Week 7

This week, your students round up their study of the Sun with an experiment which explains the seasonal and geographic variations in the Sun's path.

Continue the activities started in the previous weeks:

* Once this week (before Lesson 18):
  - .Sunset
  - .Noon shadow

As their study of the Solar System draws to a close, your students should be made aware that the universe is much larger than the Solar System.

* Research topics: stars, galaxies, black holes, quasars, ...

After the last lesson, ask the students for all the words they can think of that have something to do with the Solar System. They should be able to come up with a very long list. If you kept the list made before the first lesson, comparing the lists should make clear how much was learned.

Lesson 19
A TILTED PLANET

OBJECTIVES:

* To account for seasonal variations in the Sun's path with the help of a model.

GRADES: 6 and up.

SCHEDULING:

This lesson will take one class period.

PREPARATION:

Use the ALMANAC to find the times of sunrise and sunset at one week intervals for the past several weeks (starting on the day of the gnomon experiment).

A day or two before doing this activity, ask the students to check whether the North Star is still in the same place in the night sky. (It will be.)

DISCUSSION:

Start out by discussing all the records you have of the Sun's motion: sunset drawings, noon shadow records.

* How has the Sun's path changed in he past few weeks?

(Inspecting the records should reveal that the time and direction of sunset has changed; that the length of the noon shadow has changed.)

Write the times of sunrise and sunset for the past weeks on the chalkboard.

* How long was the day each time? How has it changed?

MATERIALS:

* A bright light
* A 9" x 9" styrofoam stand
* A 1/16" diameter dowel, 9" long
* A styrofoam ball, 3" diameter
* A straight pin
* A 1" square of thin cardboard, marked with the compass directions (Figure 9-1)
* A protractor
* Some cellophane tape

STUDENT SHEETS:

* Tilted Planet

ACTIVITY:

Because this experiment is complicated and requires a lot of space, it is best for you topo demonstrate it while your students watch. Encourage them to ask questions and to comment on the experiment.

By pressing firmly down, place the protractor vertically into the styrofoam stand, so its center and zero degree line are level with the surface of the stand.

Poke the dowel through the styrofoam ball. Be careful to go as nearly through the center of the sphere as possible.

The basic setup of the experiment is illustrated in Figure 9-2. Poke the dowel into the styrofoam stand near the center of the protractor, at an angle of 65 to 70 degrees (this will give your globe the same tilt as the Earth.) Tape the dowel to the protractor for stability. Slide the sphere on the dowel so that its center is at the same height as the light source. (This is

essential for the experiment to work.)

Poke the pin through the dot at the center of the cardboard square, and place it on the sphere, at a point approximately half way between the pole and the equator. The North mark on the square should be directly North of the pin (i.e. between the pin and the North Pole).

Make the room as dark as possible, so that the bright light is the only source of light and that the shadow of the pin is clearly visible on the cardboard. The pin represents a gnomon on the Earth's surface, and the light represents the Sun.

Explain that the Earth's axis always points to the North Star. This can be verified by the fact that Polaris does not move in the night sky, while all the other stars appear to turn around it. Tell your students that while carrying out this experiment, the axis should always point to the North. On the other hand, the Earth travels around the Sun, which leads to the different positions shown on the student sheet.

Discuss in which direction the globe should rotate around its axis in order for the Sun to "rise" roughly in the East. (In other words, when the pin comes into the light, its shadow should point in a generally Westerly direction.)

Hand out the Tilted Planet student sheet. Place the Earth model in various positions around the "Sun", always making sure the axis points to the North. Show the students what happens with the gnomon shadow as the Earth rotates around its axis. Repeat the experiment as often as necessary for the students to

be able to answer the questions.

CONCLUSIONS:

The conclusions for this lesson and the next are summarized on the student sheet titled "The Year".

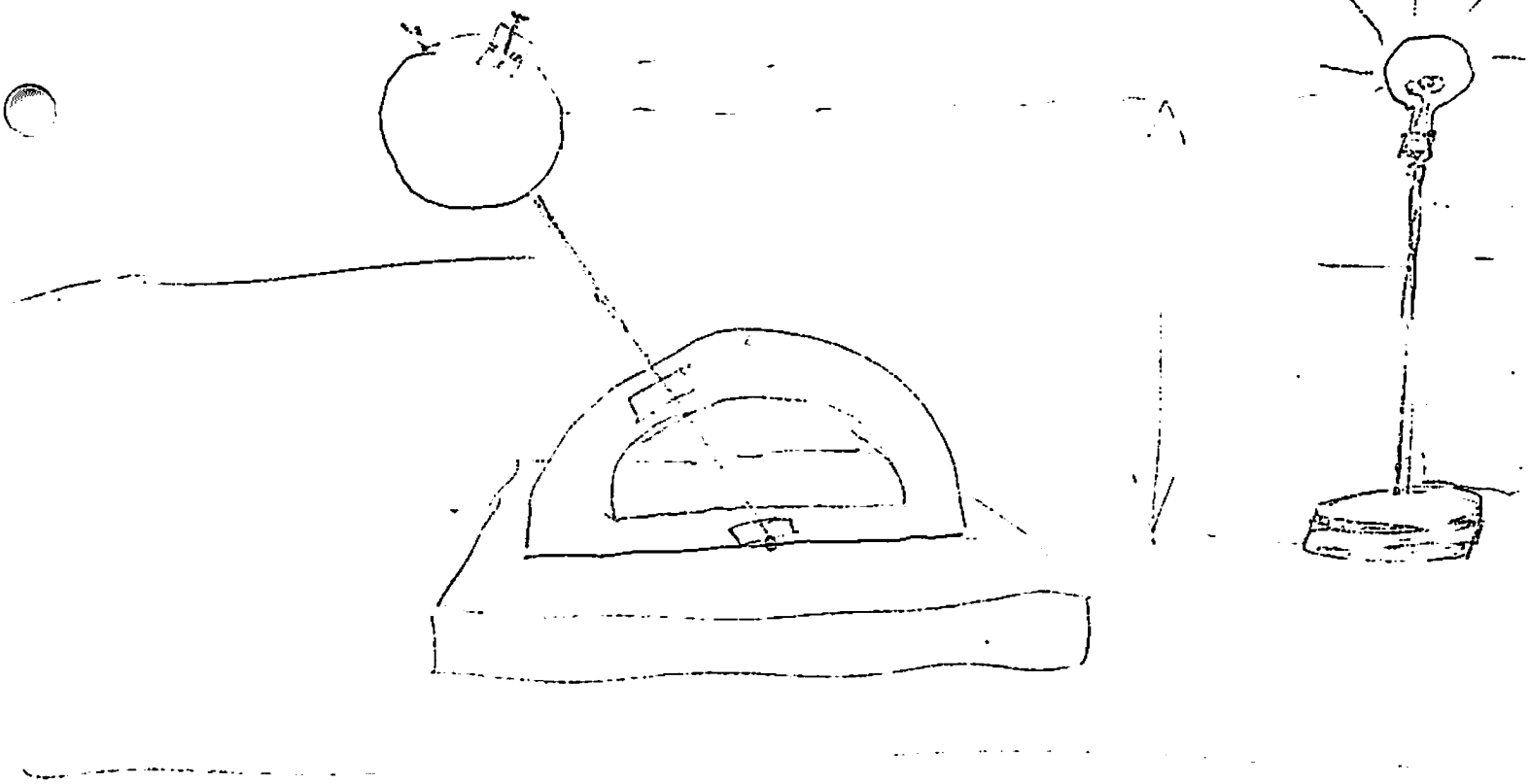


Fig 9-2

Fig 9-1

A TILTED PLANET

The figure shows three possible ways to place the Earth in relation to the Sun. Experiment with each position, and answer the questions below. (Remember that the gnomon shadow points in the direction opposite to that of the Sun.)

* In which position does the Sun rise in the North East? the East? the South East?

* In which position is the midday shadow the longest? the shortest? Is there a position where the gnomon has no shadow?

* In which position does the Sun set in the North West? the West? the South West?

* In which position is the day longer than the night? the night longer than the day? in which position are they equal?

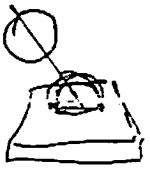
* Which position corresponds to winter? summer? spring? autumn?

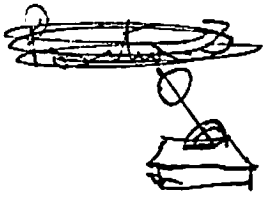
Position 1 :

(top of axis points to "Sun")

Position 2

(top of axis at right angles to "Sun")





Position 3
(top of axis points away from light)

THE YEAR

WINTER SOLSTICE: December 21. The Sun rises and sets at its furthest South position. Midday shadows are the longest of the year. Shortest day of the year. Longest night.

SPRING EQUINOX: March 21. The Sun rises due East, sets due West. Night and day are of equal duration.

SUMMER SOLSTICE: June 21. The Sun rises and sets at its furthest North position. Midday shadows are the shortest of the year. Longest day, shortest night.

FALL EQUINOX: September 21. The Sun rises due East, sets due West. Night and day are of equal duration.

Lesson 24

LATITUDE

OBJECTIVES:

* To understand how latitude affects the Sun's path.

* To learn about the Tropics, and the Arctic and Antarctic Circles.

GRADES: 6 and up.

SCHEDULING:

This lesson will take one class period.

PREPARATION:

You will use essentially the same experimental setup as in the last lesson.

STUDENT SHEET:

* Where on Earth?

ACTIVITY:

Run through the experiment of Lesson 18, with the following change: place the gnomon very near the North Pole. (This will help answer the questions about the Arctic Circle.)

Then, place the gnomon very near the Equator. (This should help answer the questions about the tropics.)

With each position of the gnomon, place the Earth at the various positions around the Sun, until the students can answer the questions on the sheet.

CONCLUSIONS:

The conclusions to this Lesson and the previous one are summarized on the student sheet titled "The Year". Hand out the sheet and discuss it.

WHERE ON EARTH?

* In which position does the area around the North Pole have constant daylight? constant night? a night and a day?

* Try to place the gnomon so that it has no shadow. Where on the globe is this possible?