MAST ACADEMY OUTREACH

MIDDLE SCHOOL PROGRAM

Adventures Aboard

WOW
(Weather on Wheels)

Post-Site Packet

MAST Academy

Maritime and Science Technology High School

Miami-Dade County Public Schools

Miami, Florida

MAST ACADEMY OUTREACH

WEATHER ON WHEELS POST-SITE PACKAGE

TABLE OF CONTENTS

TEACHER INSTRUCTIONS

WEATHER ON WHEELS POST-SITE PACKAGE

1. **Grade on-site lessons, and total points**

2. **Using data collected while on WOW, have students complete the activity "Analysis of Class Weather Data." You may want to reproduce the chart on page 3 on your blackboard; a representative from each on-site team can add their data to the chart, after which students can transfer the compiled data to their own chart.**
   Be sure that students understand that the units used to label their graphs will depend on the range of measurements the class obtained on-site.

3. **Have students read the background information on weather satellites, then complete the activity "Around the World." The materials needed to complete the activity are listed on page 13. The polar orbit and geostationary orbit templates are located on pages 18 and 19.**

4. **Using the satellite images found on pages 24-27, have students complete the activity "TV or Not TV."**

5. **Combine pre, on, ond post-site scores to compute a total grade for WOW activities. The Satellite Word Search and Satellite Crossword Puzzle are optional activities for your students, and should not be included in the post-site score.**

6. **Complete the evaluation forms located on page 3, and forward within 10 days of competion of all activities to MAST Academy Outreach, Mail Code 7161.**

MAST Academy Outreach
greatfully acknowledges
the assistance given by the
members of the
Weather on Wheels
Advisory Committee

Commander Virginia Newell, NOAA/AOML
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Mr. Victor Wiggert, NOAA/AOML
Dr. Dean Churchill, University of Miami/RSMAS

Analysis of Class Weather Data

Directions: While on Weather on Wheels, you and your classmates collected from the Weather Monitor (Station 7) measurements of temperature, relative humidity, air pressure, and wind speed (among other things). Since these measurements were taken as you rotated through the various weather stations, each group collected the measurements at different times. In this activity, you will compile class data to see if these measurements changed over the two hour time period you spent aboard Weather on Wheels.

Use the chart below to compile class data. The data should be arranged chronologically (that is, earliest measurement first, latest measurement last). Space is provided for up to 10 groups of measurements. The changes in each measurement over time can then be graphed using the graphs on the following pages. Be sure to properly label (with units) each graph.

Time	Outside Temperature (^{0}C)	Relative Humidity (%)	Air Pressure (mb)	Wind Speed (mph)

Changes in Temperature over Time

Time

Changes in Air Pressure over Time

Time

Changes in Relative Humidity over Time

Time

Changes in Wind Speed over Time

Time

Answer the following questions:

1. Did the temperature from the Weather Monitor increase or decrease over time, or did it stay about the same?__________________________________

2. If the temperature changed much during the measurement period, explain why. Consider time of day, % cloud cover, etc. in your explanation.

   ____

   ____

   ____

3. Did the relative humidity increase or decrease over time, or did it stay about the same?____

4. How do the changes (if any) in relative humidity compare to changes in temperature?____

   ____

5. Did the air pressure increase or decrease over time, or did it stay about the same?____

6. How do the changes (if any) in air pressure compare to changes in temperature?____

   ____

7. Did the wind speed increase or decrease over time, or did it stay about the same?____

8. How do the changes (if any) in wind speed compare to changes in temperature? Air pressure?____

   ____

   ____

   ____

Weather Satellites

The National Aeronautics and Space Administration (NASA) launched TIROS (Television Infrared Observational Satellite), our nation's first series of weather satellites, on April 1, 1960. Weather satellites can take two different kinds of images to record Earth's atmosphere. Visible, or daylight, pictures can be taken. These images show variations in the surface of Earth and contours of the clouds as they might look to an astronaut in space.

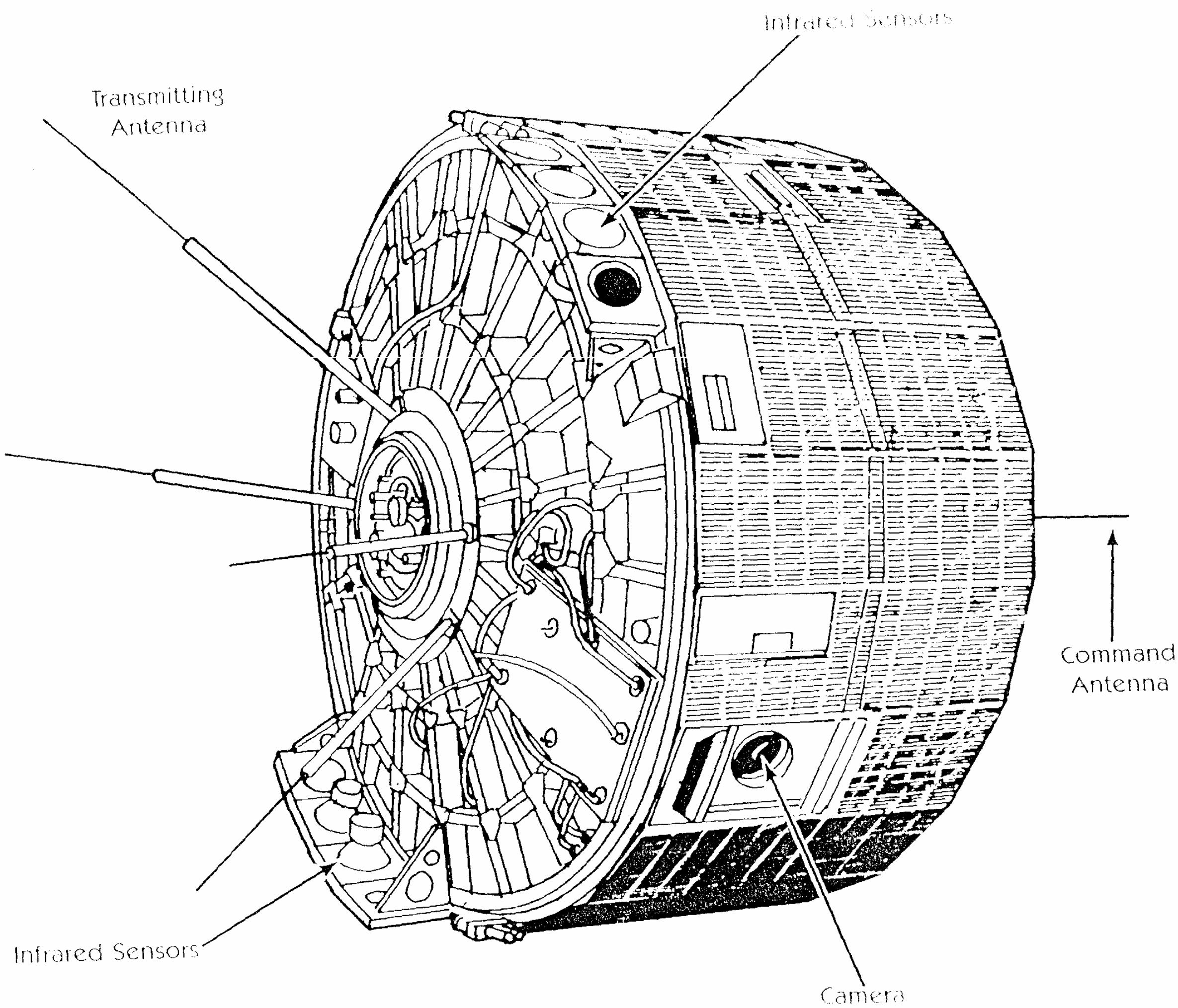
When no visible light is present, satellite cameras can rely on infrared wave lengths, which the human eye cannot see but which are temperature sensitive. Infrared TV images record the differences in heat given off by clouds and Earth. Warmer areas, such as the ground, appear dark gray or black in these pictures. Cooler areas are represented by various shades of gray; in the case of clouds, each successively lighter shade of gray represents a higher-altitude cloud.

Attached to the bottom of each TIROS satellite were two tiny cameras, one wide-angle and one narrow-angle, that recorded images of Earth's cloud cover as our planet rotated on its axis. Because the satellites had to keep spinning in order to maintain their orientation, the cameras aboard TIROS photographed different strips of cloud cover with each turn of the satellite.

TIROS 1 was placed in a near-equatorial orbit, and was able to photograph cloud patterns at some distance above and below the equator, eventually photographing two-thirds of our planet's cloud cover. Through the images these satellites sent back to Earth, meteorologists could monitor cloud patterns over large portions of Earth for the first time.

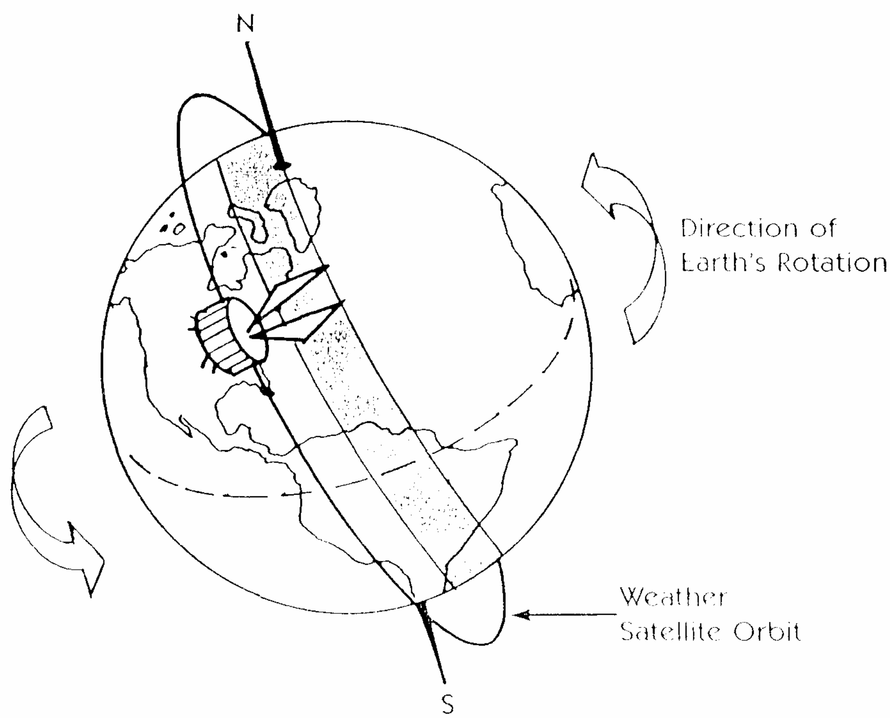
The first TIROS cameras, however, could record only the day side of Earth. Night photographs were impossible.

TIROS Spacecraft



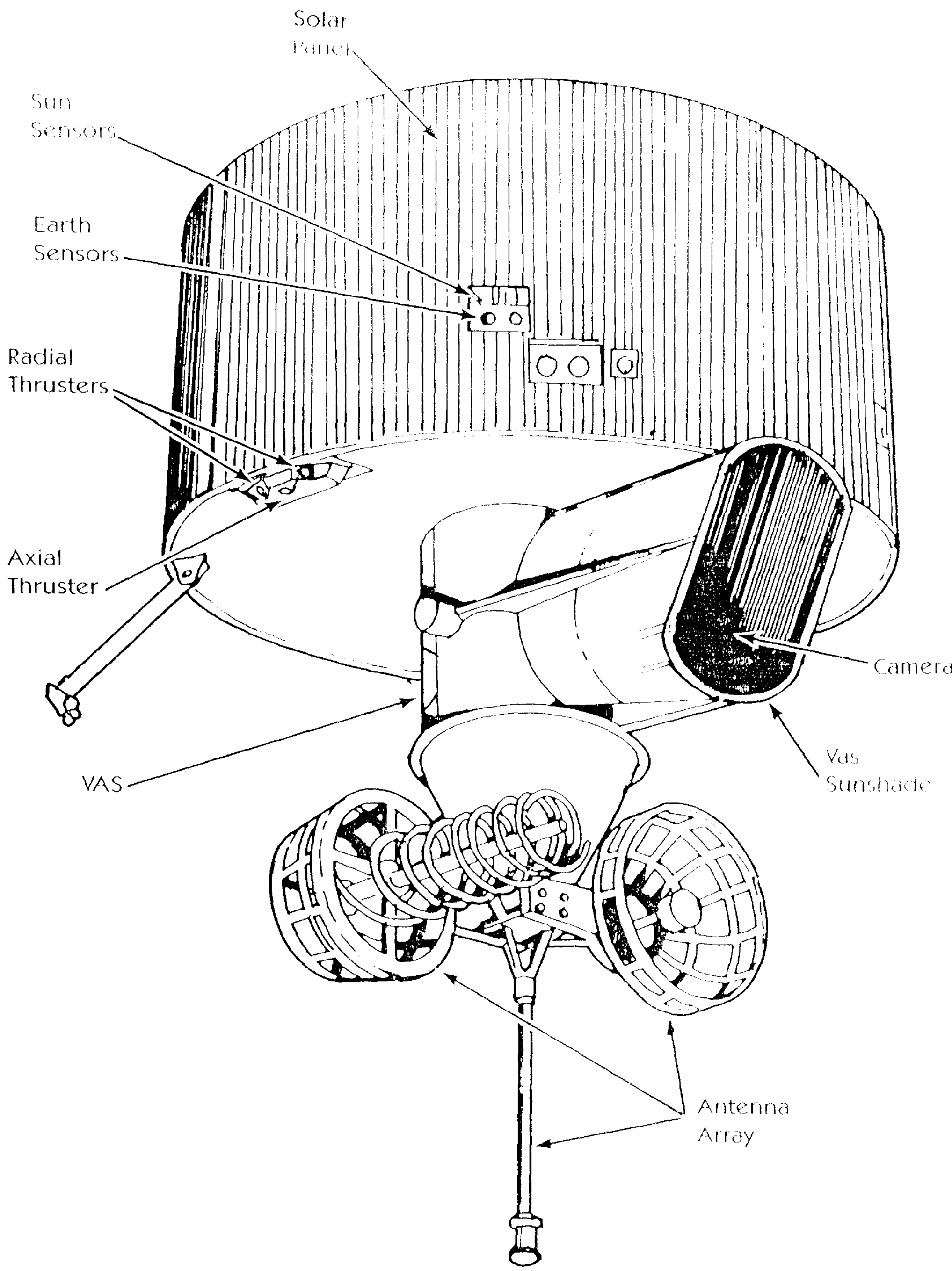
Then NASA engineers developed a type of TIROS satellite that could not only spin on its axis and remain stable, but also turned in space like a cartwheel. Instrumentation was attached to the rim of this satellite, so that it always had a camera looking at Earth. Two of these newer types of satellites - TIROS 9 and 10 - were placed in Sun-synchronous, polar orbits.

As illustrated below, a polar-orbiting satellite circles the globe from north to south. In a Sun-synchronous orbit, a satellite crosses over the same point on Earth at the same times each day. Scientists, therefore, can compare changes that take place over a particular area of Earth from one time to next. The orbit derives its name from the fact that time on Earth is determined by the position of our planet with respect to the Sun.



Weather Satellite in Polar Orbit

Goes Satellite



It was not until 1964, when NASA launched *Nimbus*, that recording at night became possible. *Nimbus* could remain stable without having to spin, so its sensors could face Earth constantly. In addition, *Nimbus* carried infrared radiometers capable of taking the first night images of clouds. The *Nimbus* satellites also carried prototypes, or test models, of space-borne instruments that would eventually lead to our current weather satellites, which can scan all of Earth 24 hours a day.

The TOS (TIROS Operational System) series, derived from experience gained with TIROS 9 and 10, was launched by NASA in 1966. The TOS series was a further improvement on TIROS. These satellites gathered even more sophisticated kinds of weather information than the earlier satellites, and distributed the information to a wider variety of users than TIROS.

Four years later, in 1970, the ITOS (Improved TIROS Operational System) series of weather satellites was launched. In addition to its two TV cameras making daylight images, ITOS carried a scanning radiometer enabling the satellite to take images of Earth from space regularly and around-the-clock.

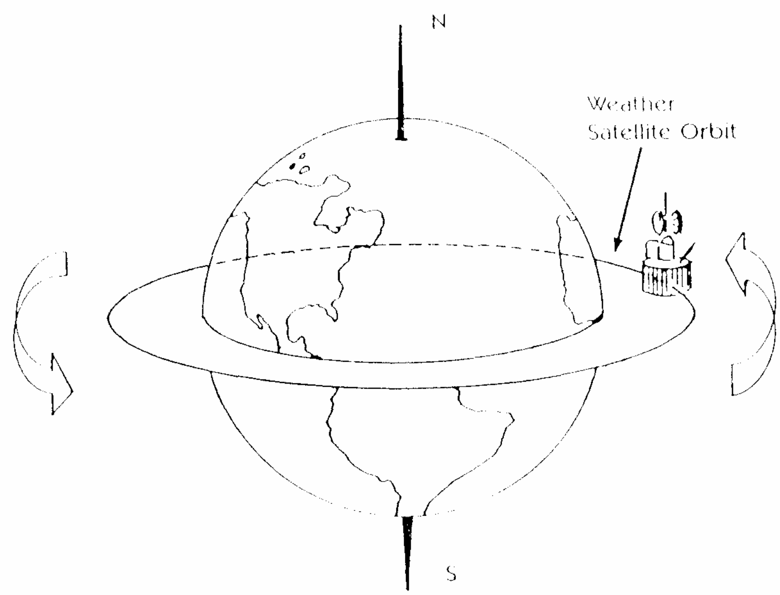
In 1970, NASA transferred the operation of weather satellites to a newly established agency, the National Oceanic and Atmospheric Administration (NOAA) in the U.S. Department of Commerce. In this new partnership, NOAA manages the processing and distribution of the millions of bits of data and images that the weather satellites produce daily. NASA, in turn, contributes to the research and development of these satellites, oversees their manufacture by private companies, purchases and launches the satellites, and evaluates their performance in flight.

With the launch of the NOAA-N series in June 1979, the current generation of polar-orbiting weather satellites made its way into space. The instrumentation aboard these satellites can observe both the surface features of our planet and the vertical structure of the atmosphere.

The newest generation of weather satellites is the GOES (Geostationary Operational Environmental Satellite) series. Unlike polar-orbiting weather satellites, a GOES satellite is positioned above the equator, where it travels at a speed matching Earth's rotation. Thus the satellite, appearing fixed above that one spot on the equator, can see one side of Earth at all times. To get this incredible pole-to-pole view from one spot above the equator, a geostationary orbit must attain an extraordinary high altitude.

One GOES satellite is positioned to image the western United States and the Pacific Ocean. The other satellite images eastern United States and the Atlantic Ocean. Together they cover most of the Western Hemisphere from the North Pole to the South Pole, each one sending back messages to Earth twice a day. Thus, this pair of satellites assures that measurements for any region in the Western Hemisphere are no more than six hours old. In severe weather conditions, engineers at ground stations here on Earth can direct the GOES cameras to take images more often.

Most of the weather photographs on television originate on the GOES satellites. We see them after computers have enhanced the data, usually making the clouds appear white and superimposing the clouds on a map with lines dividing states or regions.



Weather Satellite in Geostationary Orbit

Activity: Around the World

Focus Model of Weather Satellite Views of Earth

Task Students construct models of Earth and the two types of weather satellites and demonstrate the way each offers a different view of Earth.

Supplies A sheet of light cardboard or one side of a manila file folder, 6 straight pins, tape, a pair of scissors, a pen or fine marker, 2 paper clips, photocopies of the polar-orbit and geostationary-orbit templates that appear after this activity, and 2 styrofoam balls, each 75 millimeters (3 inches) in diameter.

Procedure

General Preparation

1. Using the orbit templates as a guide, cut out one ring representing a polar orbit and one ring representing a geostationary orbit. (Hint: you'll find it easier to cut out the inside circle if you fold each paper ring in half before you begin.)
2. Lay the two paper rings on one side of a manila folder or sheet of light cardboard. Trace the outlines, and cut out the two orbit rings.
3. Glue each paper ring onto a cardboard ring so the rings are rigid.

Making the Polar-Orbiter Model

1. Stick one straight pin into a styrofoam ball. Stick another pin in the other side of the ball, directly below the first one. Label the points "N" and "S" for the North Pole and South Pole.
2. Use a marker to draw a circle around the ball from pole to pole.
3. Place a polar-orbit ring over the ball, lining it up with the circle you just drew.
4. Tape an orbit ring to the pins at the poles. The ball should rotate freely under the ring, as shown in the illustration on the template.
5. Clip one of the satellite rings to the polar orbit at the zero mark on the orbit, halfway between the North Pole and South Pole. This will be the starting point.

Answer the following questions:

6a. What imaginary line on Earth runs directly below the satellite?___________

____

b. What is the latitude of this imaginary line?___________________________

____

7. Holding the model by its orbit, rotate Earth to the right until it lines up with the line you drew for the polar orbit.

a. By rotating the model to the right, did you rotate Earth east or west?____

____

b. Does the satellite move with Earth as it turns?_______________________

____

c. In which direction does the satellite move?__________________________

____

8. Move the satellite northward until it is over the North Pole. Answer the following questions:

a. What area on Earth is the satellite photographing?____________________

____

b. What is the latitude of the point directly below the satellite?_____________

____

c. How many degrees in its orbit has the satellite now moved?____________

____

9. Continue moving the satellite in its orbit until you reach Earth's equator again. Remember, as the satellite moves, Earth turns slightly on its axis. Rotate Earth a little to the right. Answer the following questions:

a. In which direction is the satellite now traveling: North, South, East, or West?____

____

b. How many degrees has the satellite moved around its orbit?____________

____

c. What is the latitude of the area being photographed by the satellite?____

____

10. Move the satellite further until it is now over the South Pole. Also, rotate Earth just a little more on its axis. Answer the following questions:

a. How many degrees does the satellite move through one orbit?__________

____

b. The satellite is back over the equator again. What happened to Earth's position while the satellite was orbiting?_________________

____

c. Is the satellite photographing the exact spot at the equator as it did on the previous orbit? Explain.____

____

d. The satellite will continue to cross the equator at a slightly different place on each orbit. When will the satellite cross the same point that it crossed at the very start?____

____

e. How long will it take the satellite to photograph the entire Earth?_________

____

f. How long does it take before the satellite can take a second photograph of the same spot on Earth?____

____

g. What type of orbit is this?____

____

h. Name a satellite that was launched into this type of orbit.________________

____

Making the Geostationary-Orbiter Model

1. Take the remaining styrofoam ball, and draw a circle half-way between the poles. This line will represent the equator.
2. Place two pins opposite each other at the equator.
3. Use a marker to draw another circle around the ball, this time from pole to pole. Stick two pins into the line, one opposite the other. Label the points "N" and "S" for the North Pole and South Pole.
4. Line up the zero mark on the orbit with the equator, as shown in the small illustration on the template. Tape the geostationary-orbit ring to the pins. The ball should rotate freely under the ring, as shown in the illustration on the template.
5. Clip the satellite on its orbit at the zero mark, halfway between the North Pole and South Pole. This will be the starting point.

   What area on Earth is the satellite photographing?____________________

   ____

6. Hold the styrofoam ball by the pins at its poles, and rotate it slowly to the right. Answer the following questions:

a. When you stationed the satellite on its orbit at the zero mark, what area of Earth was it imaging?

b. While Earth is turning on its axis, what area is the satellite photographing?_ ____

____

c. In which direction is the satellite moving: North, South, East, West?

____

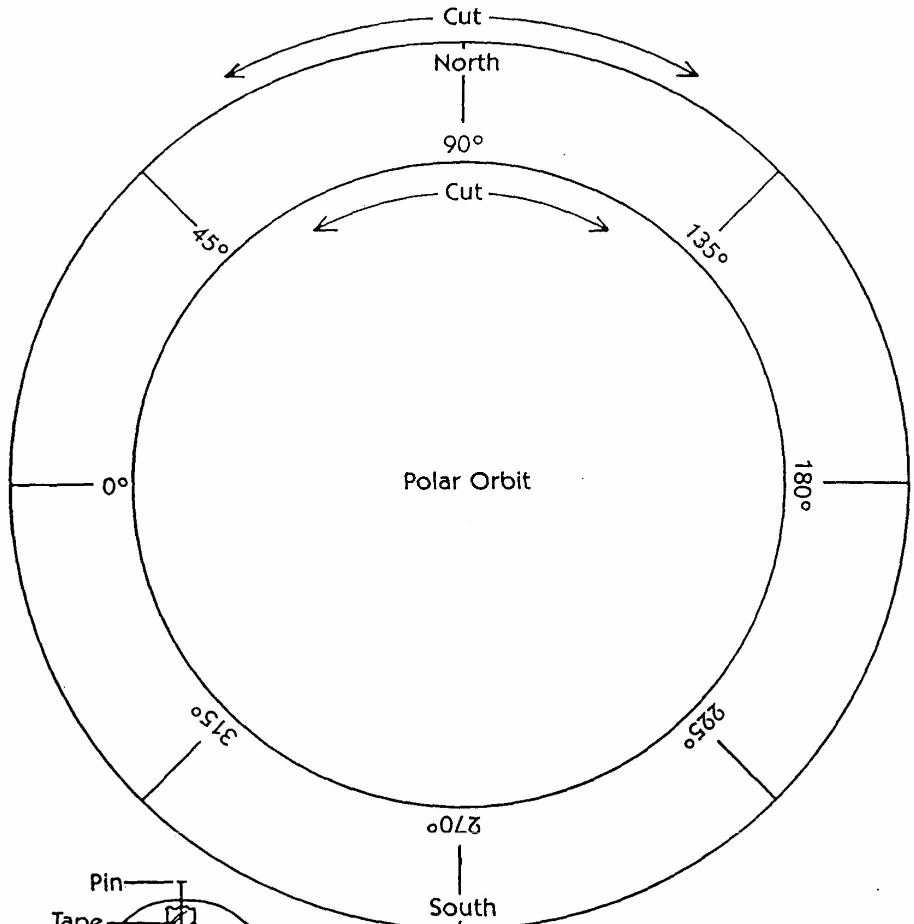
d. Will the satellite ever be able to photograph the other side of Earth?

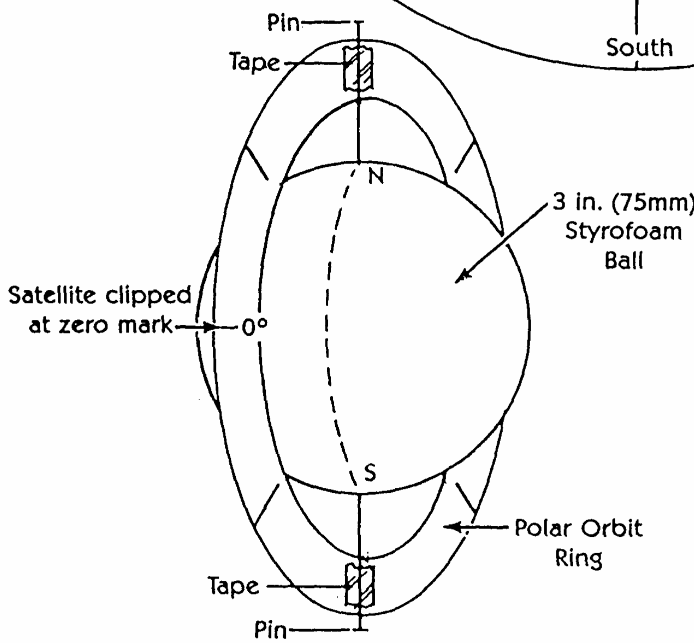
____

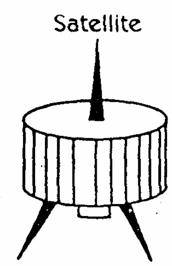
e. Name a satellite that has been launched into this type of orbit.___________

____

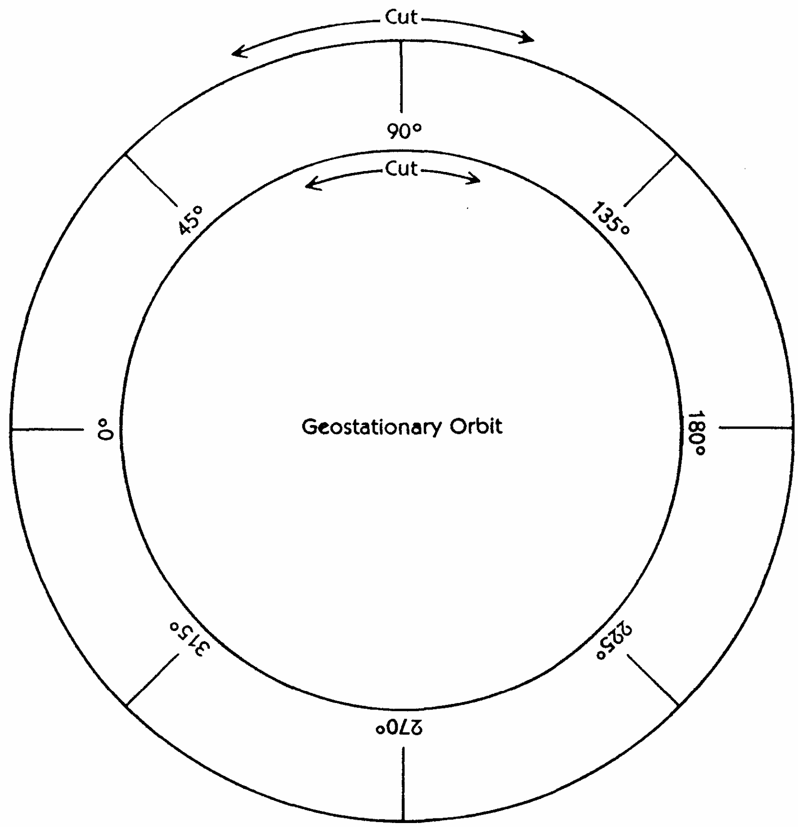
Polar Orbit Template

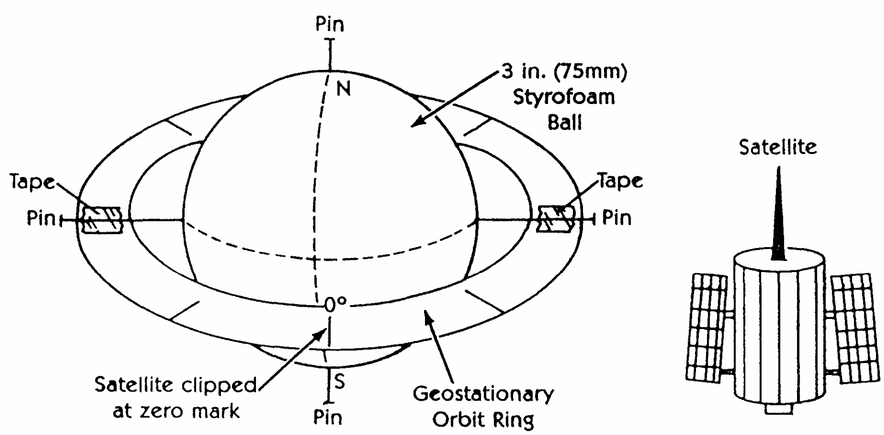






Geostationary Orbit Template





Activity: TV or Not TV

Focus Weather Forecasts from Weather Satellite Images

Task Students analyze patterns from weather satellite images and make some weather forecasts.

Supplies Visible-light photograph of Hurricane Agnes taken on June 19, 1972, visible-light photograph of low-pressure area taken in June 1970, infrared photograph and visible-light photograph taken on June 24, 1988, of a tropical disturbance in the Gulf of Mexico.

Procedure

1. Examine the visible-light photograph of Hurricane Agnes acquired by a weather satellite. (The outline of the United States has been added by computer.) Answer the following questions:

a. What kind of weather is Texas having?______________________________

____

b. What kind of weather is California having?___________________________

____

c. Examine the hurricane in the southeast United States. Notice the swirling pattern. In what direction is the hurricane spinning?___________________

____

d. Where is the eye of Hurricane Agnes located?________________________

____

e. Why do you think there are more clouds on the northeast side of the hurricane than on the west side? Hint: Remember the direction in which air flows around a low-pressure area in our hemisphere and how air picks up moisture.____

____

f. Hurricane Agnes moved very slowly in a northeast direction. It did severe damage to Pennsylvania. Forty-four people died and nearly a billion dollars worth of damage from flooding occurred. Could you have foreseen the hurricane coming to Pennsylvania?______________________________

____

g. Would you have issued a hurricane warning to the people in Texas? Why?____

____

2. Examine the visible-light photograph acquired by a weather satellite of a low-pressure area. Here you see a much larger part of North American. The exact center of this low-pressure area is near Illinois. Notice the swirling of clouds. Notice the two bands of clouds coming out from the area. What do you think the two bands are? You may want to refer to the colored weather map you made in your pre-trip activities to answer the following questions:

a. In which direction does air move around a low?_________________

____

b. Where is the air coming from on the west side of the low? Is the air cool or warm? Is it dry or moist?_______________________________________

____

c. Locate the band of clouds stretching south from the low. This band separates the cool and warm air masses. What type of front is this?_____

____

d. Notice how lumpy the cloud arm is. What type of clouds are they?_______

____

e. The warm air is moving northward around the right side of the low. Can you locate the warm front? Describe the location.____________________

____

f. Notice how unbroken and uniform the cloud pattern is. What type of clouds are these?____

____

g. Name several states that are probably having thundershowers.__________

____

h. In what states is drizzle or steady rain falling?________________________

____

i. This entire weather system will slowly drift eastward. What forecast can you make for Georgia and Florida?________________________________

____

j. What is your forecast for Texas?__________________________________

____

3. Examine the infrared photograph and visible photographs of a tropical disturbance in the Gulf of Mexico. Answer the following questions:

a. The darkest centers in the infrared photo indicate severe thunderstorms in the Gulf of Mexico. What is probably causing these thunderstorms? (Hint: Look at the pattern and shapes of clouds.)____________________

____

b. Notice the area with the various shades of gray in the lower right-hand section of the infrared photograph. What is probably happening here?____

____

c Find the same area on the visible-light photo. Describe what you think is happening.____

____

d. What is the weather like in Nebraska? This photograph was taken during the severe drought in the Midwest in the summer of 1988.______________

____

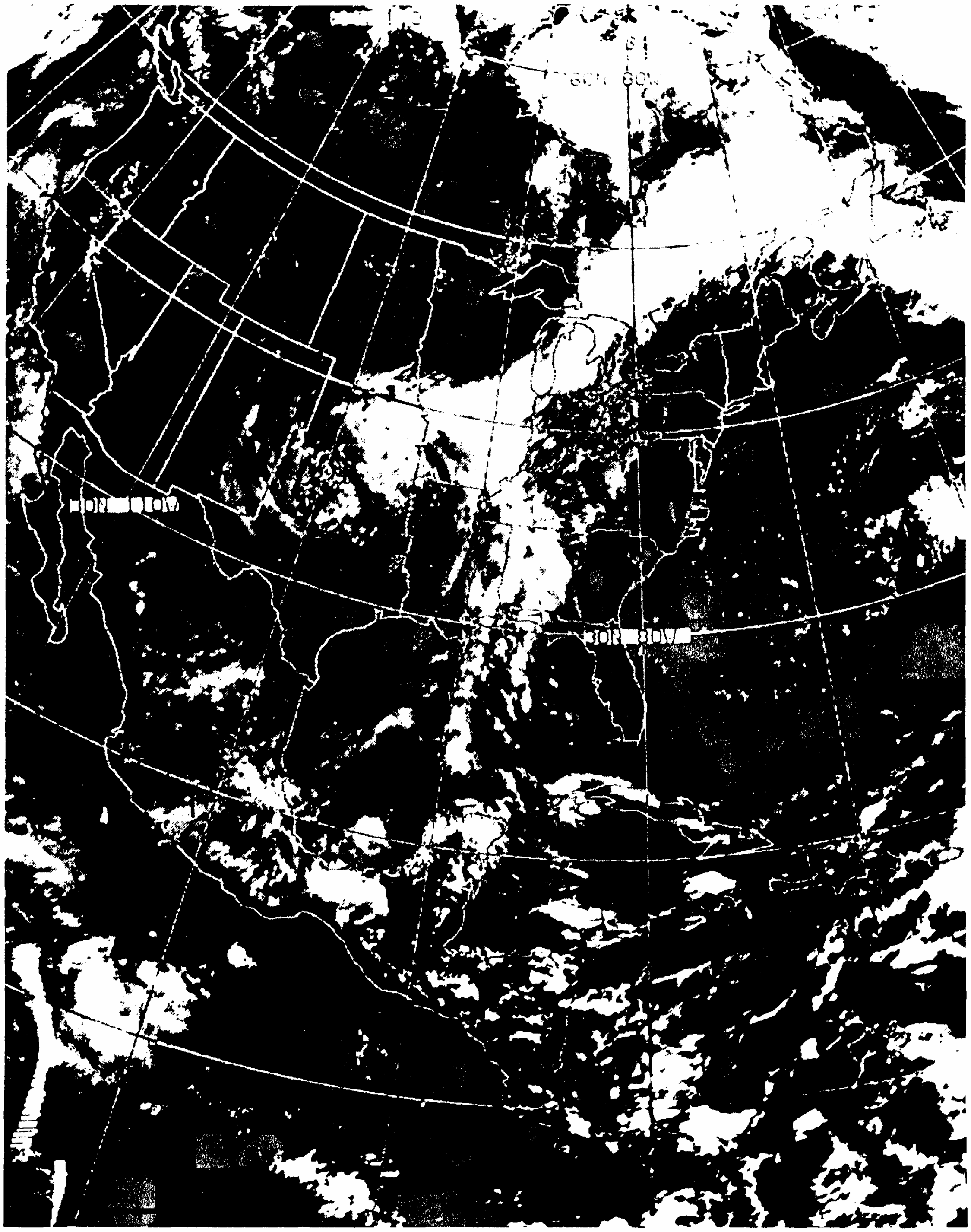
e. Do you think that Nebraska will have any rain in the next few days?

____

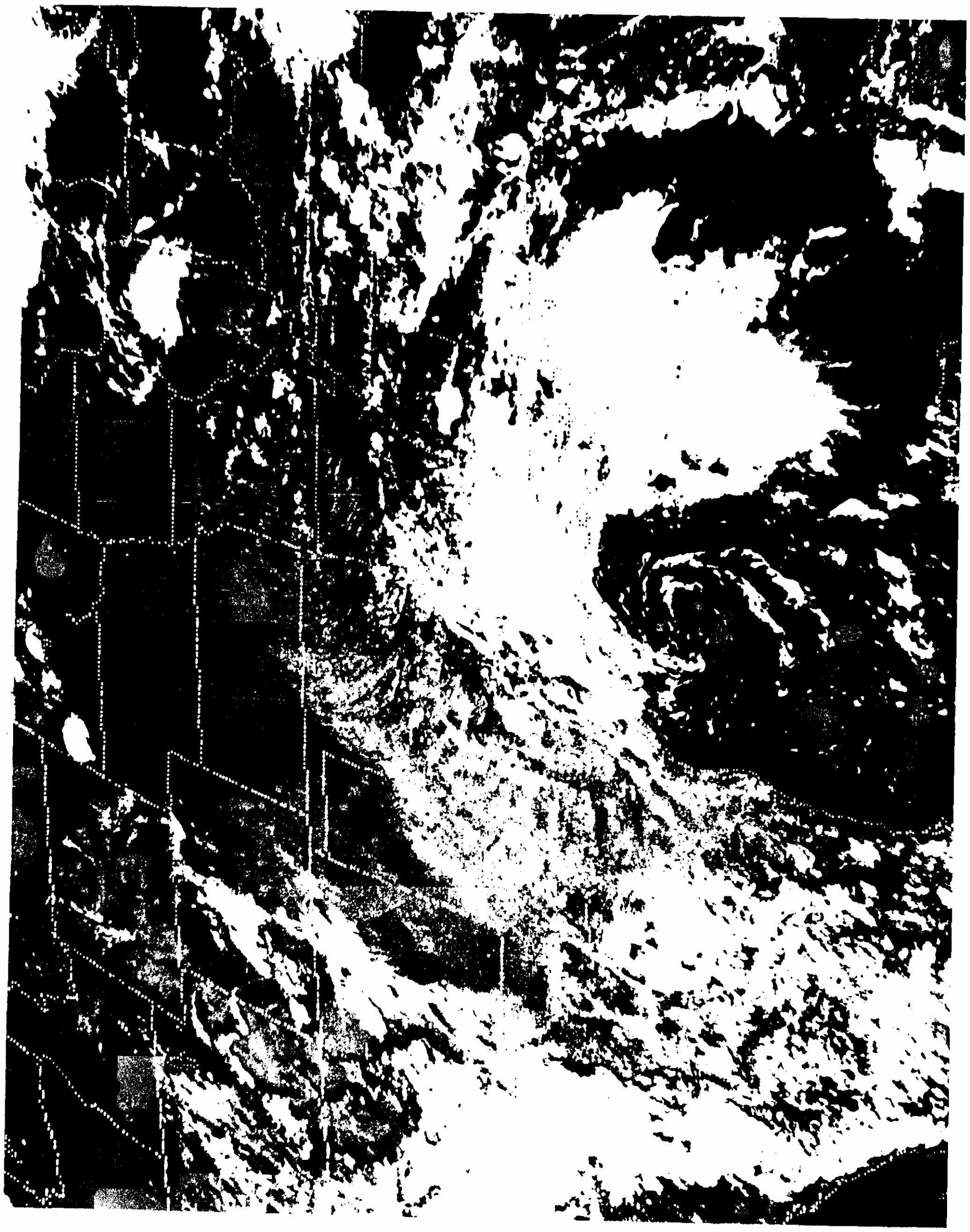
When you get home...

Watch the satellite photographs shown on the television weather programs, and try to identify the weather systems and cloud types that are shown. Try to come up with your own forecast before the announcer gives his or her prediction.

1. Satellite visible photograph of Hurricane Agnes, June 19, 1972.



2. Satellite visible photograph of a low-pressure area in the centra section of the United States, June 2, 1970.



3 . Satellite visible photograph of a tropical disturbance in the Gulf of Mexico, June 24, 1988.

Satellite Word Search

R M U V B O R B I T S N A E F X L I I Q B S L M G

X A K X T C G Q V A S P Y Y D Q S A N W O D H A E

K K D G X Y S C O L L N A Q D Z N Z F C M P Z B O

L V L I D O L H S R Y I Z C Q A T Y R M T R O A S

N D T Q O Y S D R O C K E T E E I W A Q L B J J T

M M G F J T V P B W U Z A S I A W E R U N Y M F A

J S O N V L E T P W Y I O L P L N I E U N H H Z T

N S M A P M M L P K K T Y R H O C V D F V J M O I

N J W T J S S M E F L B P E L O L V S I J W X T O

O M P H O J A Z E V U Q N H M A Q A X U E E X E N

A V P G D X S T Z C I Y X R L Z H H R E X O T Y A

A I H U T W L Y E R T S X O S T S D A T A Z U E R

U E X V P E I R H L Y N I R G G H L G P L L S U Y

K C X J R A I U O N L N T O G V J H L L U I G E Z

T S S U G T U T L Q P I C K N T C B A V Q O D J U

J I T F E H T Q O I X X T O Z P E O U Y P V T G X

Z I R I Q E H W Y S K M U E G W R E N I T W A R U

A E I O C R B A B K U J K W H C V N C S C C O A U

Y Y Q W S H L O K G S K I O Y C O K H I L J X V Y

H K C Z G O E S M I D E Y G F K R E W A B V W K W

Find the following words hidden in the puzzle. Read across, down, backwards, and diagonally.

Data	ITOS	Polar	Space
Geostationary	Launch	Radio	Television
GOES	NOAA	Rocket	TIROS
Infrared	Orbits	Satellite	Weather

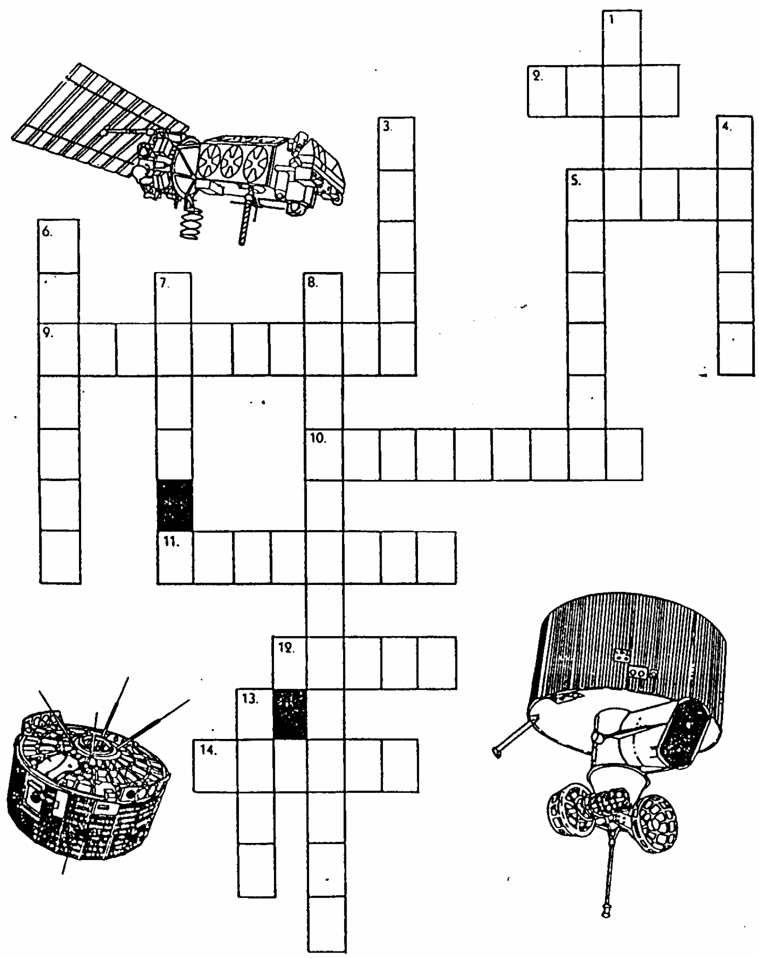
Satellite Crossword Puzzle

Across

2. Improved TIROS Operational Satellite (abbreviation)
5. Method of communicating with a satellite in orbit
9. Large sphere of air surrounding Earth
10. Any object in orbit around Earth
11. Type of light that we cannot see but that satellite can detect in total darkness
12. Television and Infrared Observation Satellite (abbreviation)
14. Lift-off or take-off of a rocket

Down

1. National Oceanic and Atmospheric Administration (abbreviation)
3. Vast area outside of Earth's atmosphere where satellites orbit
4. Type of orbit that circles the Earth over the North and South Poles
5. Object used to place a satellite into space orbit
6. State or condition of the atmosphere at any time
7. Geostationary Operational Environmental Satellite (abbreviation)
8. Type of orbit in which the satellite remains above the same place on Earth
13. National Aeronautics and Space Administration (abbreviation)



Answer Key

Analysis of Class Weather Data

Answers will vary with specific measurements collected.

Around the World

Part 1 Making the Polar-Orbit Model

6. a) the equator
   b) 0 degrees
7. a) east
   b) no
   c) west (opposite the direction of Earth's rotation
8. a) the North Pole
   b) 90 degrees
   c) 90 degrees
9. a) south
   b) 180 degrees
   c) 0 degrees
10. a) 360 degrees
    b) rotates from west to east
    c) no; that spot has moved east as the Earth rotated
    d) at the same time the next day
    e) one day
    f) polar orbit
    g) TIROS, ITOS, NOAA-N

Part 2: Making the Geostationary-Orbit Model

5. the equator
6. a) the equator
   b) the equator
   c) the equator
   d) west
   e) yes
   f) GOES

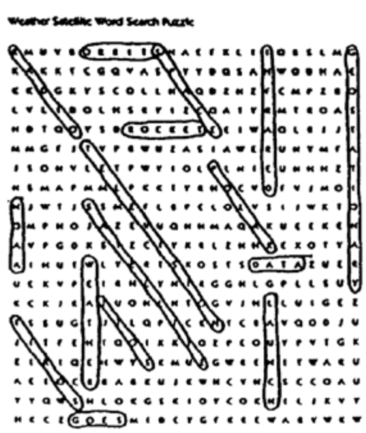
TV or Not TV

1. a) clear, sunny

b) overcast/foggy on coast; clear inland
c) counterclockwise
d) over the Gulf of Mexico, south of Pensacola, Florida
e) tropical moisture from the south and east is converging on the hurricane's northeast side as it rotates to produce heavy cloud cover with precipitation; air to the west of the hurricane is associated with a high over the Midwest, and is thus drier.
f) yes; if the hurricane continued to move in a northeasterly direction, Pennsylvania was directly in its path.
g) no, since the hurricane is moving in the opposite direction.

2. a) counterclockwise
b) from the northwest; cool and dry
c) cold front
d) cumulus, cumulonimbus
e) Extending to the northeast from the center of the low
f) stratus, nimbostratus
g) Illinois, Iowa, Missouri, Tennessee, Oklahoma, Alabama, Florida (Panhandle)
h) Michigan, Wisconsin
i) thunderstorms
j) dry, clear

3. a) tropical moisture on the east side of the system
b) local afternoon thunderstorms
c) the thunderstorms are resulting from prevailing seabreezes
d) clear and dry
e) no



The School Board of Miami-Dade County, Florida, adheres to a policy of nondiscrimination in employment and educational programs/activities and strives affirmatively to provide equal opportunity for all as required by:

Title VI of the Civil Rights Act of 1964 - prohibits discrimination on the basis of race, color, religion, or national origin.

Title VII of the Civil Rights Act of 1964, as amended - prohibits discrimination in employment on the basis of race, color, religion, gender, or national origin.

Title IX of the Education Amendments of 1972 - prohibits discrimination on the basis of gender.

Age Discrimination in Employment Act of 1967 (ADEA), as amended - prohibits discrimination on the basis of age with respect to individuals who are at least 40.

The Equal Pay Act of 1963, as amended - prohibits sex discrimination in payment of wages to women and men performing substantially equal work in the same establishment.

Section 504 of the Rehabilitation Act of 1973 - prohibits discrimination against the disabled.

Americans with Disabilities Act of 1990 (ADA) - prohibits discrimination against individuals with disabilities in employment, public service, public accommodations, and telecommunications.

The Family and Medical Leave Act of 1993 (FMLA) - requires covered employers to provide up to 12 weeks of unpaid, job-protected leave to "eligible" employees for certain family and medical reasons.

The Pregnancy Discrimination Act of 1978 - prohibits discrimination in employment on the basis of pregnancy, childbirth, or related medical conditions.

Florida Educational Equity Act (FEEA) - prohibits discrimination on the basis of race, gender, national origin, marital status, or handicap against a student or employee.

Florida Civil Rights Act of 1992 - secures for all individuals within the state freedom from discrimination because of race, color, religion, sex, national origin, age, handicap, or marital status.

School Board Rules 6Gx13- 4A-1.01, 6Gx13- 4A-1.32, and 6Gx13- 5D-1.10 - prohibit harassment and/or discrimination against a student or employee on the basis of gender, race, color, religion, ethnic or national origin, political beliefs, marital status, age, sexual orientation, social and family background, linguistic preference, pregnancy, or disability.

Veterans are provided re-employment rights in accordance with P.L. 93-508 (Federal Law) and Section 295.07 (Florida Statutes), which stipulate categorical preferences for employment.

REVISED 8/1/01