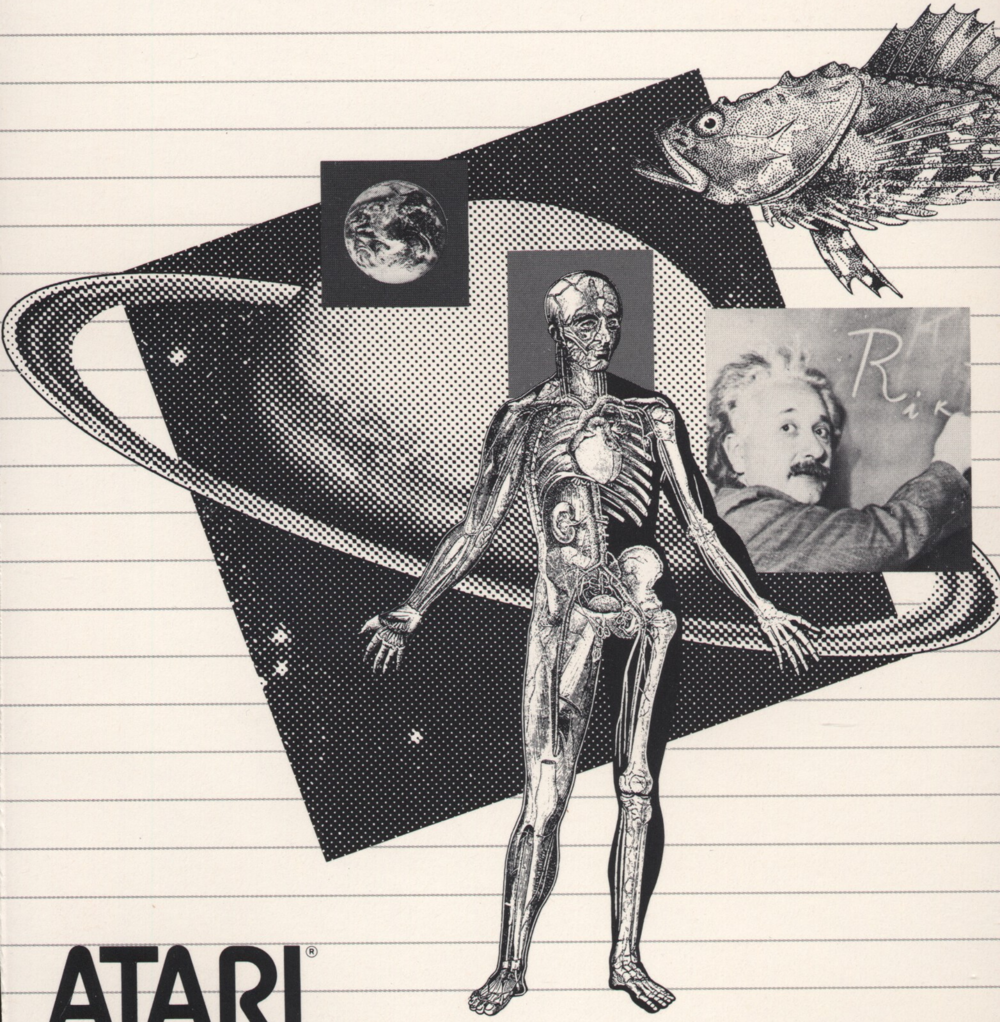
Earth Science



ATARI®
LEARNING SYSTEMS

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Using This Program at Home

Many ATARI® Learning Systems program manuals were originally designed for use by teachers in the classroom. The programs themselves, however, are no less engaging and instructive for "independent learners"—children, students, and adults—working at home.

Every manual includes a "Getting Started" section that explains how to load the program into your computer system quickly and easily. Since many basic prompts and other instructions are displayed right on your screen, that's all you'll need to begin learning and exploring with most ATARI Learning Systems programs. But whether you're a parent, a tutor, or a home learner teaching yourself, it's a good idea to look through the teaching materials in your manual. You're likely to find important details on using the program, valuable supplementary information on its subject matter, and some creative ideas for getting the most educational and entertainment value out of your ATARI Learning Systems program.

Introduction

The *Earth Science* module contains lessons for upper elementary or junior high science classes. Three programs—*Solar Distance, URSA Lesson*, and *URSA Rotation*—cover the astronomy topics of distance in space and rotation of constellations. *Earthquakes* and *Minerals* instruct students on calculating the distance to an earthquake epicenter and on identifying 29 common minerals.

Earthquakes, *Solar Distance*, and *URSA Rotation* take advantage of of the computer's ability to calculate—quickly and accurately—such mathematical relationships as seismic waves and interplanetary distances.

Handout pages in this guide may be duplicated for use with students.

Index to Programs on Diskette

Earthquakes

Simulates locating the epicenter of an earthquake

Minerals

Identifies 29 minerals commonly studied in earth science

Solar Distance

Develops a concept of distance in space by having students take "trips" to planets

URSA Lesson

Identifies and displays the star patterns in the five major constellations

URSA Rotation

Simulates the patterns and rotation of the five major northern hemisphere constellations

Getting Started

Follow these steps to load the Earth Science program into your ATARI computer system:

1. With your computer turned off, turn on your television set or monitor and disk drive. Wait for the busy light on the disk drive to go out.

2. If your computer is *not* equipped with built-in ATARI BASIC, insert an ATARI BASIC cartridge in the cartridge slot (the left cartridge slot on the ATARI 800® computer).

3. Insert the Earth Science diskette in your disk drive (disk drive 1, if you have more than one drive) and close the disk drive door or latch.

4. Turn on your computer. As your disk drive goes to work, you'll hear a beeping sound while the first part of the program loads into your computer. After several moments, a title screen will appear on your screen, followed by a menu of program selections.

Because your computer loads portions of the program as you use them, you must leave the Earth Science diskette in your disk drive while using the program.

Many questions asked by the Earth Science program require a simple Yes or No answer. You may respond by typing **YES** or **NO**, or simply by typing **Y** or **N**. Always press **RETURN** to confirm your response to a question. Before pressing **RETURN**, you may usually change your response; just use the **DELETE BACK SPACE** key to delete your original response, then type in the new response.

To return to the program menu, hold down the **ESC** key in response to any question. When the question Do you want to try again? appears, type **N** and press **RETURN**.

How to Locate an Earthquake

Specific Topic:	Earthquakes
Type:	Simulation
Reading Level:	7–8 (Dale-Chall)
Grade Level:	7–9

Description

This simulation guides students through the calculations necessary to locate an earthquake. They learn how seismologists examine information obtained from measurements of seismographs, including the type of wave, arrival time of the wave, and intensity or strength of the earthquake. From this information, seismologists can locate an earthquake's origin just minutes after it happens.

Objectives

- To calculate the epicenter of an earthquake, given lag-time information from three reporting stations
- To define the following: seismograph, Richter scale, epicenter, shock wave, primary and secondary waves, lag-time

Earthquakes

Background Information

Late in the 19th century it was discovered that earthquakes release energy in the form of seismic waves. Different types of seismic waves are generated by an earthquake, including:

Primary waves (P-waves)

Primary waves, similar to sound waves in the way they're transmitted, result from a back-and-forth vibration of rock. They travel fastest of all the waves and are the first to be received by an earthquake recording instrument called a **seismograph**.

Secondary waves (S-waves)

Secondary waves are similar to water waves and are caused by the up-and-down motion of rock. Secondary waves can't travel through liquids or gases, they're slower moving than primary waves, and they arrive at the seismograph some time after the P-waves.

Since primary and secondary waves travel at different speeds, there's a difference in their arrival times. The time between the arrival of the P-waves and the arrival of the S-waves is called the **lag-time**. Lag-time depends primarily on the distance from the earthquake's starting place to the seismographic station. In general, the longer the lag-time, the more distant the earthquake.

Usually people describe the location of an earthquake by giving its epicenter. But the actual location of the earthquake is underground, at a point called the **focus**. The

epicenter is the place on the earth's surface directly above the focus.

Use in an Instructional Setting

Preparation

Earthquakes have been felt or recorded all over the world. You could find newspaper stories of a recent earthquake, or you might use descriptions of famous earthquakes of the past, such as the San Francisco earthquake of 1906 or the Tokyo earthquake of 1923.

Before individuals or small groups of students run Earthquakes, have them study the student reading in Handout 1, Locating the Epicenter. Use an overhead projector and compass to demonstrate the procedure from Handout 1.

Have students complete Handout 2, Earthquake Terms, and share the Answer Key with the class. Students should now be prepared to use the program. Give each student a copy of Handout 3, Earthquakes Calculation, and a compass before they run the program.

Using the Program

After going through the lesson and receiving the seismic graphs, students should calculate each city's distance from the epicenter and draw distance circles on their maps. Reach a group consensus on the epicenter location, and position the epicenter box at that location.

Following the group demonstration, have each student or small group of students use several copies of Handout 3, Earthquakes

Calculation, while running the program two or three times.

Follow-up

Show a film on earthquakes.

Discuss the following topics:

- Causes of earthquakes (read an article on continental drift or sea floor spreading)
- Methods by which earthquakes tell us about the interior structure of the earth
- Modern engineering in earthquake regions—how it has saved property and lives since the time of the San Francisco earthquake
- Past distribution of earthquakes (plot the locations on a map)

Locating the Epicenter

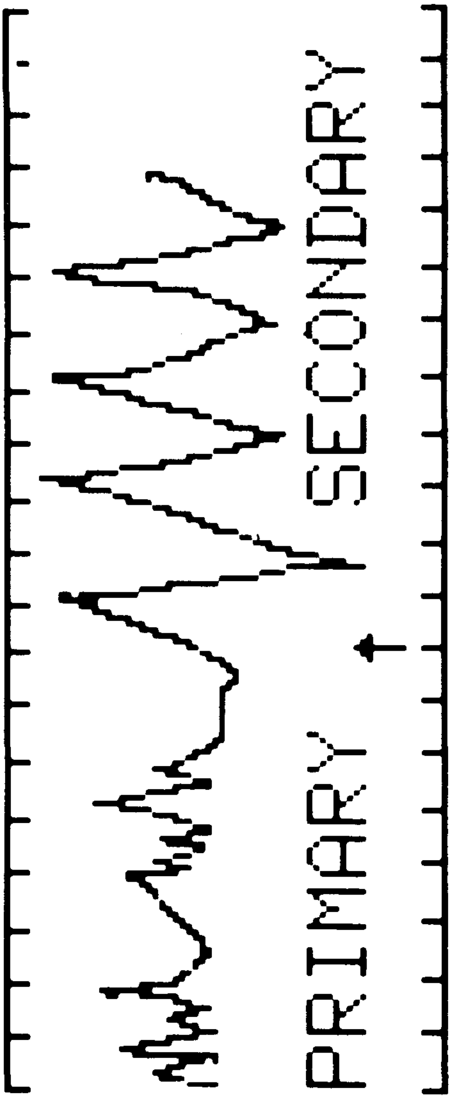
Late in the 19th century it was discovered that earthquakes release energy in the form of waves called seismic waves. Two types of waves are generated by earthquakes:

Primary waves (P-waves)

Primary waves, similar to sound waves in the way they're transmitted, result from a back-and-forth vibration of rock. They travel fastest of all the waves and are the first to be received by an earthquake recording instrument called a **seismograph.**

Secondary waves (S-waves)

Secondary waves are similar to water waves and are caused by the up-and-down motion of rock. Secondary waves can't travel through liquids or gases, they move more slowly than primary waves, and they arrive at the seismograph some time after the P-waves.


PRIMARY
SECONDARY

Since primary and secondary waves travel at different rates of speed, there's a difference in their arrival times. The time between the arrival of the P-waves and the arrival of the S-waves is called the **lag-time**. Lag-time depends primarily on the distance from the earthquake's starting place to the seismographic station. In general, the longer the lag-time, the more distant the earthquake.

Usually the location of an earthquake is referred to as its epicenter. But the actual location of the earthquake is underground at a point called the **focus**. The **epicenter** is the place on the earth's surface directly above the focus.

If you know the speed of travel for each type of earthquake wave and the lag-time for the two waves, it's possible to calculate the distance from a seismographic station to the epicenter of an earthquake. For example, if the P-wave travels at an average rate of 6.1 kilometers per second, it would travel a distance of 100 kilometers in 16.4 seconds.

P-wave

rate 6.1 km/sec.

time to travel 100 km $\frac{100 \text{ km}}{6.1 \text{ km/sec.}} = 16.4 \text{ sec.}$

The S-waves travel at only about 4.1 kilometers per second and would travel 100 kilometers in 24.4 seconds.

S-wave

rate 4.1 km/sec.

time to travel 100 km $\frac{100 \text{ km}}{4.1 \text{ km/sec.}} = 24.4 \text{ sec.}$

The lag-time for 100 kilometers would be 24.4 minus 16.4, or 8.0 seconds. This means that for every additional 100 kilometers the earthquake epicenter is from the station, the lag-time will be an additional 8.0 seconds.

Lag-time for 100 km

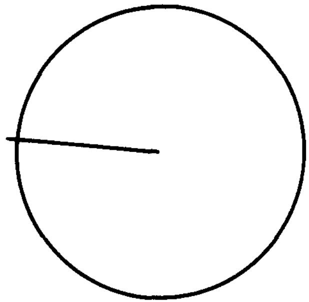
$24.4 \text{ sec.} - 16.4 \text{ sec.} = 8.0 \text{ sec.}$

If you know the lag-time, you can calculate the distance to an epicenter by dividing the lag-time by 8.0 and then multiplying the result by 100.

Distance to Epicenter

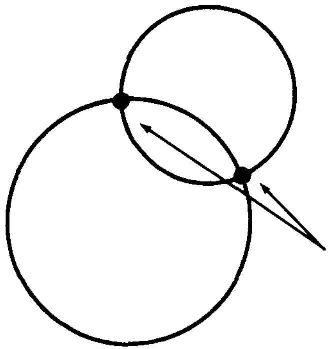
$\frac{\text{lag-time}}{8.0 \text{ sec.}} \times 100 = \text{distance to epicenter}$

Calculating the Distance from a Seismographic Station to the Epicenter of an Earthquake



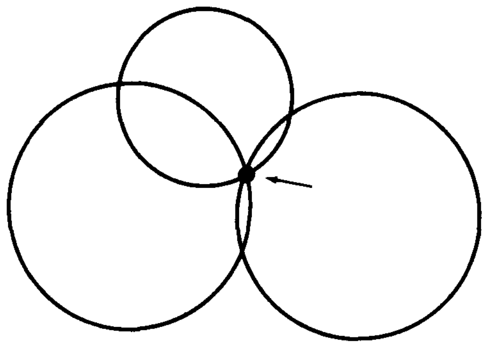
Epicenter can be anywhere on this circle.

One Station—One Circle With a lag-time of 120 seconds, divide 120 by 8 and then multiply by 100. This calculation tells that the earthquake is 1500 kilometers away. But in which direction is it? All the possible places 1500 kilometers away from a point give a circle with a radius of 1500 kilometers. The location of the earthquake lies somewhere on the circle.



Epicenter must be on one of these two points.

Two Stations—Problem Still Not Solved Information from two stations gives two intersecting circles. The location of the earthquake must be at one of the intersection points, because it must lie on both circles. But which one?



Epicenter must be here.

It Takes Three Stations A third station with its information of lag-time is needed to solve the problem. The intersection of three circles, one for each seismographic station, pinpoints the location of the earthquake.

Earthquake Terms

Name ______________________

Class ____________ Date ____________

Match the following terms on locating an epicenter:

1. Fastest-traveling earthquake wave: ____
2. Difference in arrival time of waves: ____
3. Waves similar to water waves: ____
4. The location of an earthquake on earth's surface: ____
5. Where measurements of earthquake waves are made: ____
6. For every additional 100 kilometers the earthquake is away from the epicenter, there's a lag-time increase of ____ .

A. Secondary wave
B. Seismographic station
C. 100
D. 200
E. 8 seconds
F. Primary wave
G. Circle
H. Epicenter

7. With information from only one station, you know the earthquake's location is on a ____ .

8. For every additional 8 seconds of lag-time, the earthquake is another ____ kilometers away.

9. Lag-time if earthquake is 200 kilometers away: ____

10. Distance to epicenter if lag-time is 16 seconds: ____

11. Complete the tables below.

Lag-time is:	Distance to epicenter is:
8 seconds	____
16 seconds	____
128 seconds	____
424 seconds	____
296 seconds	____

Distance to epicenter is:	Lag-time is:
120 kilometers	____
800 kilometers	____
7700 kilometers	____
3250 kilometers	____
1500 kilometers	____

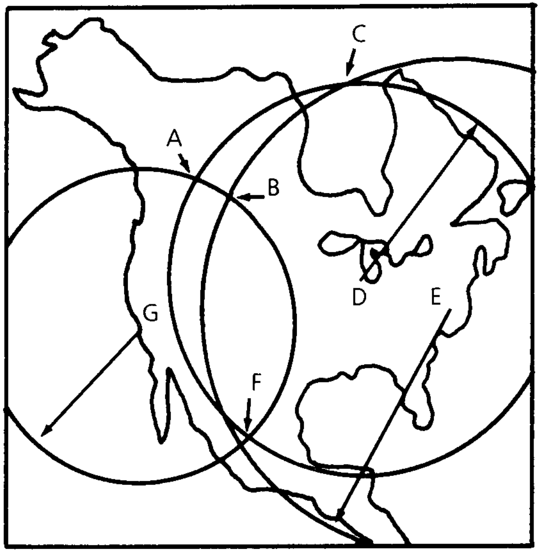
I. 16 seconds

J. Lag-time

Circle the correct answer.

12. Earthquake waves that are similar to sound waves are the
    A. Secondary waves
    B. Primary waves

13. As the distance between a seismographic station and an earthquake increases, the difference in arrival time of P and S waves will
    A. Increase
    B. Decrease
    C. Remain the same
    D. Double



The diagram illustrates how to locate the epicenter of an earthquake using information from stations in California, Illinois, and Washington, D.C. Use the diagram to answer the next question.

14. The epicenter of the earthquake in the diagram above is located nearest which letter? ____

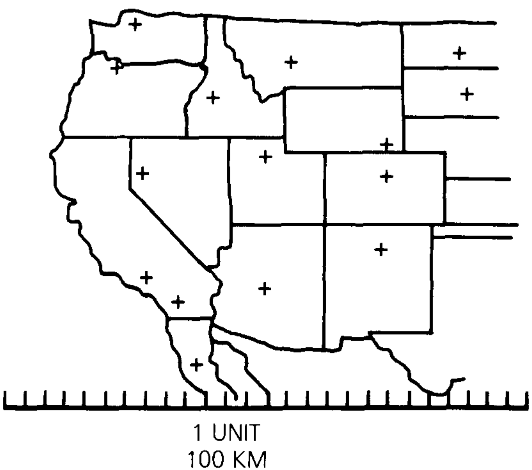
Earthquakes Calculation

Name ______________________

Class ______________ Date ______________

As you run EARTHQUAKES, use a compass to draw the circles locating the epicenter. Draw an X on the epicenter.

Earthquake 1

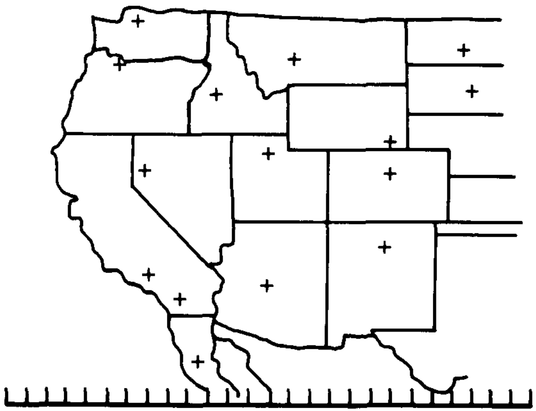


Station: ______________________
Lag-time: ______________________
Distance: ______________________

Station: ______________________
Lag-time: ______________________
Distance: ______________________

Station: ______________________
Lag-time: ______________________
Distance: ______________________

Earthquake 2



Station: ______________________

Lag-time: ______________________

Distance: ______________________

Station: ______________________

Lag-time: ______________________

Distance: ______________________

Station: ______________________

Lag-time: ______________________

Distance: ______________________

Earthquake Terms Answer Key

Locating the Epicenter

1. F
2. J
3. A
4. H
5. B
6. E
7. G
8. C
9. I
10. D
11.

Distance to epicenter is:	Lag-time is:
100 kilometers	9.6 seconds
200 kilometers	64.0 seconds
1600 kilometers	616.0 seconds
5300 kilometers	260.0 seconds
3700 kilometers	120.0 seconds

12. B
13. A
14. F

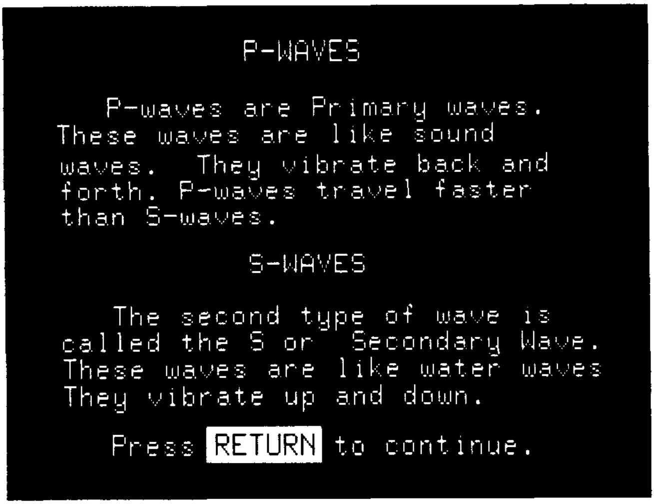
Sample Runs

The program provides three options:

1. an explanation
2. a lesson
3. a "quake"

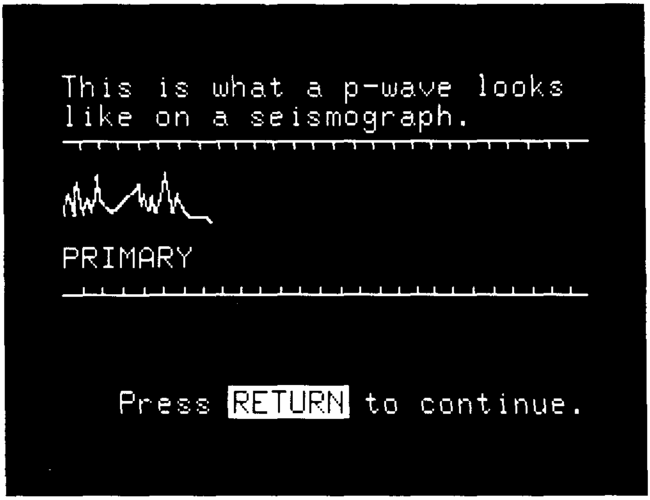
This frame is from option 1.

If students choose option 2, they receive a lesson on finding the epicenter of an earthquake.

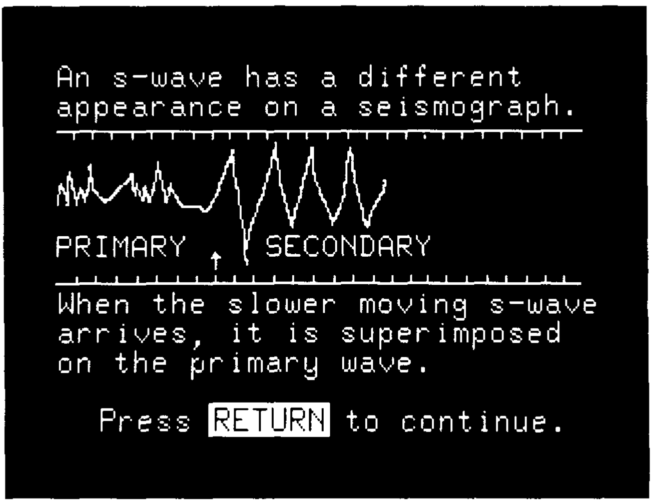


Examples of Screen Output

Sample Runs



Computer graphics diagram a primary wave...

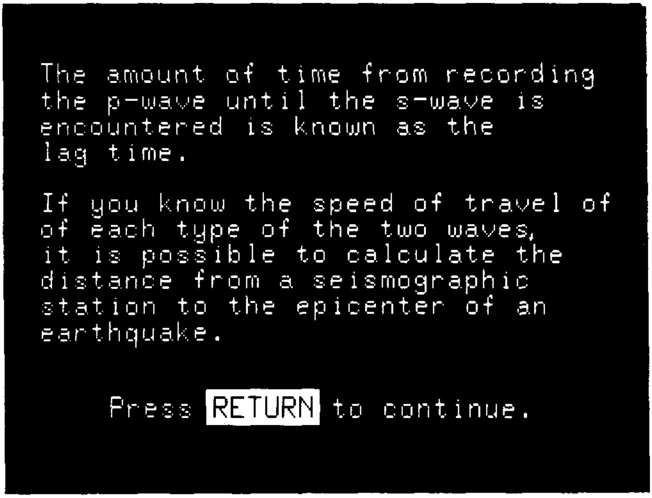


and a secondary wave.

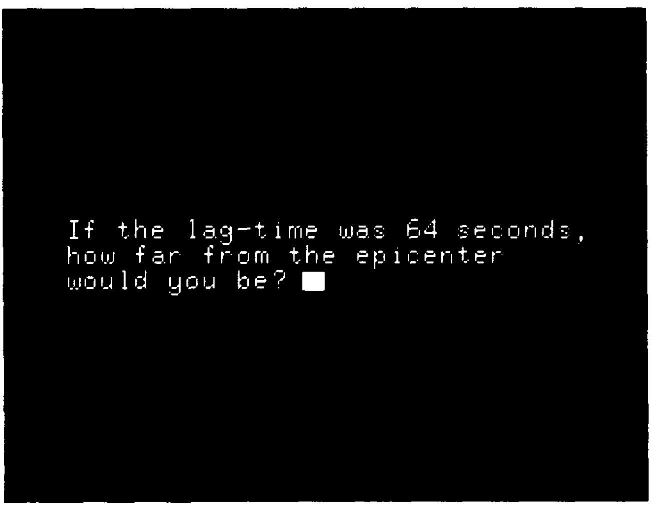
Examples of Screen Output

Sample Runs

The lesson explains lag-time...



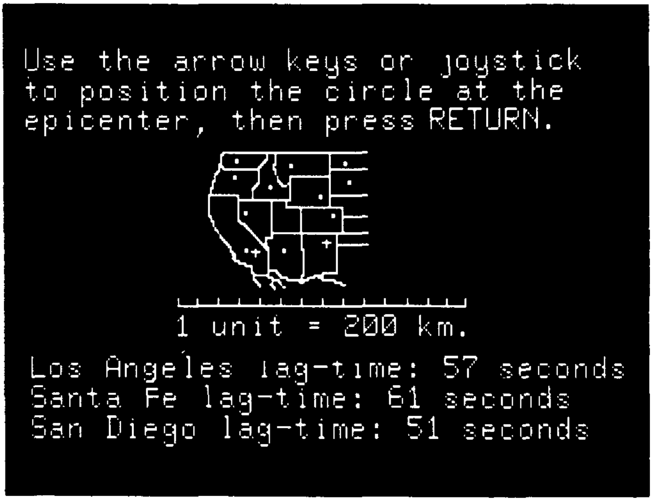
followed by a problem that brings together what has been taught about primary waves, secondary waves, and lag-time.



Examples of Screen Output

Sample Runs

A map shows three randomly selected seismograph stations with the lag-time measurement for each.



Using option 3—a "quake'—students try to pinpoint the epicenter of an earthquake with the locator. The computer then shows its exact location at the point where the three circles converge. After pressing the return key, students see the distance (in kilometers) they were from locating the epicenter.

Examples of Screen Output

Identification of Minerals

Specific Topic:	Minerals
Type:	Problem Solving
Reading Level:	5–6 (Dale-Chall)
Grade Level:	6–9

Description

The Minerals program works as a mineral identification key to isolate distinguishing characteristics for the 29 minerals most commonly studied in earth science classes. The program assumes that a student has an unknown mineral to identify and asks the student to examine the mineral and perform tests on it. If these examinations and tests are correctly interpreted by the student, the unknown mineral will be identified by the computer.

Objectives

- To recognize those characteristics of minerals that identify a unique mineral
- To examine or perform tests on a specific mineral in response to computer prompts
- To classify minerals by the criteria each meets or fails to meet
- To experience a systematized laboratory process of examining and testing objects for classification

Minerals

Background Information

A student must learn to follow a procedure for examining a mineral and performing tests to identify it correctly. Minerals takes a student one step at a time through an identification procedure. The computer assumes that a student has an unknown mineral. After listing the equipment needed, it directs the student to perform various tests and make observations to determine the mineral's characteristics. After enough distinguishing characteristics are identified, the program responds with the name of the mineral.

The computer's ability to identify a mineral correctly depends on the student's ability to interpret tests and observations correctly. If a mineral sample is not a true representation of the mineral, or if the student incorrectly interprets the test, an incorrect identification will take place and the computer will ask the student to try again.

The primary benefit of this program is not in the mineral identification but in guiding students through a *process* of identification. After several trials a student should be able to use the flowchart (like the one on Handout 4) of a similar model to identify any mineral.

Minerals

Minerals used in the program are listed below:

Apatite
Azurite
Beryl
Calcite
Chalcopyrite
Cinnabar
Copper
Corundum
Feldspar
Fluorite
Galena
Graphite
Gypsum
Halite
Hematite
Hornblende
Kaolinite
Limonite
Magnetite
Malachite
Mica
Olivine
Pyrite
Quartz
Sphalerite
Sulfur
Talc
Topaz
Tourmaline

Mineral Properties

Properties of minerals that are easily observed or tested are used to form the key upon which Minerals operates. One of the most easily seen properties is the way in which a mineral separates or breaks. This is called cleavage. A few minerals, such as mica, separate into thin sheets. Halite breaks into square corners, calcite into angular ones.

Another property used to identify minerals is their hardness. Diamond is one of the hardest minerals, graphite one of the softest. Hardness and cleavage are the most useful properties in identifying minerals.

A few minerals can be identified by their reaction to acid solutions. When a dilute acid such as hydrochloric is placed on the surface of these minerals, bubbles of carbon dioxide gas are released. Calcite reacts in this way.

Use in an Instructional Setting

Preparation

Students should know that rocks are made up of chemical elements and compounds. The geologists who study the earth and the rocks from which the earth is made call these elements and compounds **minerals**.

A study of the properties of minerals would be valuable preparation for use of the Minerals program. (See Background Information.)

Students should understand the difference between minerals and rocks. Most of the rocks they find outside are combinations of minerals.

Before running the program, students should be familiar with the following terms describing mineral characteristics. They should know how to determine whether a mineral exhibits each characteristic.

1. Cleavage. Is there cleavage in the mineral structure?
2. Breaking into transparent sheets. How does "breaking" occur?
3. Leaving a mark on a streak plate. Do all minerals of the same color have the same streak?
4. Hardness. Can the mineral be scratched by a nail, glass, fingernail, or copper coin?
5. Color. How is the predominant color determined?

The following material should be available for students to use in performing tests:

A piece of glass
A piece of quartz
A piece of white paper
A nail
A copper penny
A streak plate
Hydrochloric acid (only for calcite and halite tests)

Using the Program

Have students begin using the program with known samples before attempting to test unknown specimens.

The computer program can be used as a supplementary activity during a study of minerals, with three work stations set up in the classroom:

Station One:	Work at computer
Station Two:	Use the flowchart (handout 4)
Station Three:	Check identification wheel (if available)

Given several unknown minerals to identify, students will use each of the three stations to identify at least one of them, and will record all results on Handout 5, Mineral Identity. Each student will need a separate copy of Handout 5 for each station.

Handout 4, Minerals Flowchart, can be cut out and posted on one sheet of poster board for display at station two.

Follow-up

Study the rocks that are most common in the earth's crust by using Handout 6, Common Rocks in the Earth's Crust. Students can find information on these rocks in the library and also use characteristics they discovered while running Minerals.

Some minerals are important because they supply metals. Have students find out how metals are obtained from minerals.

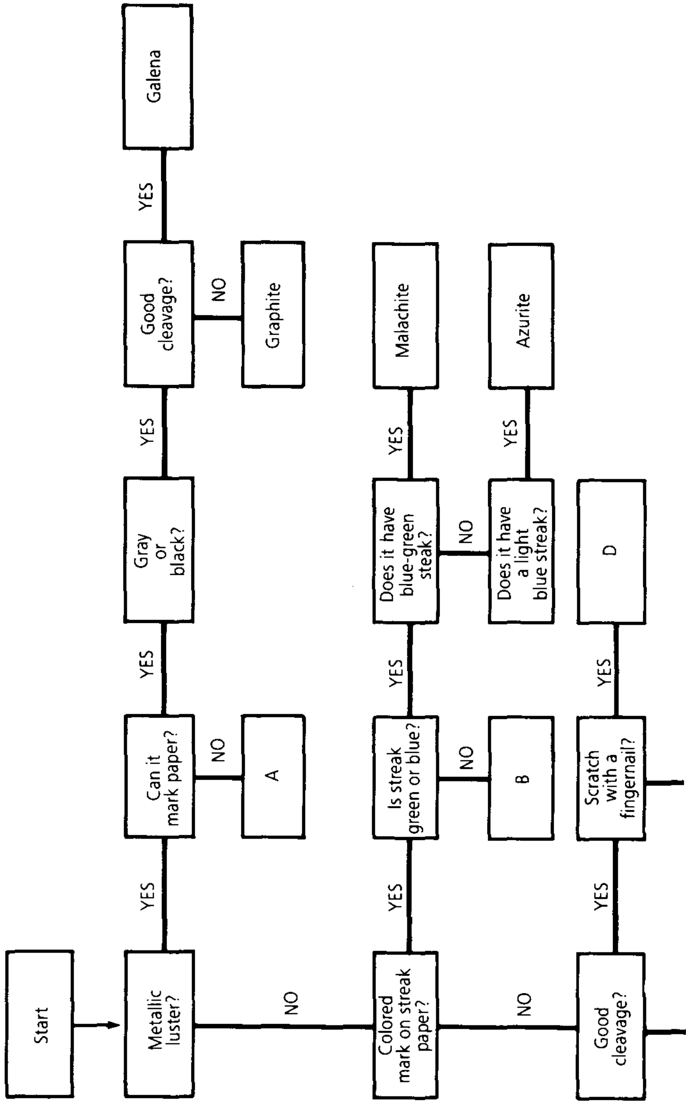
Have students look up the names of very rare mineral stones, research how they are used, and learn how scientists make artificial gems in a laboratory.

Have students make reports on precious and common metals. They could also make a display of their uses.

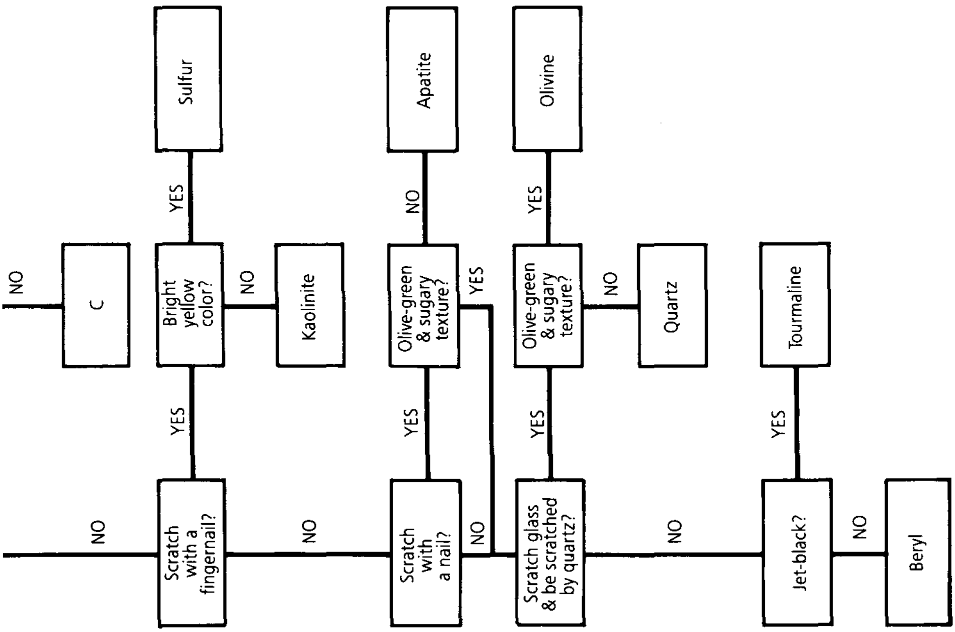
Have students experiment with growing crystals.

Students could collect rock specimens from driveways, ornamental landscape coverings, gravel pits, and other accessible areas. They could examine, test, and attempt to identify these minerals. This will be more difficult than working with known pure specimens, since many rocks are mixtures of minerals. In some igneous rocks, the minerals are clearly visible because of color differences, such as in granitic gneisses where pink feldspar stands out from the white or gray quartz. In still other rocks, the mineral particles are so small that their identification requires microscopic or qualitative analysis and the knowledge of physical chemistry.

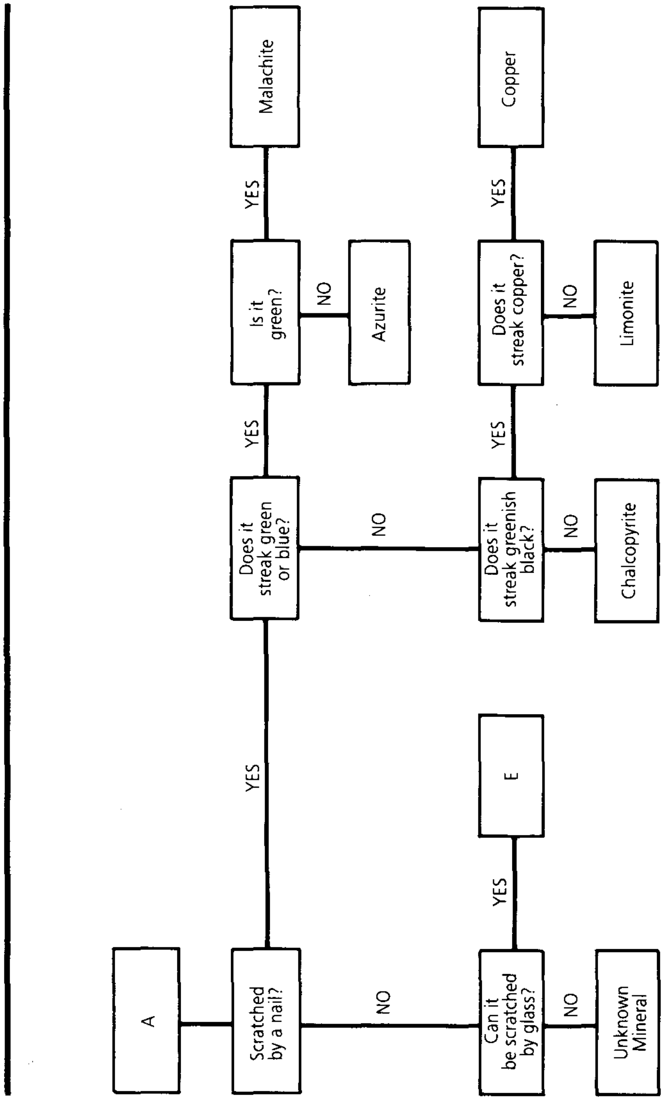
Handout 4
Minerals Flowchart

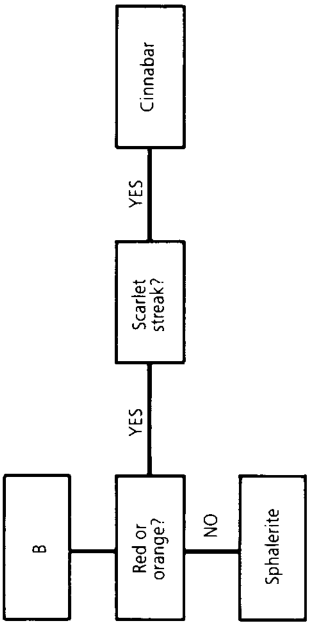


Minerals Flowchart

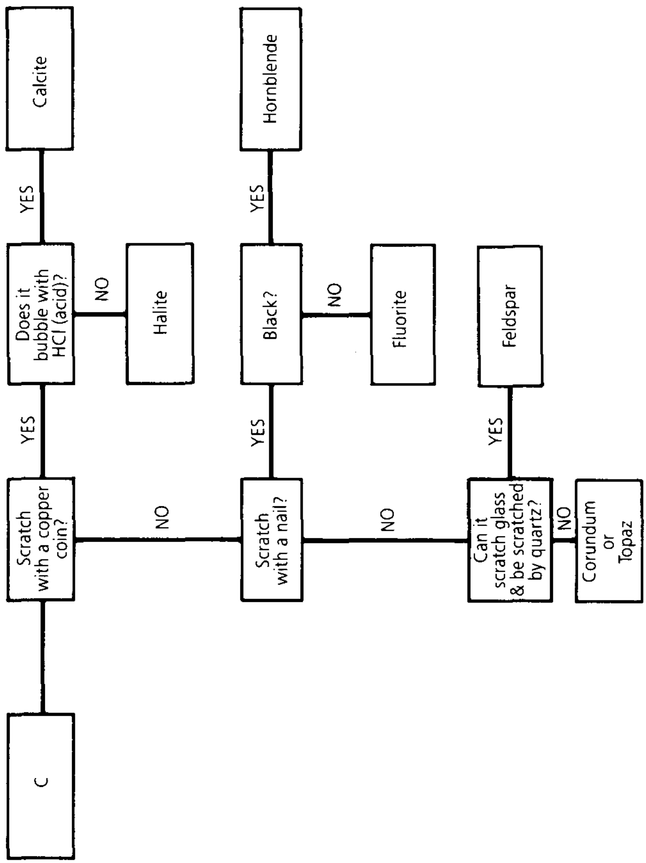

NO
C
Sulfur
YES
Bright yellow color?
NO
Kaolinite
YES
NO
Scratch with a fingernail?
NO
Apatite
NO
Olive-green & sugary texture?
YES
YES
Scratch with a nail?
NO
Olivine
YES
Olive-green & sugary texture?
NO
Quartz
YES
Scratch glass & be scratched by quartz?
NO
Tourmaline
YES
Jet-black?
NO
Beryl

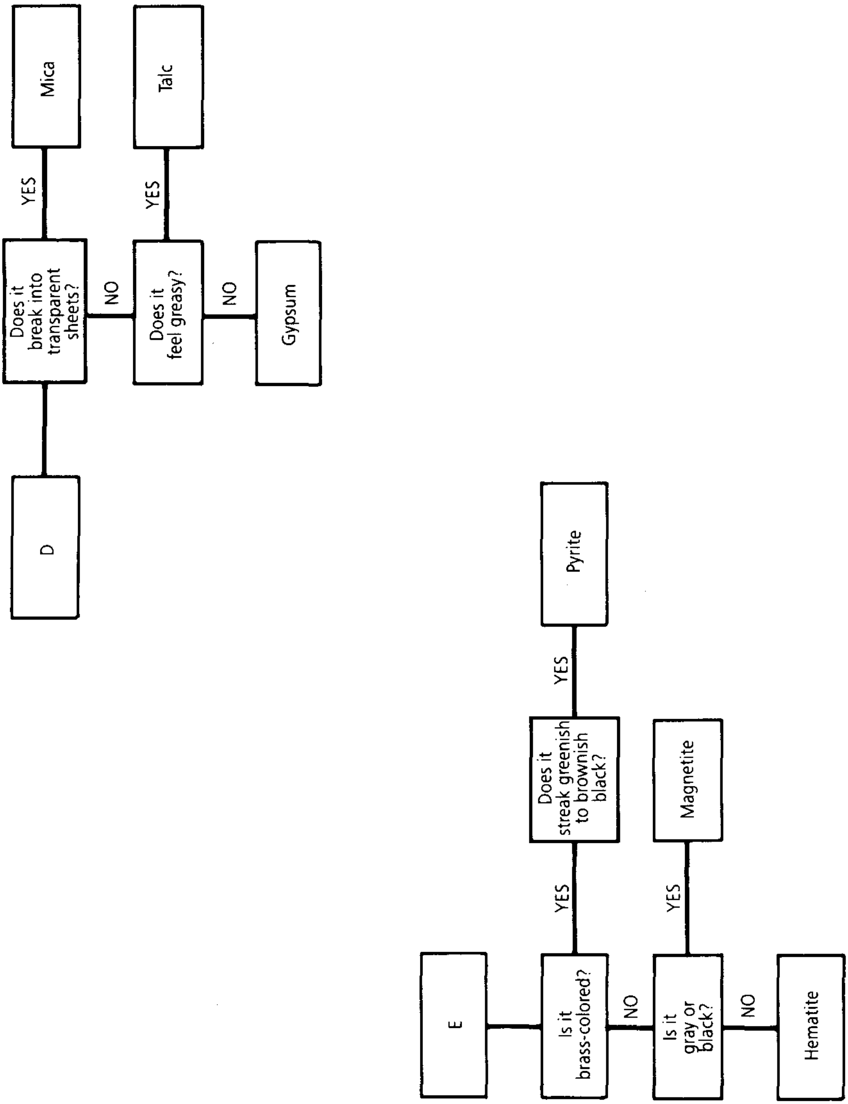
Handout 4
Minerals Flowchart
(Page 2)




B
Red or orange?
YES
Scarlet streak?
YES
Cinnabar
NO
Sphalerite

Handout 4
Minerals Flowchart
(Page 3)




D
Does it break into transparent sheets?
YES
Mica
NO
Does it feel greasy?
YES
Talc
NO
Gypsum
E
Is it brass-colored?
YES
Does it streak greenish to brownish black?
YES
Pyrite
NO
Is it gray or black?
YES
Magnetite
NO
Hematite

Mineral Identity

Name ______________________

Class ______________ Date ______________

Circle the station at which you are working:

Computer **Flowchart** **Identification Wheel**

Answer Yes or No for the tests and observations you make for your sample:

_______ Does it have metallic luster?

_______ Can it mark paper?
_______ Can it be scratched with a fingernail?
_______ Can it be scratched with a nail?
_______ Can it scratch glass and be scratched by quartz?
_______ Can it be scratched with a copper coin?
_______ Can it be scratched by glass?

_______ Is it gray or black?
_______ Is it jet-black?

________ Is it bright yellow?
________ Is it olive-green and sugary in texture?
________ Is it brass-colored?
________ Is it red or orange?
________ Is it green?
________ Is it black?

________ Does it feel greasy?
________ Does it have good cleavage?
________ Does it have cubic cleavage?

________ Does it leave a colored mark on a streak plate?
________ Does it streak green or blue?
________ Does it have a blue-green streak?
________ Does it have a light blue streak?
________ Does it streak greenish or brownish black?
________ Does it have a scarlet streak?
________ Does it streak greenish black?
________ Does it streak copper?
________ Does it bubble with HCl (acid)?

________ Does it break into transparent sheets?

Common Rocks in the Earth's Crust

Name ______________________________

Class ________________ Date ________________

There are over 2000 minerals in the earth's crust. Rocks are made up of combinations of these minerals. Most of the rocks found on or near the surface are made up of the minerals below. The two most common of these rocks are *basalt* and *granite*. But this is not true in southeastern Minnesota and many other areas of the world, where the surface rocks are sedimentary: usually lime/dolomites, sandstones, and shales. Here, quartz is found only as sand particles in sandstone, and feldspars are rare. Calcites and magnesium carbonate minerals make up the common surface rocks. Look up the minerals below in the library, and fill in the information asked for.

Quartz
Three characteristics of quartz are:

1. ____________ 2. ____________ 3. ____________

Quartz is formed by: ____________

____

Quartz is commonly found: ____________

____

Feldspar
Three characteristics of feldspar are:

1. ____________ 2. ____________ 3. ____________

Feldspar is formed by: ____________

____

Feldspar is commonly found: ____________

____

Common Rocks in the Earth's Crust

Name ______________________________

Class ______________ Date ______________

Pyrite

Three characteristics of pyrite are:

1. ______________ 2. ______________ 3. ______________

Pyrite is formed by: ______________________________

____

Pyrite is commonly found: ______________________________

____

Mica

Three characteristics of mica are:

1. ____________ 2. ____________ 3. ____________

Mica is formed by: ____________

____

Mica is commonly found: ____________

____

Sand

(Made up of pieces of quartz)

Three characteristics of sand are:

1. ____________ 2. ____________ 3. ____________

Sand is formed by: ____________

____

Sand is commonly found: ____________

____

Common Rocks in the Earth's Crust

Name ______________________________

Class ______________ Date ______________

Calcite

Three characteristics of calcite are:

1. ______________ 2. ______________ 3. ______________

Calcite is formed by: ______________________________

____

Calcite is commonly found: ______________________________

____

Clay

Three characteristics of clay are:

1. ____________ 2. ____________ 3. ____________

Clay is formed by: ______________________________

____

Clay is commonly found: ______________________________

____

Sample Runs

```
This program will help you
determine which mineral you
are examining.  You will be
asked questions about your
mineral.  To answer the
questions you will make some
observations of the mineral
or do some simple tests.

  Press RETURN to continue.
```

Minerals is used to identify mineral samples.

```
You will be using the following
items:

PAPER             FINGERNAIL
STEEL NAIL        GLASS
QUARTZ            STREAK PLATE
COPPER COIN       HYDROCHLORIC ACID

     Press RETURN to continue.
```

The computer instructs students on how to answer and what equipment they will need to test their minerals.

Examples of Screen Output

Sample Runs

The question is the first in a series of questions the computer asks the students to answer.

```
Apatite         Galena        Mica
Azurite         Graphite      Olivine
Beryl           Gypsum        Pyrite
Calcite         Halite        Quartz
Chalcopyrite    Hematite      Sphalerite
Cinnabar        Hornblende    Sulphur
Copper          Kaolinite     Talc
Corundum        Limonite      Topaz
Feldspar        Magnetite     Tourmaline
Fluorite        Malachite

Does your mineral have a metallic
luster? ■
```

After enough characteristics have been identified, the computer will tell students the name of the mineral being investigated.

```
Apatite         Galena        Mica
Azurite         Graphite      Olivine
Beryl           Gypsum        Pyrite
Calcite         Halite        Quartz
Chalcopyrite    Hematite      Sphalerite
Cinnabar        Hornblende    Sulphur
Copper          Kaolinite     Talc
Corundum        Limonite      Topaz
Feldspar        Magnetite     Tourmaline
Fluorite        Malachite
Based on the computer analyses of
your answers, the mineral is
Cinnabar.
      Press RETURN to continue.
```

Examples of Screen Output

Solar Distance

Distances in our Solar System

Specific Topic:	Astronomy
Type:	Simulation
Reading Level:	3.0 (Spache)
Grade Level:	3–6

Description

This simulation teaches the names of the planets and the distances between the planets and the earth. By riding a familiar vehicle such as a bicycle or train to the different planets, students can better comprehend distances in space.

Objectives

- To learn the names of the planets
- To learn the distances between earth and the planets
- To compare distances and various modes and speeds of travel
- To compare body weight as measured on the planets, moon, and sun

Solar Distance

Background Information

It is difficult to comprehend the tremendous distances in space. When measuring the distances between planets, students sometimes are unable to compare numbers because they're so large. The purpose of this program is to have students comprehend the great distances between the planets by using familiar means of transportation for their space travel. Students may choose to take a bicycle trip to the moon, and because the bicycle is a familiar vehicle, they can better comprehend the time and distance involved in making the trip. All years are calculated on a 24-hour day. Thus, riding a bicycle to the moon would take 3 years of peddling 24 hours a day; converting to an 8-hour day would make the figure three times greater, or 9 years.

The calculations are based on the following speeds of vehicles:

Walk	2.5 miles per hour
Tricycle	3 mph
Bicycle	9 mph
Motorcycle	50 mph
Car	55 mph
Train	90 mph
Propeller Plane	420 mph
Jet Plane	990 mph
Space Transport (at speed of light)	186,000 miles per second

Solar Distance

Use in an Instructional Setting

Preparation

Students should be familiar with our solar system and with the concept of "speed of light" before running the program. Use Handout 7, About our Solar System, to help develop these understandings.

Using the Program

Next divide the class into small groups to run the program. Each group picks one vehicle for traveling to different planets. Fill in the chart on Handout 8, Travel to Different Planets, to compare time required. In a fifth or sixth grade classroom, students might graph the results. Devise a scale for the number of miles, depending on which vehicle is chosen.

The groups can next use the second option. In this option, students choose a planet and are given the time it takes to travel to that planet using the various types of transportation. Before they run the program, have students guess how long it would take to get to the chosen planet. Then run the program and record the actual length of time on Handout 9, Travel by Different Kinds of Transportation.

Compare the length of time to events in the past, for example, to a time in the last century before the students' grandparents were born, or to a century earlier during the American Revolution. Write some of the distances on the board, and discuss the comparative distances between Earth and other planets, such as Mars or Jupiter.

Solar Distance

Prepare scale models, and suspend them from the ceiling to get a feeling for the relative sizes and distances of the planets.

Planet	Size of figure	Distance from Earth (in millions of miles)	Distance between planet models
Sun	"window"*	93	
Mercury	1 inch	57	2 inches from sun
Venus	2¼ inches	26	2 inches from Mercury
Earth	3 inches	0	1½ inches from Venus
Mars	1½ inches	49	2½ inches from Earth
Jupiter	33 inches	370	1½ feet from Mars
Saturn	37 inches	693	1½ feet from Jupiter
Uranus	12 inches	1,590	4½ feet from Saturn
Neptune	14 inches	2,700	5½ feet from Uranus
Pluto	1 to 1¼ inches	3,473	4 feet from Neptune

*A familiar classroom object, such as a window, is suggested to convey the relative size of the sun in comparison with the size of the planets. In actual fact, a three-story building would be more accurate.

Follow-up

Comparisons of body weight on the various planets could make a good follow-up study. Students could research the gravitational pull on the planets and study how this relates to their body weights on the planet.

Here are some other follow-up activities:

- Develop notebooks on the planets.
- Keep a list of new words in the notebooks or on the bulletin board.
- Have students give short reports on planets of their choice, or group students with similar interests and have each group make a report.
- Write a science fiction story about a space adventure.
- Take a field trip to a planetarium or plan an evening to observe the stars.
- Invite local astronomy club speakers to address the students.
- Investigate how astronomers measure distance using the speed of light.
- Research Ole Roemer, a Danish astronomer who first estimated the speed of light.
- Write a story about what the world might be like if people could travel at the speed of light.

About our Solar System

Name ______________________

Class ____________ Date ____________

1. How long does it take light from the sun to reach the earth?

2. How many planets are there?

3. What is the 4th planet from the sun?

4. Jupiter is the ______ planet from the sun.

5. Which planet is closest to the earth?

6. Which planet would it take the longest to walk to?

7. Guess how long it would take to bicycle to Saturn.

8. What is our nearest neighbor in space?

9. Which would take longer: to ride a bicycle to Mars, or to ride a bicycle to Venus?

10. Guess how long it would take to go by car to Pluto.

Travel to Different Planets

Name ______________________

Class ____________ Date ____________

You may travel to a planet, the moon, or the sun by means of one of the following:

Walk	Train
Tricycle	Propeller Plane
Bicycle	Jet Plane
Motorcycle	Truck
Car	Speed of Light

Run the program twice, and record your data in the columns below.

I choose to travel by ________		I choose to travel by ________	
Time Required		**Time Required**	
Sun	________	Sun	________
Mercury	________	Mercury	________
Venus	________	Venus	________
Earth	________	Earth	________
Moon	________	Moon	________
Mars	________	Mars	________
Jupiter	________	Jupiter	________
Saturn	________	Saturn	________
Uranus	________	Uranus	________
Neptune	________	Neptune	________
Pluto	________	Pluto	________

Travel by Different Kinds of Transportation

Name ______________________________

Class ________________ Date ________________

You may travel to one of the following:

Mercury	Uranus
Venus	Neptune
Mars	Pluto
Jupiter	Moon
Saturn	Sun

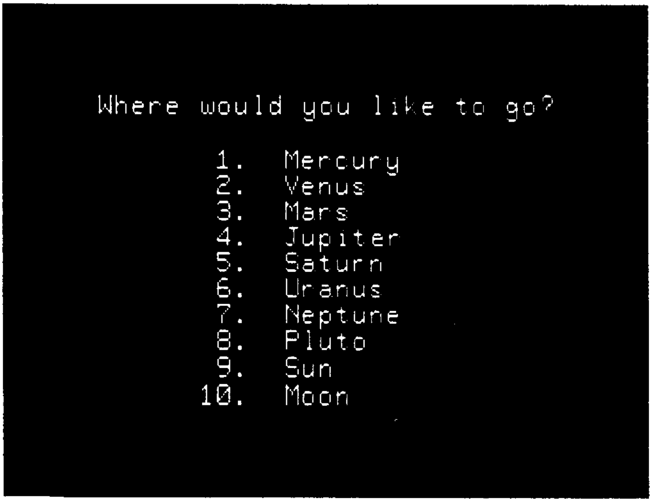
Run the program twice, and record your data in the columns below.

I choose to travel to ______		I choose to travel to ______	
Time Required		**Time Required**	
Walk	______	Walk	______
Tricycle	______	Tricycle	______
Bicycle	______	Bicycle	______
Motorcycle	______	Motorcycle	______
Car	______	Car	______
Train	______	Train	______
Jet Plane	______	Jet Plane	______
Truck	______	Truck	______
Speed of Light	______	Speed of Light	______
Propeller Plane	______	Propeller Plane	______

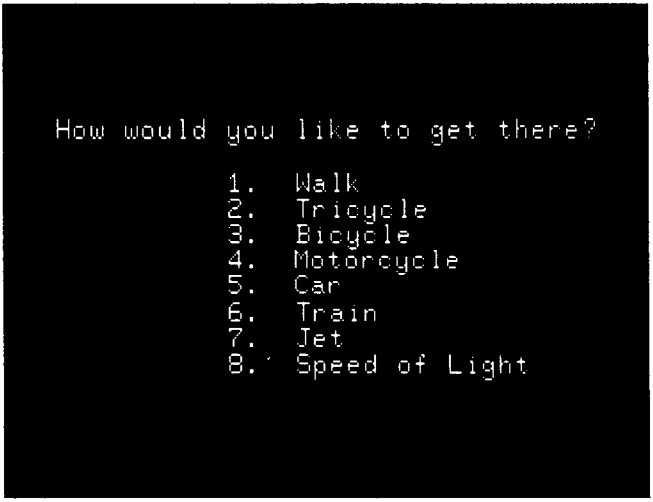
Solar Distance

Sample Runs

Students can travel to any planet, or to the sun or the moon.

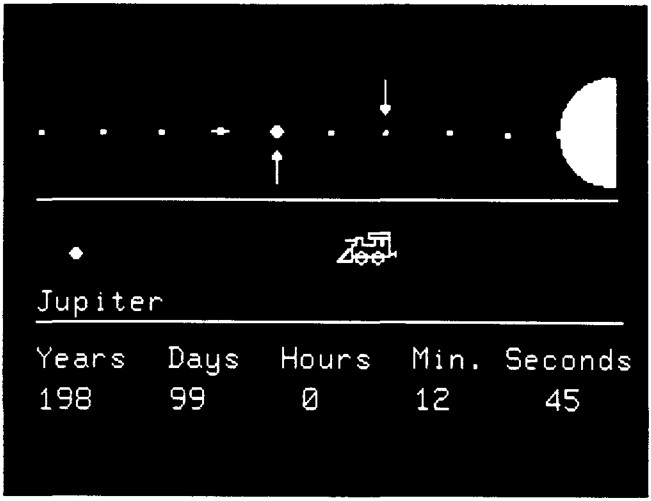


Students choose the kind of transportation they wish to use for travel.



Examples of Screen Output

Sample Runs



In this frame the student chose to take a train to Jupiter. The amount of time it takes to get there is calculated and displayed while the train moves across the screen.

At the end of the trip a summary table is presented showing the results of the students' choices.

Examples of Screen Output

Learning About the Northern Constellations

Specific Topic:	Astronomy
Type:	Simulation
Reading Level:	2.9 (Spache)
Grade Level:	5–6

Description

Students are introduced to five of the major constellations around the North Star; the computer simulates their positions at any time of the day or year. The process of keeping time by the stars is also explained.

Objectives

- To correctly use terminology associated with astronomy
- To identify the five major constellations around the North Star
- To observe the apparent rotation of the stars by viewing the sky at different times

Background Information

URSA names the northern constellations—Cassiopeia, Cepheus, Ursa Major (the Big Dipper), Ursa Minor (the Little Dipper), and Draco—and demonstrates their positions.

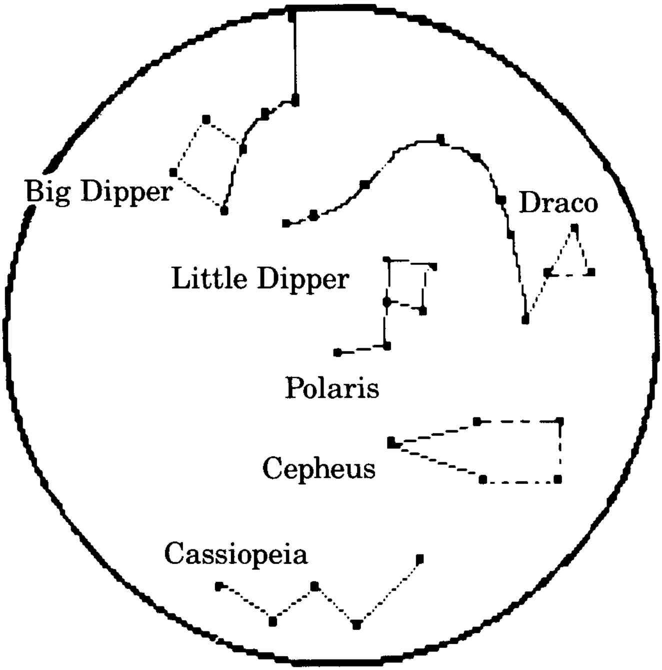
The word "constellation" comes to us from the Latin *constellatio constellatus*, to be "set with stars." A constellation, a number of fixed stars arbitrarily considered as a group, is usually named after some object, animal, or mythological creature supposedly suggested by its outlines: Cassiopeia, in Greek mythology, was the wife of Cepheus and the mother of Andromeda. Draco, Latin for dragon, is the large northern constellation containing the north pole of the ecliptic—the apparent annual path of the celestial sun. The Big Dipper consists of seven stars. The two stars in the front of the cup point to the North Star (Polaris). One of these pointers is the star Dubhe. The other is the star Merak. The Big Dipper forms a part of a larger constellation, Ursa Major or the Great Bear. The tail of the Great Bear, outlined by the bright stars of the Big Dipper's handle, is the most clearly marked position of his body.

Students may choose from two options on the menu frame: URSA Lesson and URSA Rotation.

URSA Lesson. Students learn about the constellations Big Dipper, Draco, Little Dipper, Cepheus, and Cassiopeia by seeing them printed on the screen.

URSA Rotation. In this option, students can choose any time of the day for any day of the year to see what the stars will look like. Times and days can either be predetermined by the teacher (by assigning them on Handout 12, Rotation of Constellations) or chosen by the students.

The pattern of constellations simulated by the computer is depicted below:



Use in an Instructional Setting

Preparation

Discuss the importance that people throughout history have attached to the study of the stars as aids for navigating and telling time. Just as the position of the sun guided the hunter, the herdsman, and the farmer, the nighttime sky guided our ancestors before there were clocks and compasses. From observation they knew that the Big Dipper turns slowly through the sky from east to west and that it travels a certain distance during the night. If the Big Dipper can be considered the clock in the sky, then Polaris (the North Star) can be considered the compass in the sky, since it remains almost exactly at due north.

The mythology connected with astronomy can make interesting lead-in discussions. Handout 10, The Great Bear, can be used at this time.

Using the Program

URSA may be used as a part of a general unit on astronomy. Reinforce what students have been taught about constellations by running URSA Lesson.

Discuss how the constellations seem to rotate around the pole star (Polaris). Divide the students into groups, and have each group use URSA Rotation and complete Handout 11, Rotation of Constellations. They should decide on some problem to investigate. Two suggestions: 1) the positions of the constellations three months apart but at the same time of day, or 2) the position of the constellations on the same day but at different hours. Have the groups draw conclusions and report to the class.

Discuss telling time by use of the stars, and have the students run URSA Rotation. Handout 12, Telling Time by the Stars, will help the students learn how to do this.

Follow-up

Help students appreciate the tremendous impact the idea of "star" has had. Ask students to bring examples of the star as motif in poetry, music, art, literature, or drama. Have students check the daily newspaper and take a count of the many different uses for the word "star"—for example, astrology, sports, entertainment.

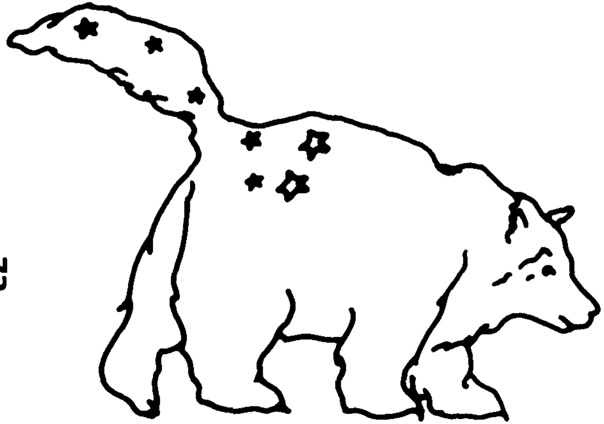
Handout 13, What Have You Learned?, can be used as an evaluation form.

The Great Bear

The Big Dipper consists of seven stars. The two stars in the front of the cup point to the North Star. One of these pointers is the star Dubhe. The other is the star Merak. The Big Dipper forms a part of a larger constellation, Ursa Major or the Great Bear. The tail of the Great Bear, outlined by the bright stars of the Big Dipper's handle, is the most clearly marked position of his body. A legend says that the Great Bear is so proud of its tail that he gazes jealously at the lone bright star in the Little Bear's tail (Little Dipper) in hope that some day he may gain possession of it. The gods have placed two "guard" stars between the Great Bear and the Little Bear to protect it.

The Great Bear has various legends based on folklore from the Romans, Greeks, Indians, and others. The following is a Greek legend:

Juno, Queen of the Immortals, was jealous of Callisto because of her association with Jupiter. Juno changed Callisto into a great shaggy bear.



Years later, Callisto's son, Arcas, met a bear on a lonely path in the mountains. Arcas pulled out his bow and arrow and shot at the creature. Just then Jupiter happened to look down from the sky, and he stopped the arrow in flight. Jupiter changed the boy into a bear and raised both bears into the sky. As he was raising the bears into the sky, their tails were stretched, which is why they now appear in the sky with long tails.

Juno was angry when she found out what Jupiter had done. She wanted to punish the bears immediately—especially the Great Bear, Callisto. The Greeks believed that the stars enjoy a dip in the waves of the ocean before they disappear below the horizon—after the long journey across the sky, the stars look forward to the dip. Seeing this as a chance for revenge, Juno harnessed her peacocks and drove to the palace of Oceanus, the ancient god of the Ocean Stream. Juno called him up from the depths of the ocean and made him swear to drive the Great Bear away from the water, and therefore the Great Bear never has the chance to wade in the western ocean. While the other constellations have a chance to immerse their stars in the waves, the Great Bear and Little Bear must ascend the steep slope of the sky, never to rest or bathe.

Rotation of Constellations

Name ______________________

Class ______________ Date ______________

Copy the position of the stars on this worksheet.

Day ______________ **Day** ______________
Time ______________ **Time** ______________

★ Polaris ★ Polaris

Day ____________________
Time ____________________

★ Polaris

Day ____________________
Time ____________________

★ Polaris

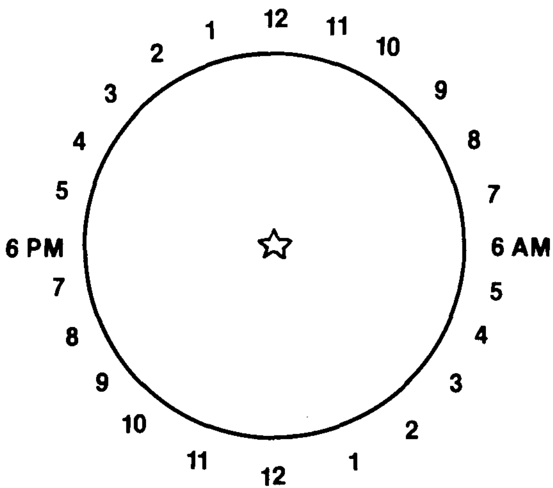
Telling Time by the Stars

Name ______________________

Class ______________ Date ______________

Run URSA Rotation. Mask out or ignore the hour information at the bottom of the screen. Follow the procedure described below, and see if you arrive at the same time the computer shows for this rotation.

The method for telling time by the stars is as follows:



First locate the Big Dipper. Now look for the two end stars in the cup of the dipper. Imagine a line drawn through these two stars (sometimes called the pointer stars) and extending above the dipper. This line will pass through the bright star, Polaris or the North Star. Now imagine that Polaris is the center of a giant clock, a clock that instead of having 12 hours has 24 hours and runs backward. This clock has a 12 in the regular 6 o'clock position. Six p.m. is at the normal 9 o'clock spot, and 6 a.m. is where 3 o'clock is located.

The pointer stars on the Big Dipper are the hour hand of the clock. Using the clock as described above, you will use the position of the pointer stars to determine the time of day by the following method:

1. What month is it? Using the numbers 1 through 12, the number of the month is ____ .

2. Multiply the number of the month by 2. ____ × 2 = ____ .

3. If the day is in the first half of the month, add 6; otherwise add 7 to the answer in Step 2.
   Day ____
   First half ____ + 6 = ____
   Second half ____ + 7 = ____

4. If the result is more than 24, subtract 24.
   ____ − 24 = ____

5. Look at the pointer stars. What hour do they indicate? ____

6. From the position determined in Step 5, move clockwise on the above clock the number of units determined in Step 4. The result is the time of day: ____ .

What Have You Learned?

Name ____________________

Class ____________ Date ____________

1. Explain why constellations seem to change positions during the night.

2. Describe how you can locate constellations.

3. Where must you be on earth to see the North Star and the Big Dipper?

4. What does the constellation Cassiopeia look like?

5. The Big Dipper is part of what larger constellation?

6. Which two stars of the Big Dipper are called pointer stars?

7. Why does the North Star appear to be stationary?

8. What does the constellation Cepheus look like?

Sample Runs

URSA is two separate programs found on the main menu.

```
        PHYSICAL SCIENCE

      1.   EARTHQUAKES
      2.   MINERALS
      3.   SOLAR DISTANCE
      4.   URSA LESSON
      5.   URSA ROTATION

      6.   PROGRAM DESCRIPTIONS
      7.   END

  Which number?
```

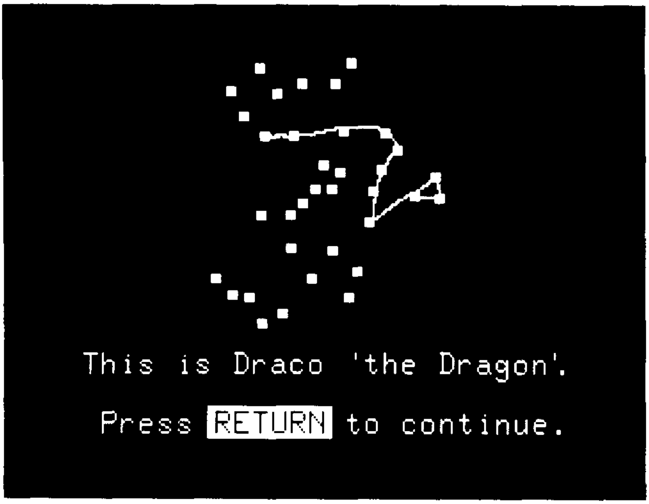
In URSA LESSON, students will learn about the constellations.

```
  Very long ago, ancient
astronomers identified groups
of stars which formed shapes
or pictures.  These groups of
stars were called
* C O N S T E L L A T I O N S *
  You may be familiar with some
constellations such as the
"Big Dipper" and the "Little
Dipper".
  The computer will now display
the pattern of these and other
constellations.
    Press RETURN to continue.
```

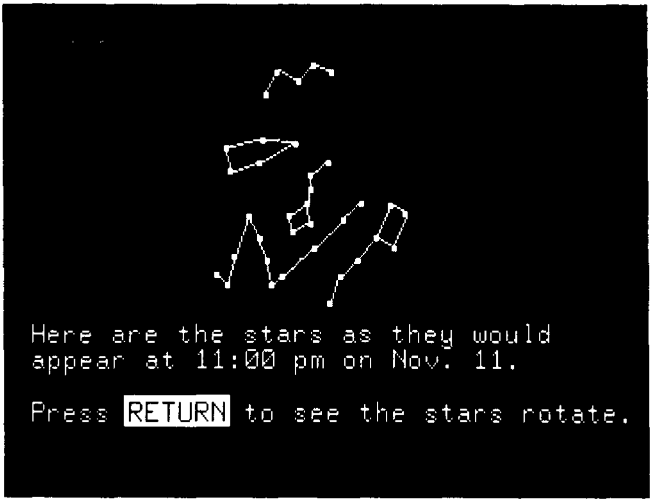
Examples of Screen Output

Sample Runs

The computer draws the constellations one at a time and names them.



In URSA ROTATION the students can choose the date and time, and the computer will show the position of the constellations.



Examples of Screen Output

The ATARI Learning Systems Earth Science program was developed by the Minnesota Educational Computing Consortium (MECC). Some authors and programmers involved in the development and conversion of these programs are noted below.

Earthquakes

Originally called Quakes, the program was developed under a MECC Mini-Grant Project by Curt Hoppe and John Lillifors, East Grand Forks School District. It was adapted by MECC staff and converted to the ATARI computer by Bret Indrelee, MECC.

Minerals

The original program was written by Steve Woodward, Alexandria, Minnesota, and contributed to the MECC Timeshare System library. It was rewritten by MECC staff and converted to the ATARI computer by Mike Boucher, MECC.

Solar Distance

Marge Kosel and Peter Burbulas developed the Solar Distance program. MECC staff added graphics, and Lance Allred, MECC, converted the program to the ATARI computer.

URSA Lesson and URSA Rotation

These programs were originally designed by Hugh Collet at a National Science Foundation Institute in Michigan. MECC staff rewrote the program and added a tutorial section. Tony Prokott, MECC, converted the program to the ATARI computer.

The content of this manual is in large part a revision of materials written and designed by Shirley Keran, MECC, which in turn included material from the book *Elementary ... My Dear Computer*, developed by Marge Kosel and Geraldine Carlstrom for timeshare computing. Teachers from throughout the state of Minnesota contributed ideas to that effort. Karen Jostad, MECC, prepared the ATARI computer *Earth Science* manual, which has been revised by ATARI staff.

ATARI®

A Warner Communications Company

P.O. Box 61657
Sunnyvale, CA 94088
Printed in U.S.A.

C024784-052 REV. A

AED8005