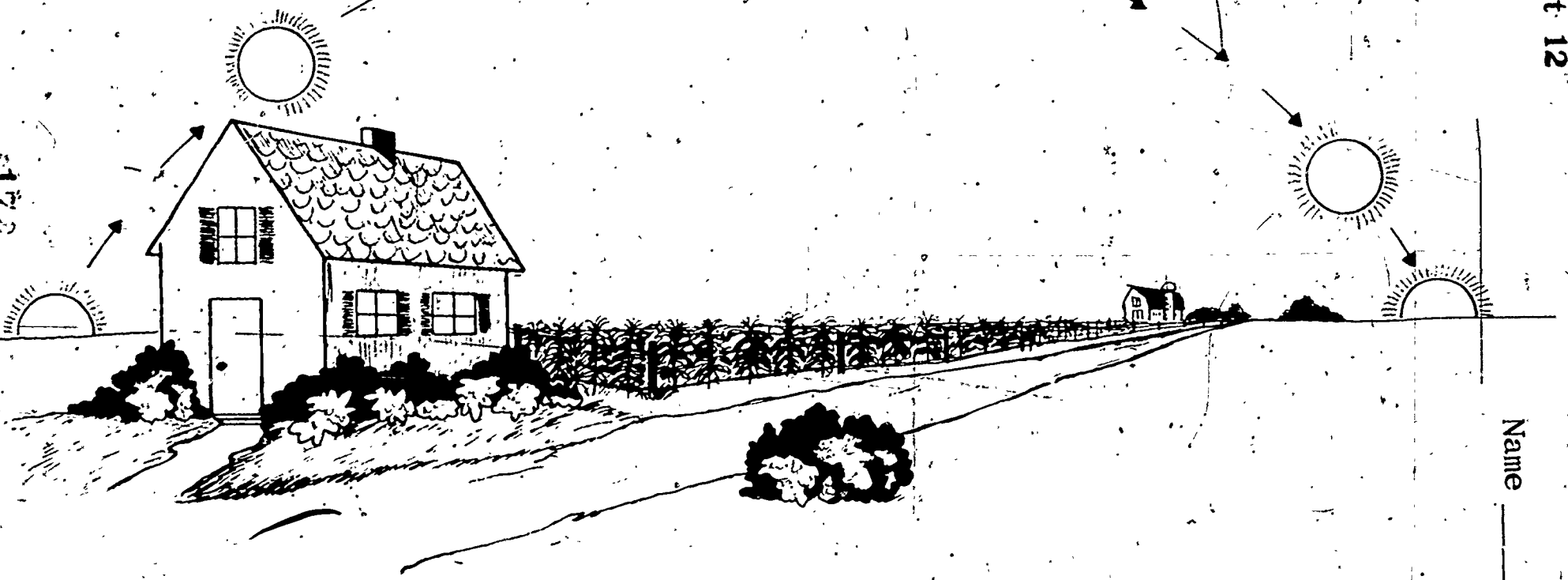
WHAT MATERIALS WOULD THE BOYS NEED TO MAKE SUCH A STUDY? LET'S LOOK AT WORKSHEET 12 AND SEE WHAT WE CAN FIND OUT.

Examine the worksheet with the children. Let them first identify the familiar things they see (the number line, the bar graph, the house, the sky, the sun) and then have them look at the pictures of the timer.

Ask the children how the timer is different from a regular clock. (They should notice that it has 24 hours on it, instead of the usual 12. They should also notice that each timer has only one hand, an hour hand.)

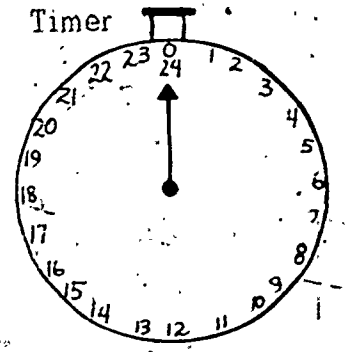
Read the caption on Worksheet 12 and ask the children to explain what it means.

How you might determine and record the length of daytime and the length of nighttime on any day of the year.

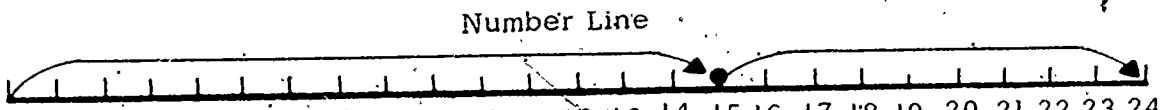


Name _____

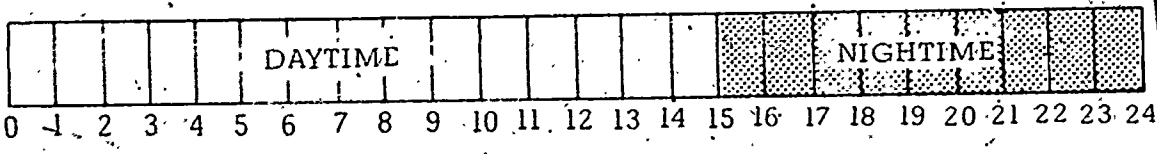
Timer



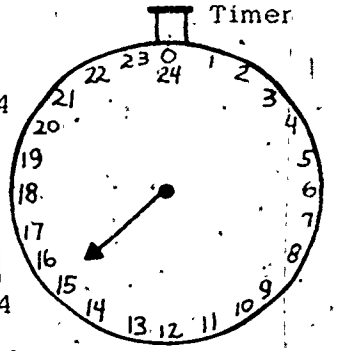
Number Line



Bar Graph



Timer



Ask the children to look at the timer in the bottom left-hand corner. The hour hand of this timer is pointing to 0, while the hour hand of the timer on the other side is pointing to 15. Tell the class that the timer was started when the sun came up and stopped when the sun went down 15 hours later.

Have the children look at the number line between the two timers. It shows that daytime started at 0 and stopped at 15. This is the same information the timer tells us.

WHAT HAPPENS WHEN THE SUN GOES DOWN? (There is darkness. It is nighttime.)

We can represent this on our number line by having nighttime start at the 15-hour mark. Since there are 24 hours in a day, nighttime ends at 24 hours. Then we start a new number line for a new day.

WHO WOULD LIKE TO USE THE PICTURE FOR A CLASS SKIT? THE FRONT OF THE ROOM WILL BE THE LANDSCAPE AND YOU WILL ALL PRETEND YOU ARE OUT-OF-DOORS WATCHING.

Bring out the cutouts and choose a child to represent daytime. As you give him the sun cutout, say:

YOU WILL BE DAYTIME. YOU WILL CARRY THE SUN BECAUSE WE SEE THE SUN IN THE DAYTIME.

Choose another child to represent nighttime. As you give him the moon cutout, say:

YOU WILL BE NIGHTTIME. YOU WILL CARRY THE MOON BECAUSE WE SEE THE MOON MOST OFTEN AT NIGHT.

Have a third child be the timer.

The skit starts with the daytime child in a squatting position on the left side of the room. The timer watches the classroom clock and, when the second hand reaches the 12, he says, "Zero." When daytime hears "Zero," he rises. As the second hand reaches 1, the timer says, "One," and daytime takes a step across the room. When the second hand reaches the 2 on the clock, the timer says, "Two," and daytime takes another step. The timer continues to call out one hour for every five seconds on the clock.

When the timer says, "Fifteen," daytime returns to the squatting position and nighttime, holding the moon, rises from the starting position on the left side of the room. As the timer calls out each hour, nighttime takes a step. While the moon is out daytime should return to the starting position.

When the second hand on the clock reaches 12 for the second time, the moon sets and the sun rises. When the second hand again reaches the 1 on the clock, the timer says, "One," and daytime takes a step. The children should realize that as soon as the 24 hours have passed, a new day is begun.

Have the children continue with the skit until they understand that the daytime/nighttime cycle continues indefinitely. After the children have practiced the skit using five-second intervals for hours, go through it again with one second representing each hour.

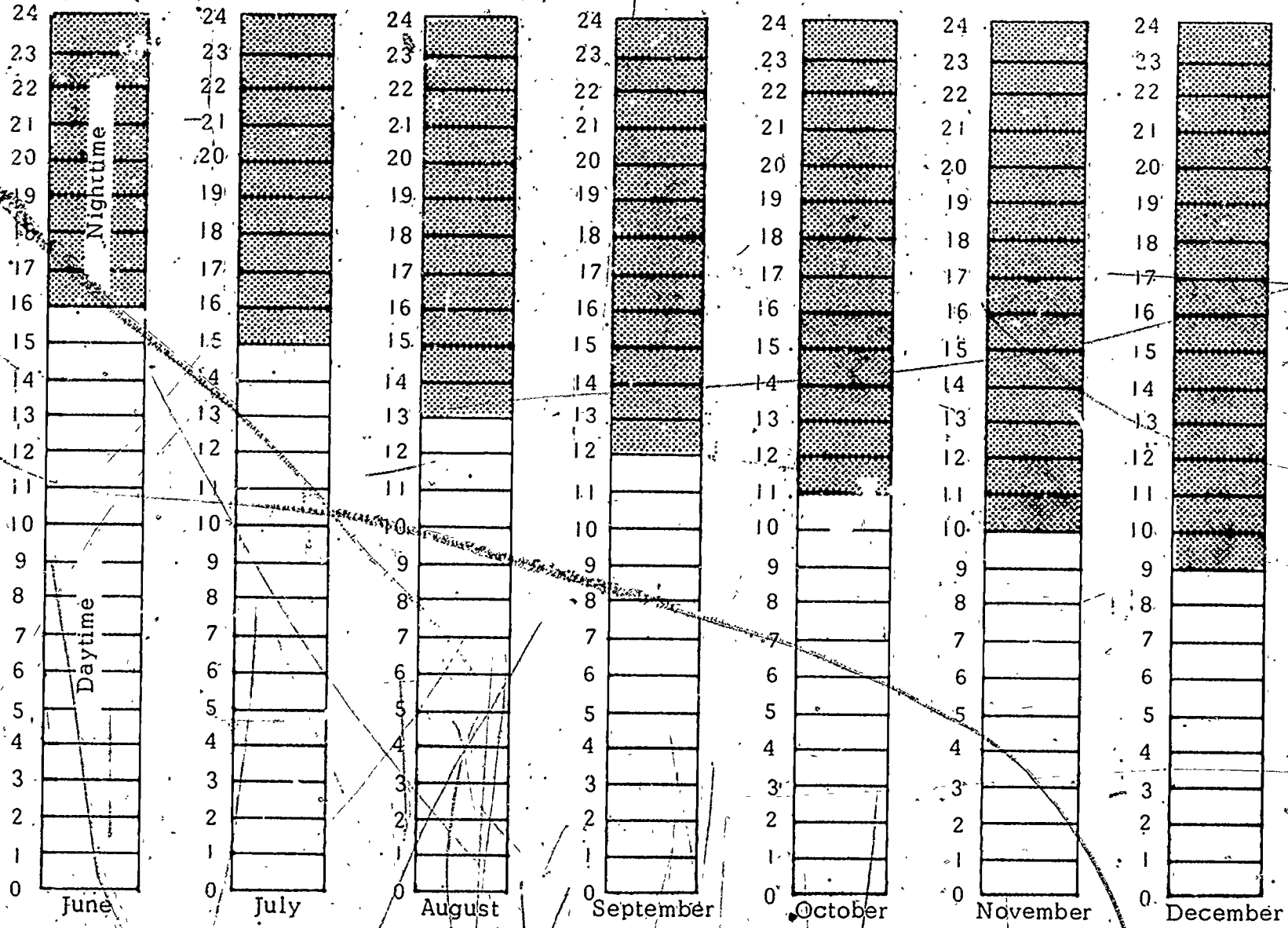
Explain that scientists have devised an automatic system for recording the length of daytime and of nighttime. The timer works like those that turn the lights on in our parks and streets when it gets dark, and turn the lights off when it gets light again. The length of time from sunset to sunrise is automatically recorded on a continuous number line. These instruments can be placed on a mountain, for example, and the length of daytime and nighttime are recorded without anybody being present.

Have the children compare the number line with the bar graph at the bottom of Worksheet 12. They should see that both of these record the lengths of daytime and nighttime.

Worksheet 13
Unit 23

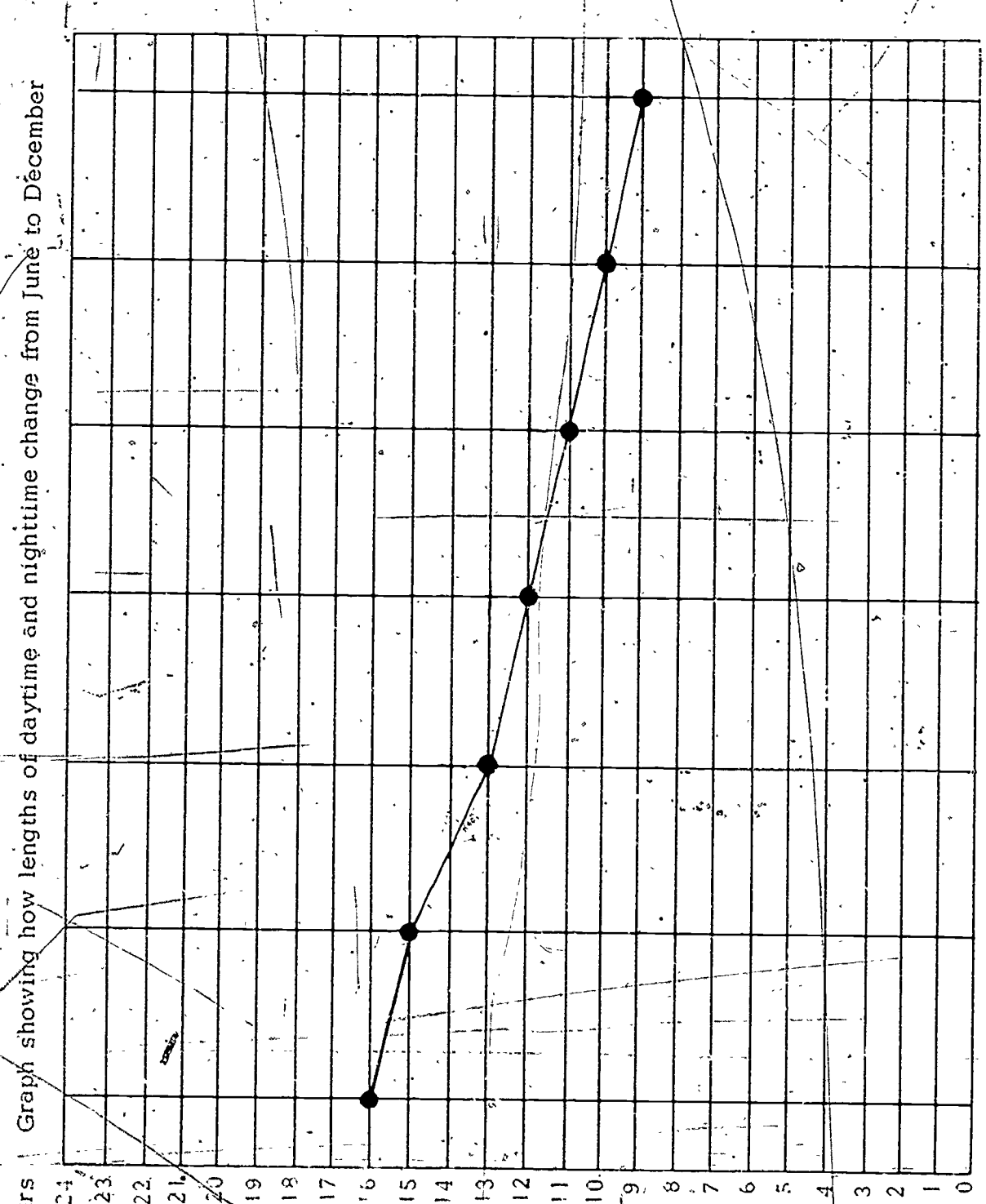
Name _____

How lengths of daytime and nighttime change from June (summer) to December (winter):



Worksheet 14
Unit 23

Name _____



Have the children turn to Worksheet 13. Select three other children to be the timer, daytime and nighttime. Let them act out the bar graph for June. Do the same for as many other months as you feel necessary. Discuss briefly all the monthly bar graphs.

Then have the children look at the line graph on Worksheet 14 and compare it with the bar graph on Worksheet 13. Discuss how the points on the line graph correspond to the heights of the bar graphs. The children should see that both graphs contain the same information.

The children should now be ready to complete Worksheets 15 and 16, using either Worksheet 13 or 14 to answer the questions.

You may want the children to tear Worksheets 15 and 16 from their Student Manuals so they can keep their manuals open to Worksheets 13 and 14 while they work.

Worksheet 15
Unit 23 Name _____

How length of daytime and nighttime change from June (summer) to December (winter)

1. How many hours long was the daytime in June?
   16 hours
2. How many hours long was the daytime in December?
   9 hours
3. How many hours long was the nighttime in June?
   8 hours
4. How many hours long was the nighttime in December?
   15 hours
5. How does the length of daytime in June compare with the length of daytime in December?
   June is about twice as long
6. How does the length of nighttime in June compare with the length of nighttime in December?
   June is about half as long
7. In which month are the length of daytime and the length of nighttime the same?
   September
8. In which months does the length of day plus the length of night equal 24?
   All of them

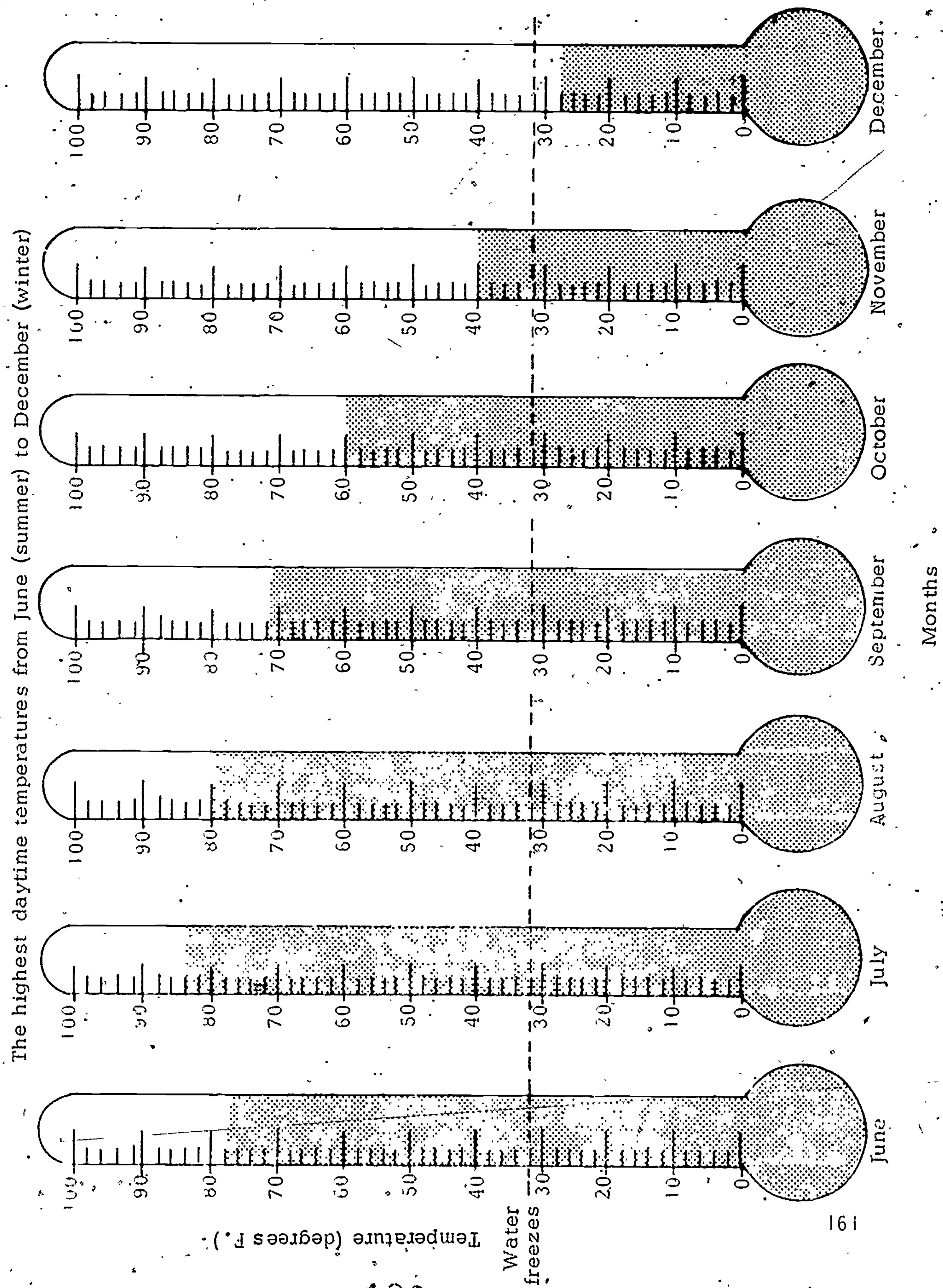
Worksheet 16
Unit 23 Name _____

More questions about changes in length of daytime and nighttime

1. Compare the amount of light a plant could get each day in June with the amount it could get each day in December.
   It could get about twice as much in June.
2. In the story, A Camp Adventure, Sid's group started on their hike at sunrise. They hiked for two hours, and then had one hour for breakfast. Then they hiked three hours to arrive at the big forest. They had lunch for one hour and then went exploring. Was it daytime or nighttime when they arrived at the big forest?
   Daytime
3. Was it daytime or nighttime when they started to explore?
   Daytime
4. How many hours did they have to explore before sunset if they hiked in December instead of August?
   2 Hours

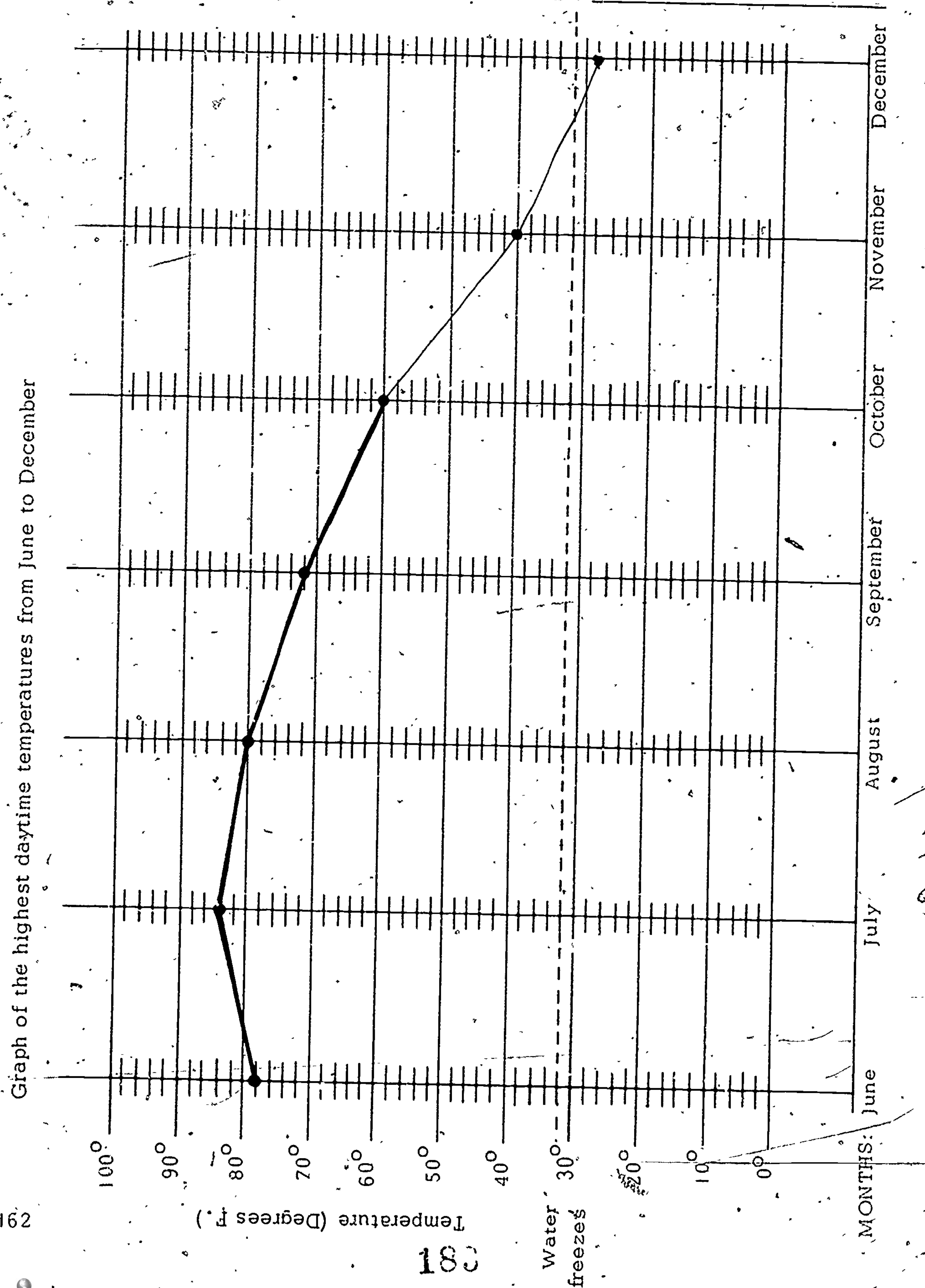
Worksheet 17
Unit 23

Name ____________________



Worksheet 18
Unit 23

Name ____________



Activity B

Have the children look at Worksheet 17, which shows the highest temperatures in each month from June to December. Discuss the thermometers, numbers, dates and water freezing line. Then elicit what this pictograph shows.

Next have the children examine Worksheet 18, a corresponding graph, where the line is not completed. Have the children complete it using the information from Worksheet 17. The children should see that both graphs show the same information.

The children are now ready to answer the questions on Worksheet 19, using either Worksheet 17 or 18.

Have the children examine Worksheet 20. Again have them recognize the familiar parts of the pictograph. Ask a child to state what this chart tells. Be sure the children realize this pictograph shows the lowest temperatures.

Worksheet 19
Unit 23

Name _____

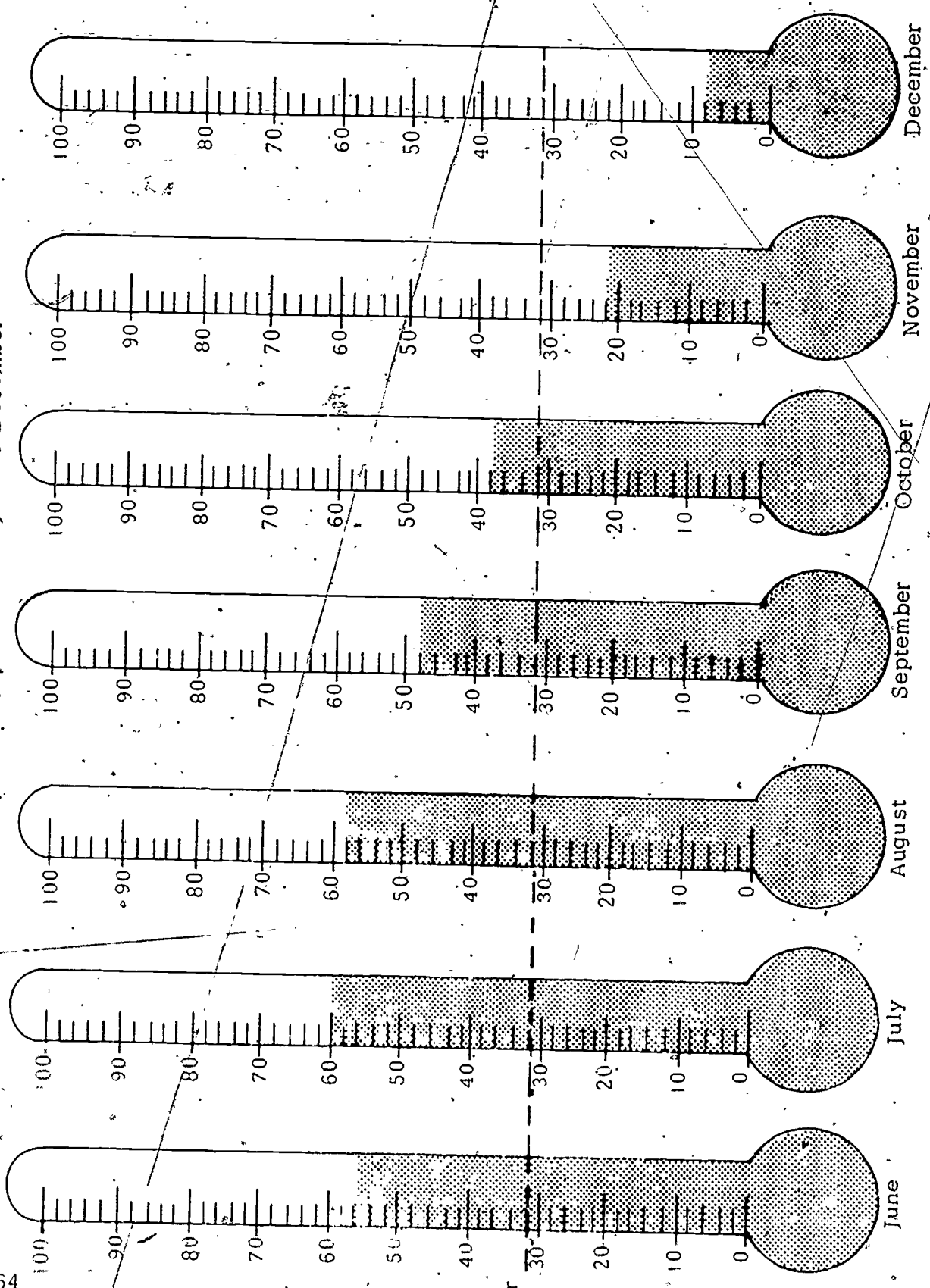
Daytime temperatures from June (summer) to December (winter)

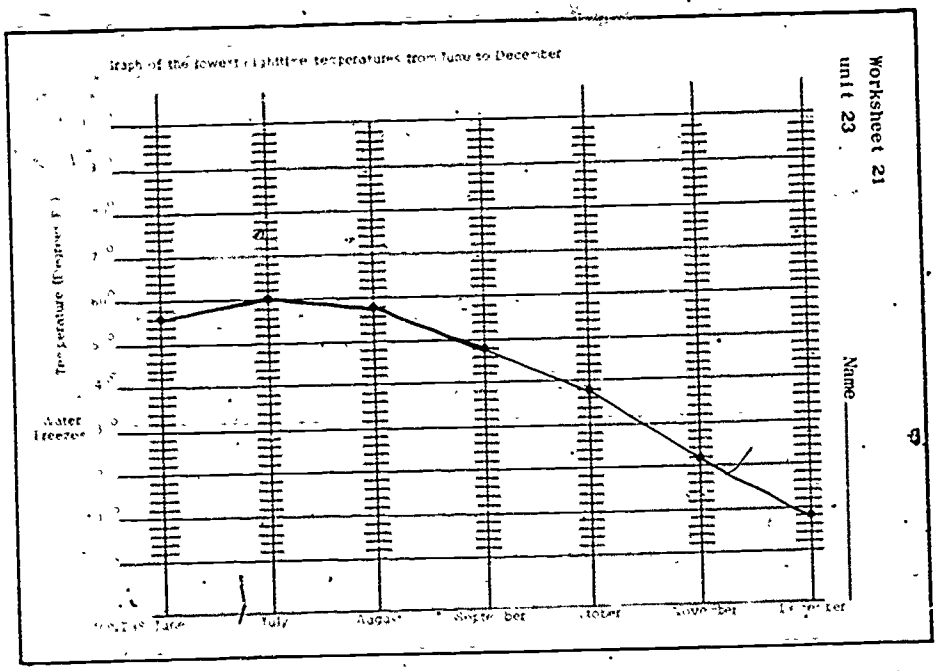
1. Which month had the warmest day?
   July
2. What was the temperature that day?
   84° F
3. Which month had the lowest daytime temperature?
   December
4. What was the temperature that day?
   28° F
5. In which month were plants and animals in below freezing temperatures during the day?
   December
6. What was the temperature that day?
   28° F
7. What effect would such low temperatures have on beetles?
   They would go to sleep
8. How do you know?
   That is what happened in our experiment

Worksheet 20
Unit 23

Name _____

Graph of the lowest nighttime temperatures from June to December





Now have the children complete the graph on Worksheet 21, using the information from Worksheet 20. Finally, the children should answer the questions on Worksheet 22, using either Worksheet 20 or 21.

Worksheet 22
Unit 23

Name _____

The lowest nighttime temperatures from June (summer) to December (winter)

1. Which month had the coldest night?
   December
2. What was the temperature that night?
   8° F
3. Of the low nighttime temperatures, which month had the warmest?
   July
4. What was the temperature that night?
   60° F
5. Which months had temperatures that were below freezing?
   November and December
6. What were the lowest temperatures those months?
   22° F and 8° F
7. What effect would such low temperatures have on fish?
   The fish should breathe more slowly
8. How do you know?
   That's what happened in our experiment

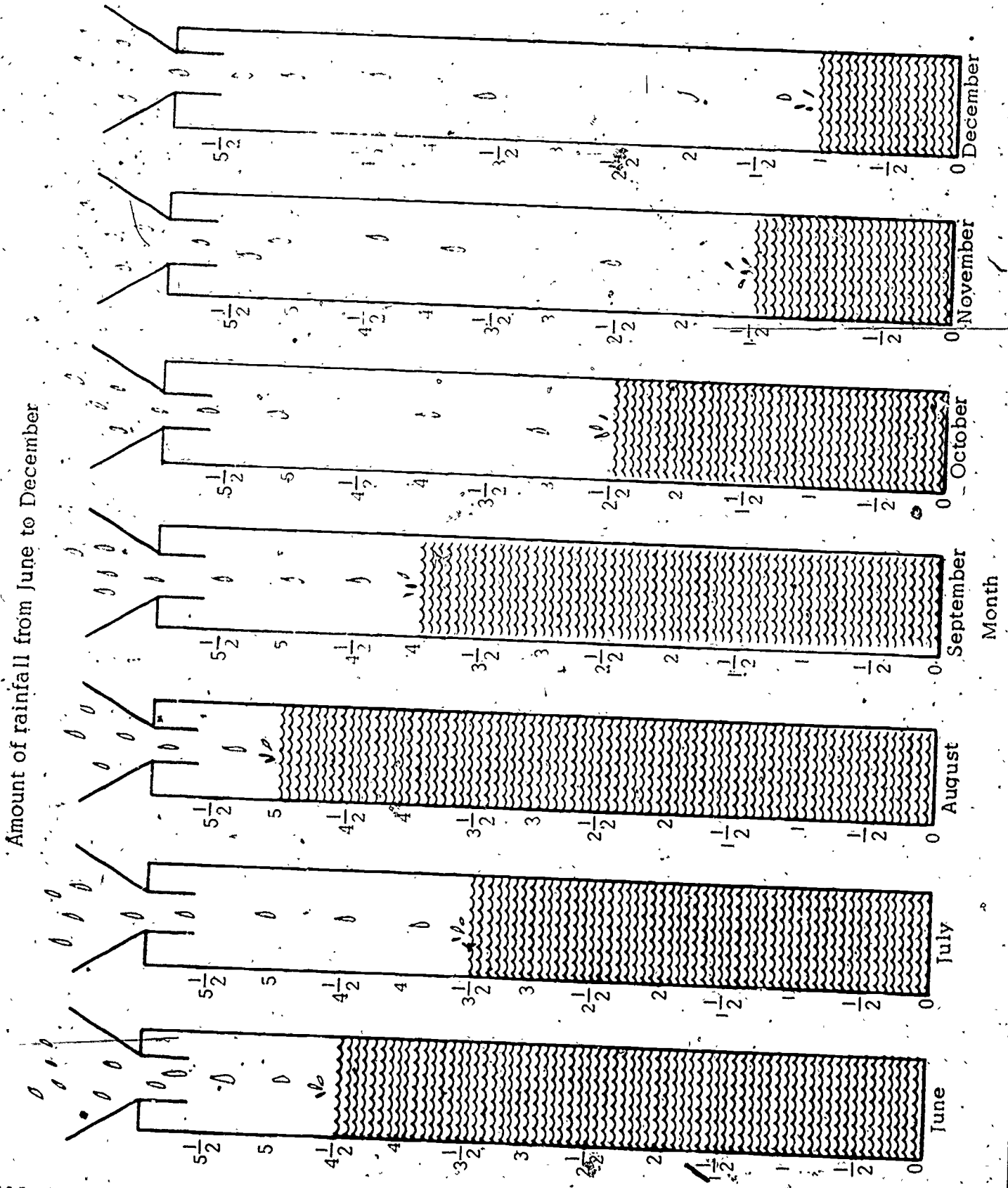
Activity C,

Ask the children to take out and examine Worksheet 23. They should identify cylinders, funnels, drops of water falling in the funnels, the numerals (inches) and the months. Call on a child to tell what this chart means.

Have the children transfer the information from Worksheet 23 to make a line graph on Worksheet 24. When the graph is completed, the children should answer the questions on Worksheet 25, using only the information from Worksheet 24.

Worksheet 23
Unit 23

Name _____

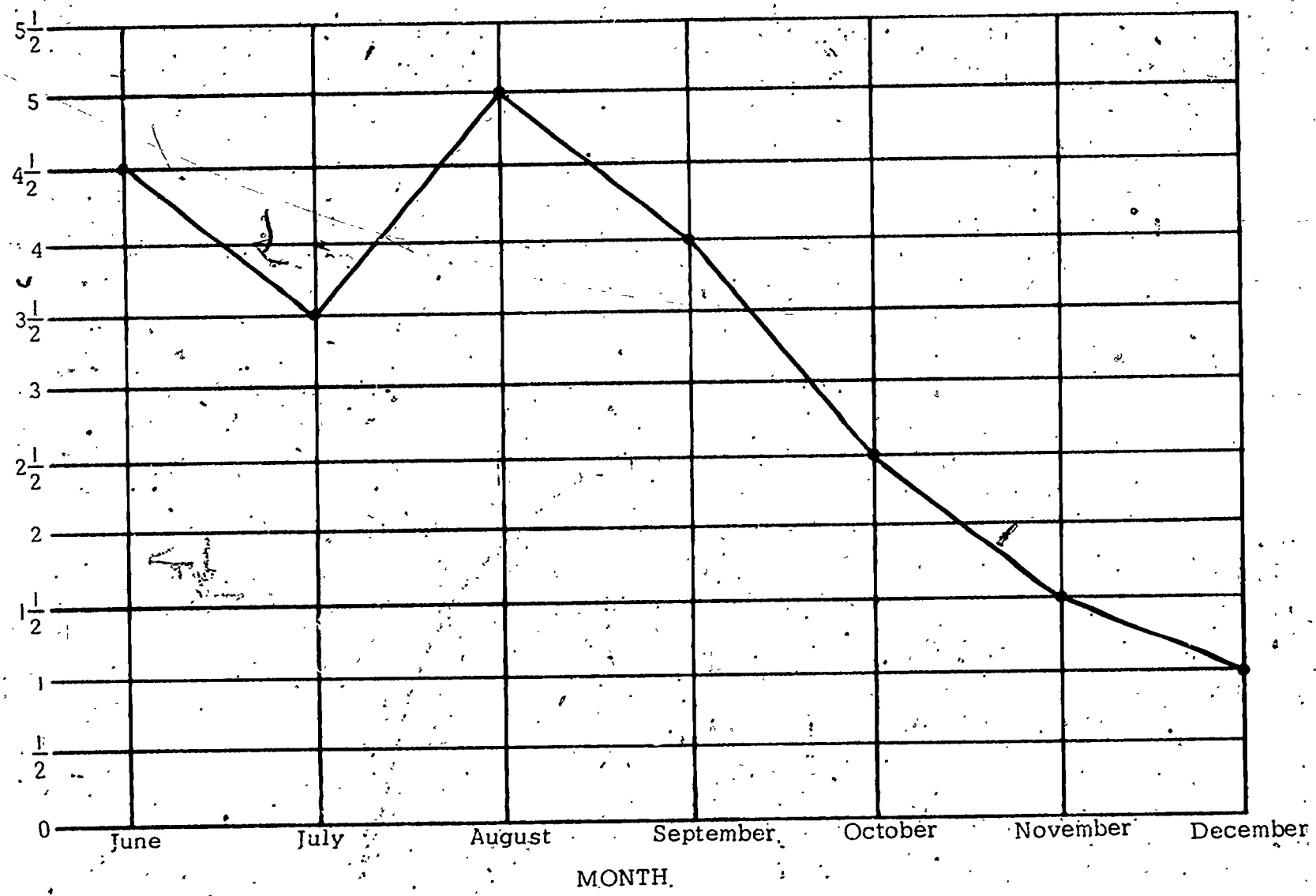


Worksheet 24
Unit 23

Name _____

GRAPH

Changes in the amount of rainfall from June to December



Worksheet 25
Unit 23 Name _____

Change in the amount of rainfall
from June (summer) to December (winter)

1. How much rain fell during the month of June?
   4½ inches
2. How much rain fell during the month of July?
   3½ inches
3. How much rain fell during the month of December?
   1 inch
4. How much more rain fell in August than in December?
   4 inches
5. What was the total amount of rain that fell during June, July and August?
   13 inches
6. What was the total amount of rain that fell during October, November and December?
   5 inches
7. How much less rain fell in December than in October?
   1½ inches

Finally, summarize the lesson by having the children answer questions such as these:

AS WINTER APPROACHES, WHAT HAPPENS TO THE LENGTH OF DAYTIME? TO THE TEMPERATURE? TO THE AMOUNT OF RAINFALL? (Daytime gets shorter. The weather gets cooler. Less rain falls.)

THESE CHANGES ARE ENOUGH TO KILL MANY KINDS OF PLANTS AND ANIMALS, YET WHEN WINTER IS OVER YOU DO SEE THESE VERY SAME KINDS OF PLANTS AND ANIMALS ALIVE. HOW CAN WE EXPLAIN THIS? (The plants and animals must do something to keep alive.)

DO YOU SUPPOSE THESE PLANTS AND ANIMALS MIGHT BE DOING SOMETHING RIGHT NOW TO PROTECT THEMSELVES AGAINST THE COMING WINTER CONDITIONS? HOW MIGHT WE FIND OUT? (Various answers: Go out and try to see what they are doing to protect themselves. Maybe we could collect some plants and animals and look at them carefully and see what they are doing to protect themselves. Maybe there are films which show what they do to protect themselves.)

TOMORROW WE WILL TRY TO FIND OUT WHAT PLANTS AND ANIMALS DO TO PROTECT THEMSELVES AGAINST WINTER.

Lesson 19: HOW LIVING THINGS RESPOND TO SEASONAL CHANGES

In this final lesson of the unit, the children will observe how some plants and animals adjust to winter conditions. They will observe a functional relation between temperature and the growth of pea seedlings and learn to associate this relation with what happens to plants in the spring and summer seasons.

It will be helpful for the purposes of this lesson to keep in mind what the children learned in Lessons 17 and 18. (The story in Lesson 17 served to start the children thinking about the changes that occur from summer to autumn, and Lesson 18 led them to observe graphic representations of the changes in moisture, temperature and light as winter approaches.)

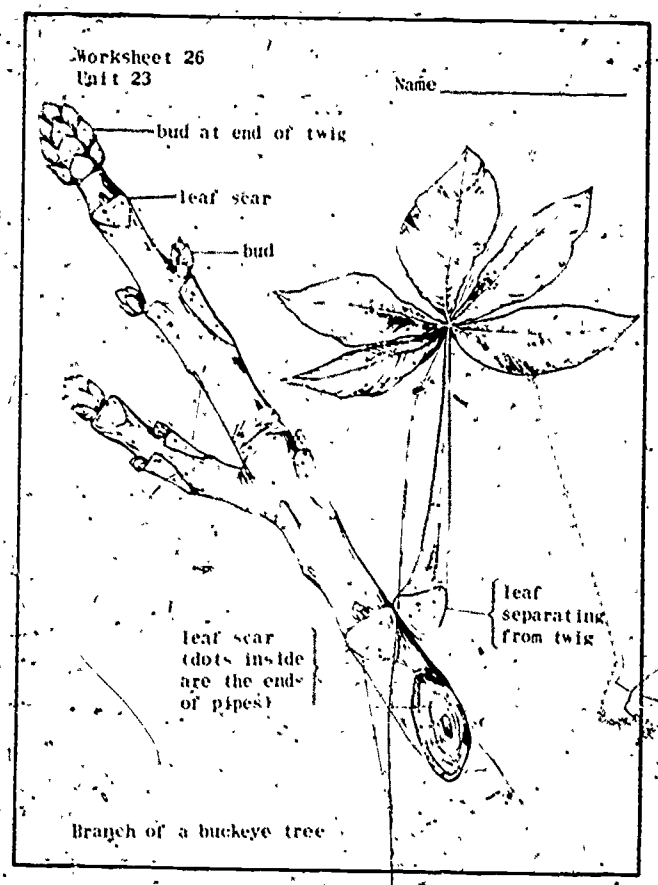
In this lesson the children will be learning about how some plants and animals respond to winter conditi s and thus survive, at least as a species, to resume active life the following spring.

Some of the responses of plants and animals are given here.

1. TREES AND SHRUBS

There are two kinds of trees and shrubs: broad-leaved ones that shed their leaves each fall, and those with narrow needle-shaped leaves that hold them even when winter comes. Why would broad-leaved trees not survive the winter if they did not shed their leaves?

Normally a leaf contains hundreds of microscopic openings (stomata) through which water vapor escapes. In the winter there is more snow than rain. Snow cannot get into the roots of a tree as water does. If the water already in the tree should escape, the tree would die. Trees with needle-shaped leaves have ways of keeping water from escaping; broad-leaved trees do not.



As winter approaches, some broad-leaved trees form tiny walls between themselves and each of their leaves. Thus the "pipes" to each leaf are sealed off. Therefore, the leaf dies and falls from the tree. If you look at a twig of a tree after its leaves have fallen, you can see the spot where each leaf was attached. This is called a "leaf scar." If you find the proper leaf you can see how its stem fits the scar exactly. Within the scar and within the leaf stem, you can see the spots where the "pipes" were cut off.

An important question remains. If the leaves fall off, how does the tree grow new leaves when winter is over? The answer to this question is that, even before the tree sheds its leaves, it already has produced leaf buds (see Worksheet 26). The leaf bud has scales which protect the young leaves inside. These remain on the tree throughout the winter. In the spring the leaf buds swell as the leaves inside of them grow. Eventually the bud scales fall off, the new leaves spread out, and the tree once again gives off water (which by then is plentiful).

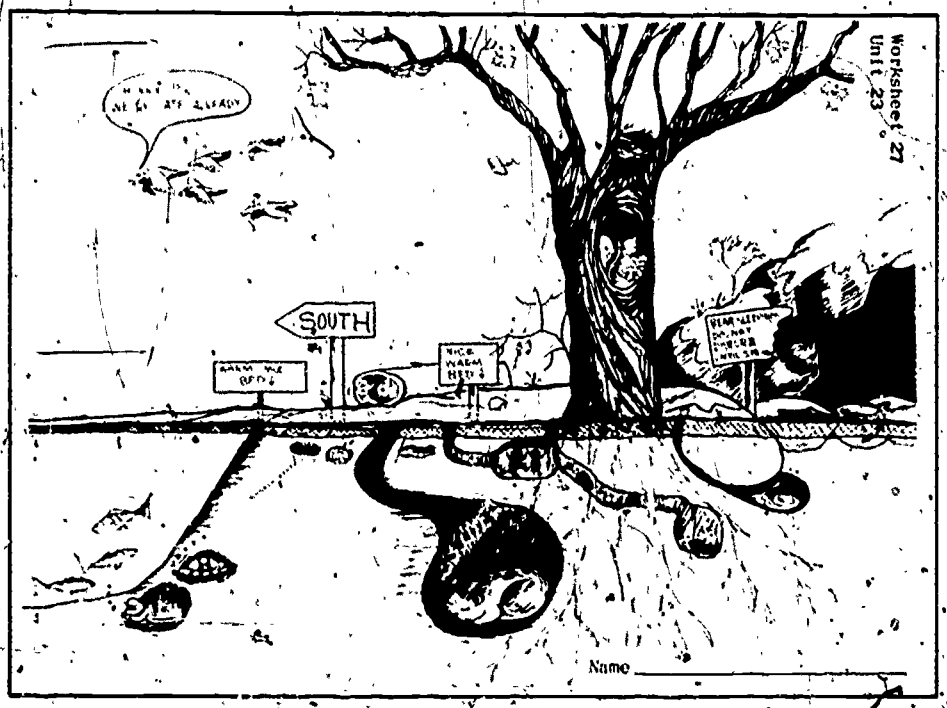
2. OTHER PLANTS

Many plants die each winter, but not before they have produced seeds. In most cases the seeds fall away from the dying plants. The seeds are able to survive lack of moisture, lack of light and very low temperatures. In other words, the conditions of winter cannot kill them. In the spring, when moisture, temperature and light are just right, the seeds germinate and produce young plants similar to the plants from which the seeds came. The effect of temperature on the growth of these young plants in spring is illustrated dramatically by Worksheet 28 on page 175.

3. WARM-BLOODED ANIMALS

There are warm-blooded animals (mammals, birds) and so-called cold-blooded animals (fish, frogs, snakes, insects). Warm-bloodedness (the ability to keep one's body at constant temperature) is itself an adaption to winter conditions. This is accomplished by fur, feathers, hair or clothing, all of which cut down on the rate at which heat is lost by the body.

Nevertheless some warm-blooded animals survive by going into a condition called hibernation. This is true of bears, for example. As their temperature falls they become inactive and go to sleep. Many warm-blooded animals, especially birds, survive the severe conditions of winter by migrating to warmer climates.



Worksheet 27
Unit 23

4. COLD-BLOODED ANIMALS

Cold-blooded animals that normally live in the soil manage to survive the winter by moving deeper into the soil, below the frost line -- the line below which the soil does not freeze. (See Worksheet 27.)

5. FISH

Fish manage to survive because ice forms only on the surface when lakes freeze over. Under the ice there is always water. In this water many aquatic insects such as dragonflies, mayflies and stoneflies survive in an egg or larval stage.

6. FROGS, TOADS AND SNAKES

Frogs and toads dig themselves deep into mud. Snakes curl themselves under rocks and hibernate there until spring conditions return.

7. OTHER ANIMALS

Many insects die as winter approaches but not before they have laid their eggs. Some insect eggs are laid early in the summer and they have hatched out into larvae. The larva forms a pupa in which it is protected against winter conditions. The following spring an adult insect comes out of the pupa. Some insects manage to get into peoples' homes, where it is warm, and where they spend the winter waiting for spring conditions to return. This is true of some houseflies, crickets, spiders and others.

. . . .

The idea of this lesson is to have the children find as many actual instances of the plant and animal responses described above as possible. If suitable audio-visual aids can be found they could contribute greatly to the lesson, especially in city schools. Even better, however, are one or more actual excursions, or short walks, through an appropriate area in the vicinity of the school where the children can do the following:

1. Observe trees and shrubs dropping their leaves.
2. Observe twigs and find matching leaves that have fallen from these twigs or are still attached to the twigs.
3. Observe leaf scars and "pipe ends" in twigs and in the leaf stem.
4. Find the leaf buds that will produce leaves the following year (usually right under the leaf scar).
5. Find places under rocks where insects have been and moved further underground for the winter.
6. Notice how many butterflies and moths are flying about at this time of the year. Review stages in their life history. Point out that adults will lay eggs and die.
7. Find insect eggs.
8. Find nests from which birds have flown, or observe birds gathering in flocks on ponds, lakes and telephone wires and are getting ready to migrate to a warmer climate.

MATERIALS

- Worksheets 26 through 29
- pencils

PROCEDURE

Review with the children the changes in conditions of moisture, light and temperature that take place from July to December. Using what they have learned from their experiments, elicit what would happen to various plants and animals exposed to the extreme cold of winter.

HOW DID BEETLES REACT TO SEVERE COLD SUCH AS WE MIGHT HAVE IN THE WINTERTIME? (They became immobile. They could not move.)

HOW DID THE GROWING GRASS REACT AFTER WE PUT IT IN THE FREEZING PART OF THE REFRIGERATOR? (The grass froze. It died.)

HOW DID THE GOLDFISH REACT TO EXTREME COLD WHEN WE PUT TWO ICE CUBES IN THE WATER? (They breathed much more slowly.)

Now elicit from the children what would happen to many plants and animals if they did not prepare for winter in some way.

WHAT WOULD HAPPEN TO MANY OF THE BIRDS IF THEY DID NOT FLY SOUTH FOR THE WINTER? (They might not find any suitable food or they might freeze and die.)

WHAT WOULD HAPPEN TO BUTTERFLIES AND MOTHS? (They might freeze or starve.)

IF ALL PLANTS AND ANIMALS DID NOT PREPARE IN SOME WAY FOR THE WINTER, WHAT LIVING THINGS WOULD BE LEFT IN THE SPRING? (Dogs, bears, wolves, deer, etc.)

WHY WOULD THEY REMAIN ALIVE? (They are kept warm by their heavy coats of fur.)

IS IT TRUE THAT ONLY MAN AND A FEW OTHER ANIMALS AND PLANTS MANAGE TO LIVE UNTIL SPRING? DO ALL THE OTHER LIVING THINGS DISAPPEAR FOREVER AFTER A WINTER OF COLD, DARKNESS AND LACK OF WATER? (No.)

HOW CAN WE EXPLAIN SEEING ALL THE PLANTS AND ANIMALS ALIVE IN THE SPRING?

Let the children discuss what they have learned from the story in Lesson 17 about the survival of different species. Discuss Worksheets 26 and 27 with them at this time. Then broaden their understanding of plant and animal reactions to the conditions of winter by using one or more (preferably all three) of the following:

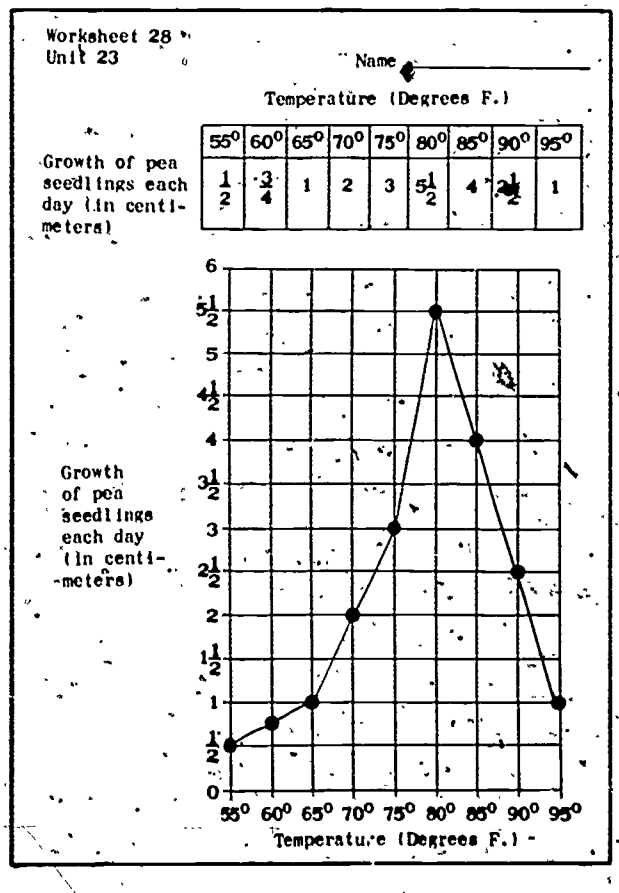
(a) Visual Aids. There are many good films for the primary grades that show how plants and animals prepare to survive the winter. Use several of these, if possible.

(b) Excursions. Take the children on short walks to places where they can see for themselves how plants and animals prepare for winter.

(c) Museum Displays. Encourage the children to bring in specimens from the list provided at the beginning of this lesson. Set up the specimens as an ongoing museum display as long as interest continues. See Living Things in Field and Classroom for suggestions about setting up a classroom museum.

Encourage the children to record their observations. Use the information given in the lesson commentary as a guide, if necessary.

WHEN WE SEE PLANTS APPEARING AGAIN IN THE SPRING, WILL CHANGES IN TEMPERATURE AFFECT THEIR GROWTH? (Let the children speculate.)


Worksheet 28
Unit 23

Name _____

Temperature (Degrees F.)

	55°	60°	65°	70°	75°	80°	85°	90°	95°
Growth of pea seedlings each day (in centimeters)	1/2	3/4	1	2	3	5 1/2	4	2 1/2	1

Growth of pea seedlings each day (in centimeters)

6, 5 1/2, 5, 4 1/2, 4, 3 1/2, 3, 2 1/2, 2, 1 1/2, 1, 1/2, 0

55° 60° 65° 70° 75° 80° 85° 90° 95°

Temperature (Degrees F.)

Ask the class to look at Worksheet 28. Tell them to look at the chart at the top of the worksheet. Explain to the children that someone did an experiment with pea seedlings to find out how much they would grow each day at a certain temperature. (For example, have them look at 55° on the chart. At 55° the pea seedlings grew 1/2 centimeter each day. Explain that seedlings were also growing at other temperatures, e.g., at the temperature of 70°, the seedlings grew 2 centimeters each day.)

Have the children graph the information from the chart at the top of the worksheet. (You may want to make a transparency to help you explain how to graph the information. However, let the children complete the graph themselves.)

The graph illustrates dramatically the effect that temperature can have on plant growth in the spring. Any gardener will see similar effects on his plants after a few warm days. Have the children complete the questions on Worksheet 29, using the graph on Worksheet 28.

Worksheet 29
Unit 23

Name _____

Use the graph you plotted on Worksheet 28 to answer these questions.

1. At what temperature did the pea plants grow the most?
   80° F.
2. At what temperature did the pea plants grow the least?
   55° F.
3. Which temperature was the most like a cool day?
   55° F.
4. Which temperature was the most like a hot day?
   95° F.
5. Which temperature was best for these plants?
   80° F.
6. What happened to the plants when it was too cold?
   They didn't grow much
7. What happened to the plants when it was too hot?
   They didn't grow much
8. When would you expect pea plants to grow best -- in the winter, summer or spring?
   Spring

Discuss with the class their answers to the questions. Make sure to relate the changes shown here to seasonal changes. The children should also see the similarity between the graph and the temperature/plant experiments they performed.

APPENDIX

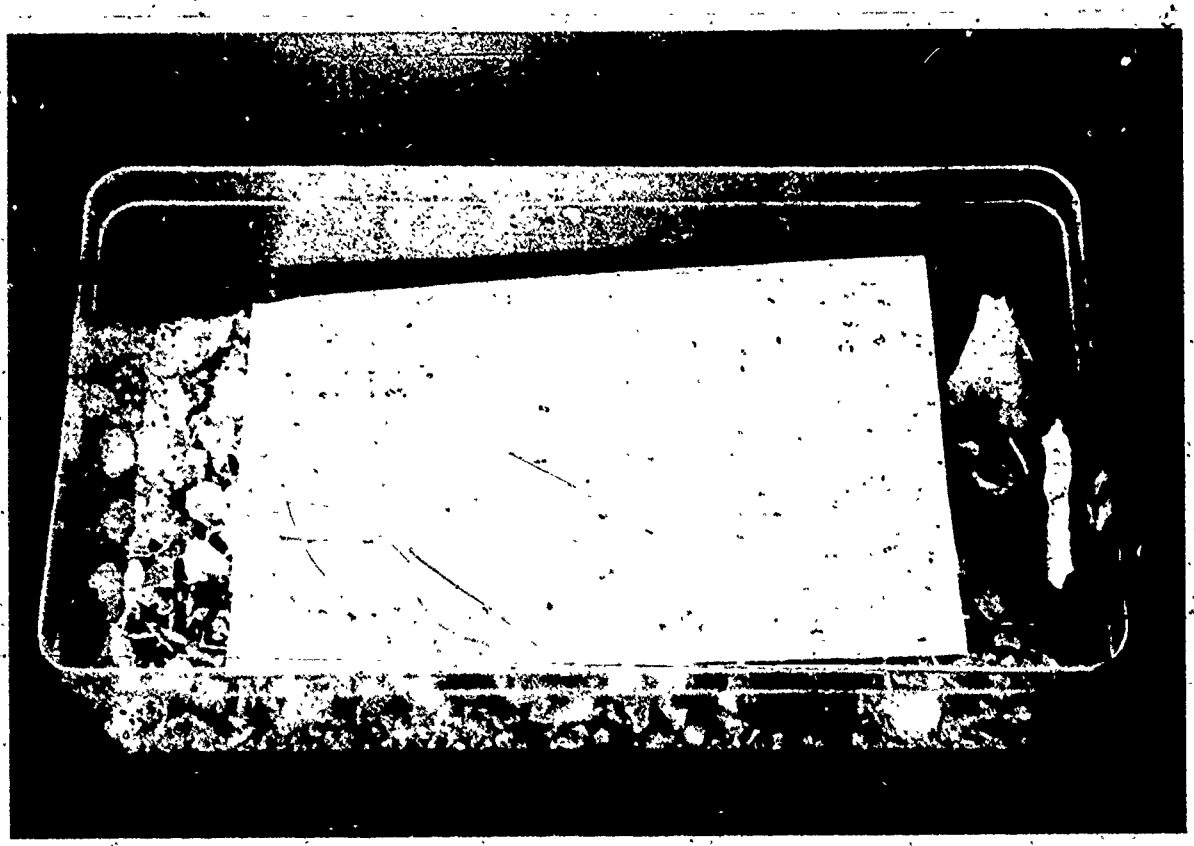
Keeping Mealworms

Mealworms can be purchased in the larval form from pet shops, bait stores or biological supply houses. Buy about twice as many as you expect to need, and the largest size if you have a choice, because these will mature much faster. Start the colony two weeks to one month in advance in order to have mature beetles ready for Lesson 6 (third week of the unit).

Your colony can be reared in a plastic shoe box about half full of cornmeal, oatmeal, graham flour, dry baby cereal or a mixture of dry, unsugared breakfast cereal. Mixtures of cereal seem to supply a better diet. Add the larvae to the box and place a few thick slices (1/4" - 1/2") of apple, potato or carrot on top of the food to provide moisture. Replace these slices when they become very dry, or if they mold. You should place a paper towel over the food, and you may want to weigh the towel down with a stone. The mealworm larvae and beetles cannot crawl up the plastic sides of the box, but they can crawl up the paper if it touches the rim of the box. Keep the shoe box away from heat sources and sunlight.

The growing larvae will shed their skins several times and then form pupae which will develop into the beetles which lay the eggs and start the cycle over. The eggs are very small and difficult to see. Starting with pet shop larvae, pupae will appear in 5 to 10 days and beetles in another 5 to 10 days. The length of the cycle depends to some extent on the age of the larvae purchased.

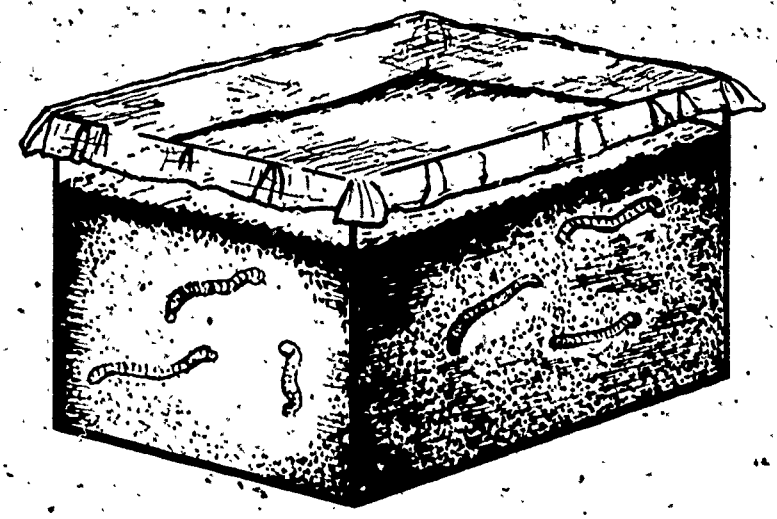
Photographs of a successful mealworm colony appear on the next page. These photographs show the placement of the whole wheat flakes, the fruit cores for moisture, and the paper towel for the darkness that mealworms seem to prefer.



Keeping Earthworms

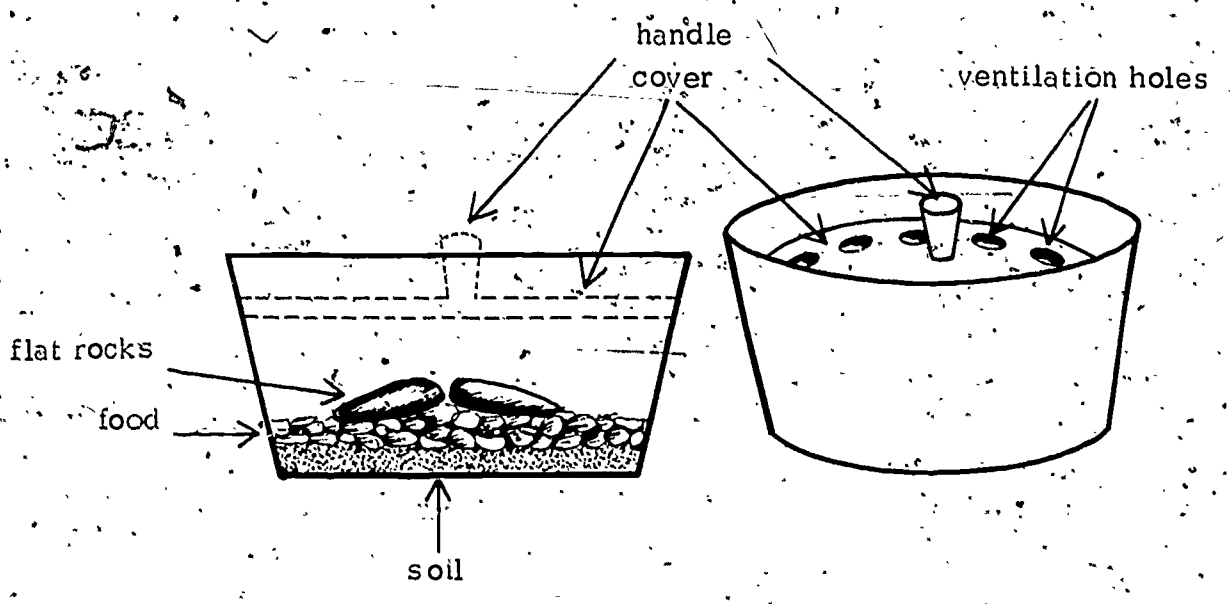
Earthworms can be kept for a few days in the soil with potted plants or in moist terraria. If you want to keep a colony going for the classroom, more permanent quarters can be provided in larger containers, such as cardboard or wooden boxes. Partially fill the container with moist garden or potting soil or with a mixture of peat moss and soil. (The peat moss will improve the texture of heavy or soggy soil.) Add the worms. You may want to cover the container with thin cloth or wire screening. The cover will retard evaporation and keep out unwanted insects. Keep the box in a dark cool place. (Earthworms will not survive long in cans or jars.)

The soil must be kept moist, so it should be sprinkled whenever it becomes dry on top. Every few days sprinkle some uncooked cornmeal or oatmeal, or coffee grounds, on the top layer of soil as food for the worms.



Keeping Sow Bugs

A sow bug colony may be maintained in the classroom in a flat-bottomed, plastic bowl or other container. Put approximately 1 inch of sandy humus in the container. This soil should be well moistened but not soaked. It is important that the soil be sandy so it will not become muddy or excessively dry on the surface. The sow bugs should be provided with some thin flat rocks to hide under. The top of the container or a piece of cardboard with holes punched out for ventilation will be sufficient to keep the sow bugs from escaping since they cannot climb the plastic walls. Sow bugs may be fed on decaying leaves or moist unsweetened breakfast cereal placed under the rocks to decay. When the soil appears dry it should be moistened again.



Keeping Goldfish

The goldfish sold in variety stores and pet shops are sturdy and easy to keep in the classroom. You will not need aerators or heaters for them. First, locate your source and buy your containers. You may also want sand or gravel and plants, but do not buy the fish until you have prepared your aquarium.

Straight-sided glass tanks are best because they provide a large air surface. Two- or three-gallon containers are often all glass. Five- or ten-gallon tanks are usually glass with metal frames. The small containers are easier to handle and cost much less. They will accomodate two medium-sized fish. Three or four goldfish can live in a five-gallon aquarium. To determine whether your tank is large enough, estimate the length of each fish exclusive of the tail fin. Provide about twenty square inches of water surface per inch of fish. Fish can be kept for several days in plastic buckets but avoid metal containers. Sand or gravel is not necessary unless you want to use it to anchor water plants.

Set the aquarium where you will want it (preferably in a cool place out of the sun) and fill it with tap water. If you use sand or gravel, lay a saucer or stiff piece of paper on the bottom and aim the stream of water at it to avoid stirring up the sand. The water should remain in the aquarium at least 24 hours before the fish are added, so the chlorine will evaporate. At this time also fill a plastic bucket or jug with water which will "age" and be ready to replenish the supply in the aquarium, when needed. You can use a few drops of water dechlorinator sold in pet stores to age the water more quickly.

After the water in the aquarium has aged and become clear, purchase your fish, a dip net, and a supply of fish food. Select medium-sized fish. Check to see that there are no dead or sluggish fish in the tank at the store. If there are, it is likely that the fish you buy will be diseased.

The fish will be given to you in a plastic bag. Float the unopened bag in the aquarium for about an hour before

releasing the fish. This allows the temperature of the water inside and outside the bag to equalize. (The shock of rapid temperature change could kill the fish.).

The usual difficulties with keeping goldfish result from keeping the aquarium too warm, keeping the fish in containers that are too small, or overfeeding. Feed the fish only a small pinch of food every day. Pet shops may recommend enough food to be eaten in five minutes each day, but ordinarily a feeding every other day will be sufficient. It is easy to train goldfish to come for food if you always feed them at the same time and in the same part of the tank, and also tap lightly on that place of the aquarium just before you add the food.

If much debris accumulates at the bottom of the tank, siphon it off. If the fish come to the surface for air they are overcrowded or the water has become foul. For the first situation, provide another container; for the second, siphon most of the water out and add new aged water from your reserve supply.

SEEDS TESTED FOR CLASSROOM USE

Kind of Seed	Days to Germination	Days to Flowering	Comments
Beans:			
mung	1	--	Excellent for experiments.
kidney, lima	3	30-40	May produce seeds in well-lighted window.
scarlet runner	5	48	Spectacular growth, beautiful flowers.
Citrus fruits (grapefruit, lemon, lime, orange, tangerine)	30	--	Germination time very uncertain; depends on condition of fruit.
Corn	4	--	Excellent for growth measurement.
Cucumber	3	60	Beautiful vine will produce tiny cucumbers.
Grape	30	--	Interesting vine.
Marigold (dwarf)	3	60	Will flower in good light.
Morning glory	3	60	Will produce ripe seeds in 90 days.
Pea	4	20	Does not do well in overheated rooms.
Pumpkin	4	--	Beautiful vine.
Radish	1	--	Seedlings are excellent for experiments.
Squash (acorn)	8	--	Beautiful vine.
Tomato (Tiny Tim)	3	74	Produces young fruit in 85 days. Seeds from mature fruit will grow.
Zinnia (dwarf)	2	60	Nice flowering plant when given adequate light.