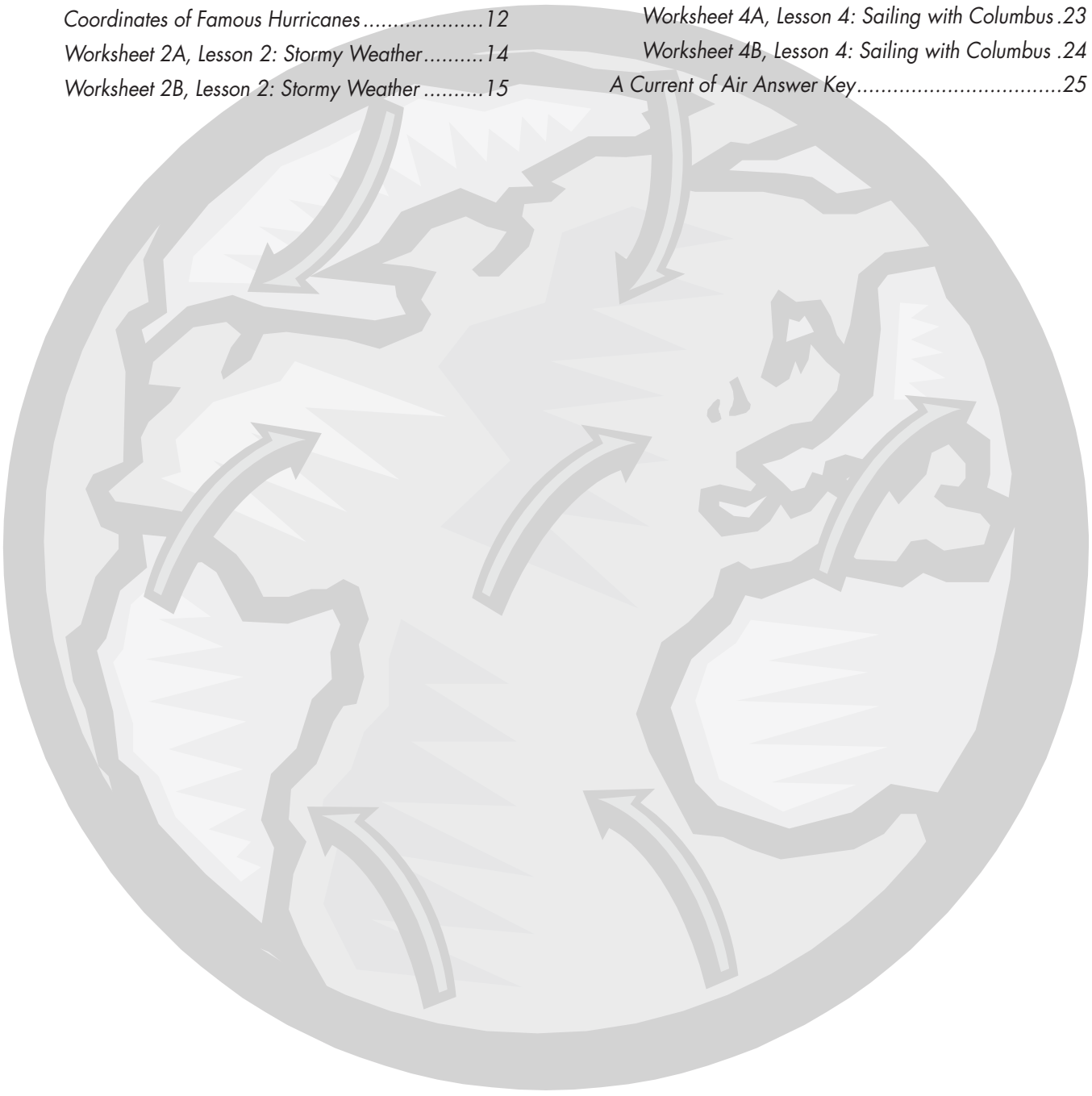
A Collection of Curricula for the STARLAB® Weather Cylinder

Including:

A Current of Air: A Guide to the Weather Cylinder by Gary D. Kratzer

Curriculum Guide Contents



A Current of Air – A Guide to the Weather Cylinder

Contributed by Gary D. Kratzer

MATERIALS

- STARLAB Portable Planetarium
- Weather Cylinder
- Earth Cylinder (optional)
- Ocean Currents Cylinder (optional)
- a red light system or red covered flashlights (optional)
- arrow pointers
- tape measures
- cassette tape of ocean sounds
- colored markers or crayons
- glow-in-the-dark hurricanes
- glow-in-the-dark sailing ships
- a two-step ladder
- duct tape or poster putty
- copies of all worksheets and coordinates

Introduction to A Current of Air

Purpose

To examine the nature of atmospheric circulation and the impact it has on the earth and its weather.

Objectives

1. To use longitude and latitude coordinates to locate the position of various wind systems.
2. To model the location of pressure systems and to infer their characteristic movements.
3. To synthesize the correlation between atmospheric circulation and ocean currents.
4. To identify the position of the jet streams and to understand their effects on the wind systems.
5. To synthesize the effects of wind systems on weather system movements.
6. To plot the paths of hurricanes and discover the effects of wind systems and pressure systems on their movements.
7. To explain why wind currents are deflected in certain directions.
8. To infer the basic concepts of navigation used by early explorers.

Suggestions

These activities were designed for use in a STARLAB but can be conducted in the classroom as well. Special attention has been given to the use of process skills in all of the activities in this guide so that your students will be active participants rather than passive observers. Many of the activities may be modified or adjusted as you see fit for your students. As you work with the Weather Cylinder you will discover a wealth of possibilities that exist for the development of additional lessons.

Lesson 1: A Current of Air

Note

In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.

Objective

To locate the positions of the wind systems, pressure systems and jet streams and infer their influences on atmospheric circulation.

Process Skills

Observing • inferring • drawing • labeling • plotting • communicating • working cooperatively

Preparation

Set up the STARLAB dome and projector. Place the Weather Cylinder (Earth Cylinder optional) on the cylinder platform. Position the projector at 90° latitude so that longitude values are visible on the horizon. If the longitude values do not appear on the horizon, you might have to straighten the wire leads on the projection lamp so that it will stand more erect in the projection socket. Review the coordinate system with your students. If an Earth Cylinder is available, the review could be conducted with this cylinder and should keep the students more focused due to fewer distractions. Point out the prime meridian, lines of longitude and latitude and the equator. Position the prime meridian straight overhead in the STARLAB. Explain and demonstrate with the arrow pointer that longitude is measured east of the prime meridian (to the right) or west of the prime meridian (to the left). Explain that latitude is measured north or south of the equator. After the review is completed, turn down the projection lamp, turn up the side lamps and switch back to the Weather Cylinder. Using red light in the planetarium lessens interference on dome projections.

Procedure

After the students are seated and materials distributed, begin the discussion of the wind systems.

Wind is the horizontal movement of air relative to the rotating surface of the earth. Air movements result from unbalanced forces acting on the earth's atmosphere. One of these imbalances is that of unequal heating of the earth by the sun with the polar regions and equator having the greatest variations of temperature. Another factor influencing wind is the Coriolis effect. This phenomenon is a result of the difference in the velocity of the earth at the poles, 0 kph (0 mph), and approximately 1600 kph (1000 mph) at the equator. Large scale movements of air that are influenced by the Coriolis effect and unequal heating of the earth are called wind systems. These systems follow the same general directional path for months at a time. High and low pressure systems are large air masses that rotate clockwise and counterclockwise. Highs are huge mountains of cool descending air and lows are valleys of warm ascending air. The jet streams are rivers of air flowing from west to east. They are located between certain wind systems. The altitude and position of the jet streams change frequently. Today we are going to learn more about the location and characteristics of the nature of atmospheric circulation.

Students may work individually or in groups of 4 students. Distribute Worksheets 1A and 1B. The students will answer all questions on Worksheet 1A and complete all

MATERIALS

- STARLAB Portable Planetarium
- Weather Cylinder (Earth, Ocean Currents Cylinders optional)
- colored marking pens or crayons
- arrow pointers
- a red light system or red covered flashlights (optional)
- copies of Worksheets 1A and 2B

drawing and labeling on Worksheet 1B. An optional color scheme could be assigned to the drawings on Worksheet 1B (i.e. wind systems in yellow, jet streams in green, high pressure system in blue and low pressure system in red).

Name_____ **Date**_____

Worksheet 1A, Lesson 1: A Current of Air

Instructions

Answer all of the following questions on this worksheet. Draw and label on Worksheet 1B. (It may be necessary for your teacher to move the projector at times so that the southern hemisphere is visible.)

1. On Worksheet 1B, label the wind system located at 0° latitude. Since this part of the earth receives maximum solar heating, how do you think the air at this latitude moves?

2. On Worksheet 1B, label the wind systems located between the equator and 30° north and south latitudes. What are these latitudes also known as? What do you think influences the curved nature of these wind systems?

3. On Worksheet 1B, label the wind systems located between 30° and 60° north and south latitudes. How do you think the wind in this location influences the weather in the United States and Canada?

4. On Worksheet 1B, label the wind systems located between 60° and 90° north and south latitudes. Why does the wind in this area flow away from the pole? What do you think influences the curved nature of this wind system?

5. On Worksheet 1B, label the jet streams located near 30° north and south latitudes and near 60° north and south latitudes. What direction do these high speed bands of air flow?

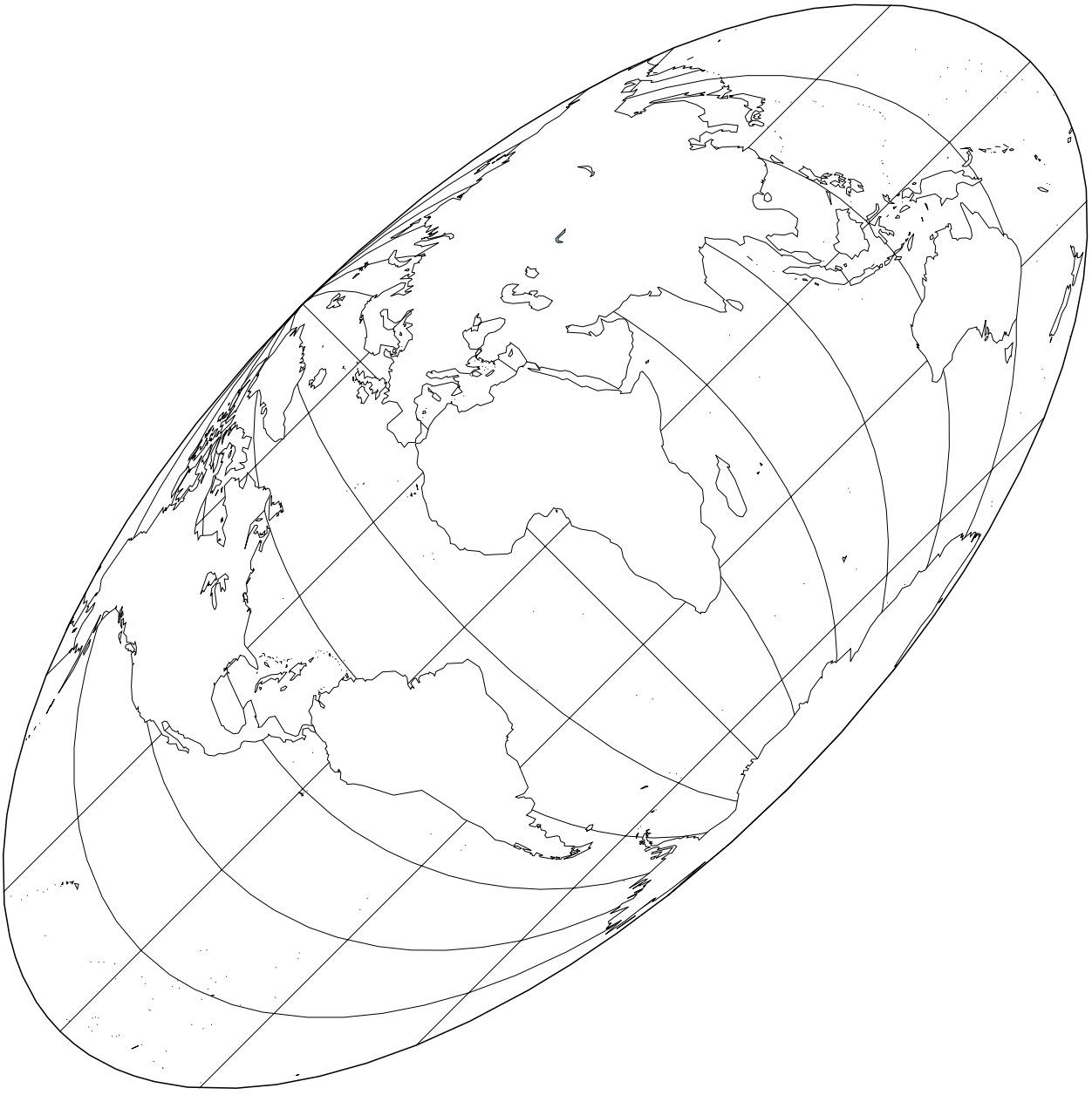
6. On Worksheet 1B, label the high pressure system located just off the east coast of the United States and the low pressure system located near the equator between Africa and South America. What direction does the air in a high pressure system rotate? What direction does the air in a low pressure system rotate? How do you think these pressure systems might influence ocean current's movements? (Project the Ocean Currents cylinder, if available).

Name_____ **Date**_____

Worksheet 1B, Lesson 1: A Current of Air

Instructions

Draw and label the positions of the wind systems, jet streams, pressure systems and lines of latitude on the map of the world below.



Lesson 2: Stormy Weather

Note

In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.

Objective

To establish a link between hurricane characteristics, the wind systems, and pressure systems.

Process Skills

Observing • plotting • communicating • working cooperatively

Preparation

Set up the STARLAB dome and projector. Place the Weather Cylinder on the cylinder platform. Set the latitude on the projector to 90° to reveal the longitude and latitude coordinates of the northern hemisphere. Make sure the area the students are plotting is not too high for them to reach when sticking on the glow-in-the-dark hurricanes. If using a two-step ladder to reach certain coordinates, exercise extreme caution. Review the concept of longitude and latitude. Ask various students to use the pointer to locate lines of longitude, latitude, the prime meridian and the equator. Have the students identify that longitude is measured east or west of the prime meridian and latitude north or south of the equator. Review the wind systems with your students. They will be focusing on the area near the Cape Verde Islands off the east coast of Africa.

Procedure

Begin the activity by asking the students about hurricanes.

What is a hurricane? Hurricanes are devastating storms with winds of 74 mph or more near the storm center. Usually tropical in origin, a hurricane is called a cyclone in the Indian Ocean and a typhoon in the Pacific Ocean.

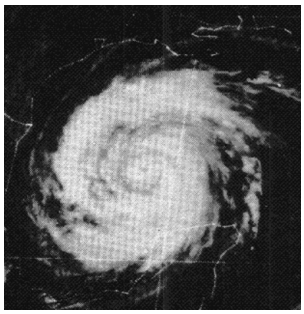
- Ask the students to use an arrow pointer to show you where they think hurricanes form (some may point to the Pacific Ocean, some the Atlantic Ocean). Tell the students that some of the worst hurricanes in history originated in the Atlantic Ocean and eventually affected the United States.
- Ask the students if they have ever used a hurricane tracking chart. Explain that STARLAB is about to become a giant tracking chart.

Today we a going to plot the paths of some of the worst hurricanes in history on our giant tracking chart! Each person will be assigned coordinates to plot onto the dome.

- Organize your students into three groups.
- Give each student a copy of the "Coordinates of Famous Hurricanes" sheet. Pass out 20 glow-in-the-dark hurricanes to each group.
- Tell the students to make a loop of duct tape or double-sided tape to put on the back so it will stick on the dome. Using the assigned coordinates, have the students locate the position of their hurricane. Make sure each student in a group gets coordinates to plot. Let one group plot on the dome while the other students are plotting on Worksheet 2A.

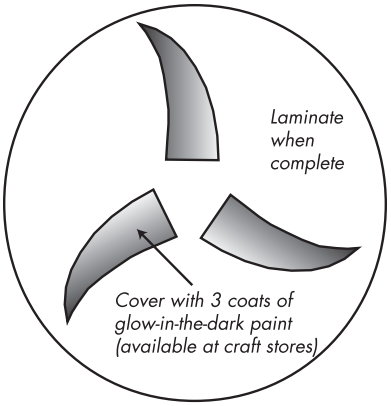
MATERIALS

- STARLAB Portable Planetarium
- Weather Cylinder
- a red light system or red covered flashlights (optional)
- glow-in-the-dark hurricanes
- coordinates of hurricanes
- duct tape (one roll per group) or double-sided tape
- color pencils or crayons
- two-step ladder
- copies of Activity Worksheets 2A and 2B



- After all coordinates are plotted, the paths of three famous hurricanes will be visible on the dome. Make sure the students have drawn and labeled the paths they see on the dome on Activity Worksheet 2A. Answer all of the questions on Activity Worksheet 2B.

How to Make Glow-in-the-Dark Hurricanes



Procedure

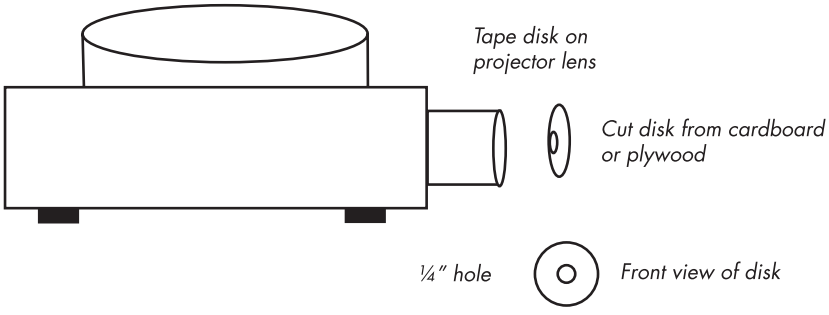
Cut out as many as 75 glow-in-the-dark hurricanes from poster board or file folders of almost any color. Paint the counter-clockwise arms with three coats of glow-in-the-dark paint. The inside of the circle does not need to be painted. The "L" (low pressure) in the center can be stenciled or drawn in. It is best to cover these in plastic (laminate) when finished. If you choose to make the "hurricanes," a six-inch diameter equals a hurricane of 240 miles in diameter.

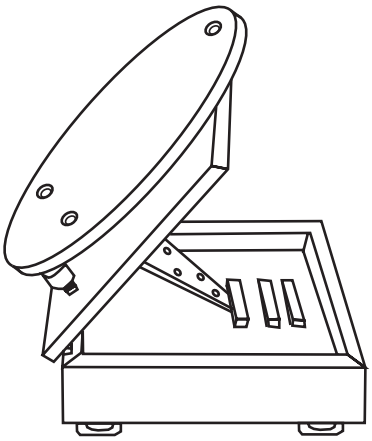
Extension

Use a slide projector to project an image of a hurricane on the dome. To achieve a small image of a hurricane, position the slide projector on the STARLAB projector case in front of the STARLAB projector. The image will need to be between 6 and 16 inches in diameter to represent a hurricane with a diameter of 240 to 640 miles. Using the coordinates of a known hurricane, have the students position the center of the hurricane image on assigned coordinates. Using duct tape, place a glow-in-the-dark hurricane in place of the hurricane image then move to the next set of coordinates. A "glowing" trail of hurricanes will be left to mark the path.

Hint

To reduce the brightness of the hurricane image on the dome, make a disk to fit over the front of your slide projector's lens (see diagram below). Cut a piece of plywood or cardboard the same diameter as the projector lens. Drill a one-fourth inch hole in the center of the disk. Tape the disk on the front of the projector lens. This will greatly reduce the brightness of the projected image but will still be bright enough to see in the STARLAB and not wash out the projections from the Ocean Currents Cylinder.





Slide projector platform

Coordinates of Famous Hurricanes

Hurricane Camille 1969

Month	Date	Time	Lat.	Long.
8	14	7 PM	19.7	82.8
8	15	7 AM	20.8	83.8
8	15	7 PM	22.3	84.4
8	16	7 AM	23.7	86
8	16	7 PM	25.2	87.3
8	17	7 AM	27	88.1
8	17	7 PM	29.2	89
8	18	7 AM	32	90
8	18	7 PM	34.5	90
8	19	7 AM	36.8	88.2
8	19	7 PM	38	84.5
8	20	7 AM	37.2	77
8	20	7 PM	36.7	73.2
8	21	7 AM	37.2	68.4
8	21	7 PM	39.1	61.4
8	22	7 AM	43	54

Hurricane Andrew 1992

Month	Date	Time	Lat.	Long.
8	19	4 AM	17.6	56.3
8	19	4 PM	19.2	59.5
8	20	4 AM	21	61
8	20	4 PM	22.3	62.5
8	21	4 AM	24.3	63.7
8	21	4 PM	25.2	65.4
8	22	4 AM	25.8	67.5
8	22	4 PM	25.4	76.5
8	23	4 AM	25.4	80
8	23	4 PM	25.8	83.9
8	24	4 AM	26.8	87.4
8	24	4 PM	28.2	90.3
8	25	12 AM	29.7	91.7
8	25	9 AM	31.5	91.5

Month	Date	Time	Lat.	Long.
8	23	4 AM	21.7	55.4
8	23	4 PM	23.7	58.2
8	24	4 AM	25.4	59.3
8	24	4 PM	28.3	60.2
8	25	4 AM	28.6	60.6
8	25	4 PM	28.6	60.1
8	26	4 AM	28.6	61.2
8	26	4 PM	27.4	62.5
8	27	4 AM	26.6	63.9
8	27	4 PM	26.5	64.9
8	28	4 AM	26.9	66.6
8	28	4 PM	28.3	67.9
8	29	4 AM	29.8	68.9
8	29	4 PM	31.2	70.1
8	30	4 AM	31.8	71.1
8	30	4 PM	32	72.5
8	31	4 AM	33.2	74.5
8	31	4 PM	35.2	75.1
9	1	4 AM	37.1	73.9

Hurricane Emily 1993

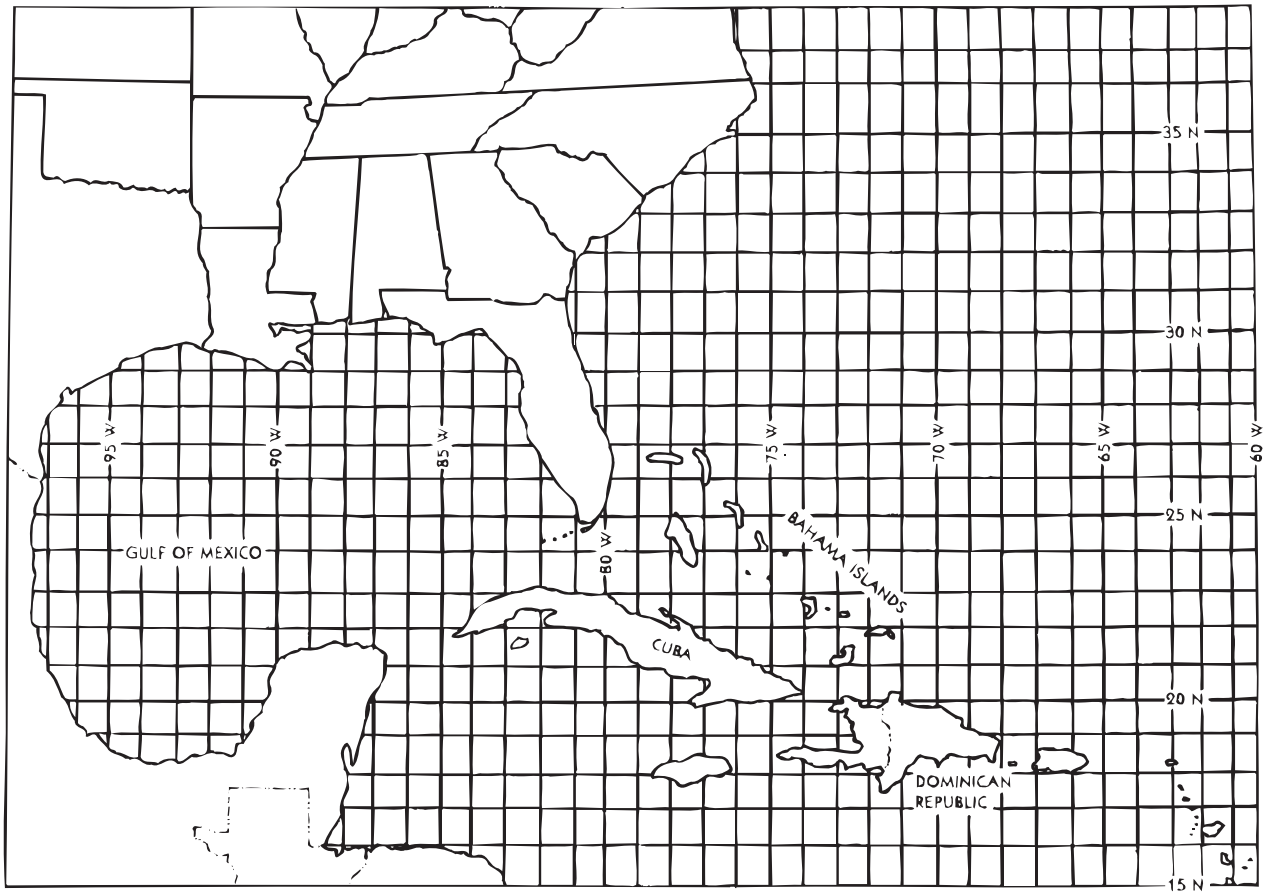
Name_____ **Date**_____

Worksheet 2A, Lesson 2: Stormy Weather

Instructions

After the coordinates of several hurricanes have been plotted on the planetarium wall, draw and label their paths and names on the hurricane tracking chart below. Color each hurricane a different color. After drawing and labeling the hurricane paths, draw the paths of the wind systems and pressure systems in the area of the hurricane paths. Answer the questions on the next sheet.

Hurricane Tracking Map, Southeast United States



Name_____ **Date**_____

Worksheet 2B, Lesson 2: Stormy Weather

1. Where do the hurricanes in the northern hemisphere seem to originate?

2. What wind system is located near the point of origin of the hurricanes that were plotted? What do you think the air conditions are like in this area?

3. Did the Bermuda High off the east coast of the United States have any influence on the paths of the hurricanes that were plotted?

4. Why did Emily and Andrew move north then abruptly curve to the east? What else might have influenced their behavior?

5. What influences do wind systems and pressure systems have on a hurricane?

MATERIALS

- Weather Cylinder
- tape measures
- copies of Worksheets 3A, 3B and 3C
- a red light system or red covered flashlights (optional)
- arrow pointer
- red and blue markers or crayons

Lesson 3: Bombs Away

Note

In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.

Objective

To infer the relationship between the path of the jet stream and Japanese balloon bombs used in World War II.

Process Skills

Observing • measuring • predicting • estimating • calculating • communicating • working cooperatively

Preparation

The STARLAB projector with the Weather Cylinder attached should be set so that all of the northern hemisphere is above the horizon (set the projector on 90° latitude). All students should receive the Activity Worksheet 3A. Allow the students to work cooperatively in groups of 4 to 6. The students will be measuring distances on the dome using the scale 1 in = 40 mi or 1 cm = 26 km. (Expect a high degree of activity. Caution the students to be careful when moving about the dome. It might be necessary to move the cylinder for some groups so that the distance they are measuring is within reach.) Using red light in the planetarium produces less interference on dome projections.

Procedure

After the students are seated in the planetarium explain the purpose of the lesson.

In previous lessons we have learned that the winds systems have a significant affect on weather phenomena all around planet Earth. Jet streams are narrow bands of high-speed winds that move from west to east in the upper atmosphere like great rivers. These great meandering northern and southern hemisphere "rivers of air" are often found at the top of the troposphere at heights of between 6,000 and 12,000 meters (20,000 to 40,000 feet) with wind speeds as high as 370 kilometers per hour (230 miles per hour) and as wide as 1,000 kilometers (600 miles). During World War II, the jet streams influenced decisions made by the Japanese military. In the latter stages of the war, they decided to put experimental "balloon bombs" into these powerful winds to find out if they would float into United States airspace. Today we will examine the results of this top secret mission that took place in the spring of 1945.

Distribute the Activity Worksheets 3B. Tell the students that the instructions are on the worksheet and to read them before they start the activity. Pass out the red and blue markers that the students will need to draw the position of the jet streams on their activity worksheets. Remind your students that the position of the jet streams will vary with seasonal changes. Have the students draw the northern hemisphere polar jet in blue and the subtropical jet in red as well as answer the questions on the worksheets.

Extensions

- Have your students draw the positions of the southern hemisphere jets on their worksheets. This part of the activity will require a substantial amount of cylinder manipulation.

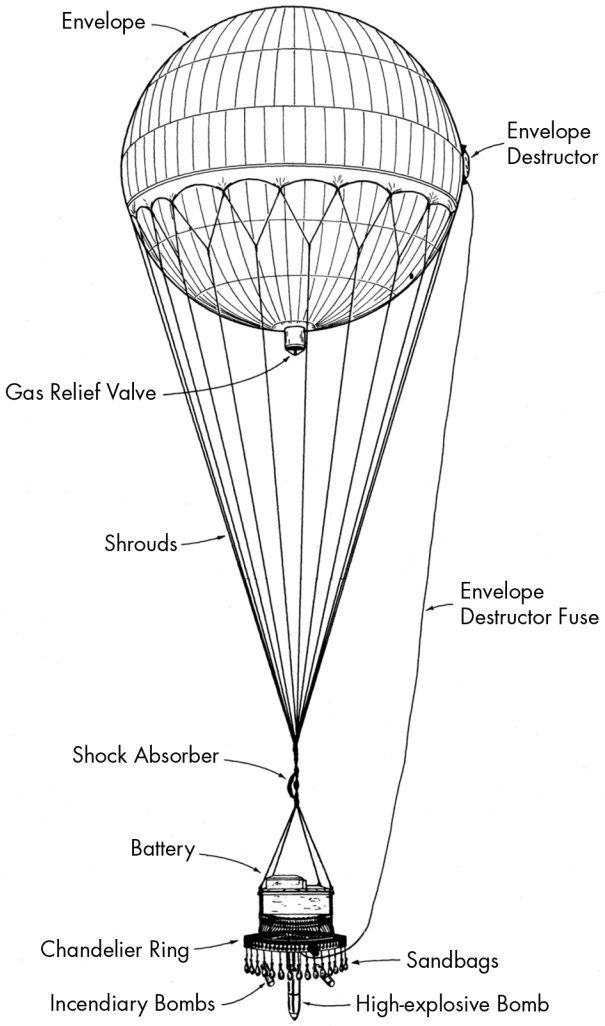
- The students can use place Post-its™ on the states where the balloon bombs fell in the United States. It might become necessary to use a two-step ladder to reach some of the northern states. **Caution: When using a two-step ladder in the dome, make sure the students can hold on to something to keep their balance.**

Name_____ **Date**_____

Worksheet 3A, Lesson 3: Bombs Away

Note

From November 1944 to May 1945, the Japanese military launched about 200 balloons with bombs attached into fast moving upper level winds know as the jet stream. They hoped these bombs would eventually land on large cities or factories in the United States. Eventually 9,000 of these devices were launched with about 1,000 of them successfully crossing the Pacific and landing in the United States. These "Windship Weapons" as they were called by the Japanese, landed in California, Oregon, Washington, Wyoming, Montana, Arizona, Idaho, Colorado, Utah, South Dakota, Michigan, Kansas, Nebraska and Texas. Only one balloon bomb actually killed anyone. A family of six was on a camping trip in Oregon when sadly one of the children found one of the bombs by a creek and picked it up causing it to explode. Virtually all of the incidents dealing with the fallen bombs were kept top-secret by the United States military to prevent a major panic by the American public.



Type A Paper Balloon

The Japanese had problems figuring the exact wind and air currents that would transport the balloons to America, creating the ballast which would gradually deteriorate upon reaching the destination, building a triggering mechanism to release the bombs and designing a method of self-destruction after a mission was complete.

After several years of working around the clock on this accelerated project, the Japanese finally produced a paper balloon about 32.8 ft. in diameter and 33 ft. tall which traveled about 120 miles per hour while in the jet stream. For firing power they used 30 cylinders of hydrogen (each weighing 132 pounds) and sand ballast packed in paper bags (each weighing about five pounds). They figured these balloon bombs would cross the ocean to American shores in about six days. Each cost about $920 to build and equip.

Question

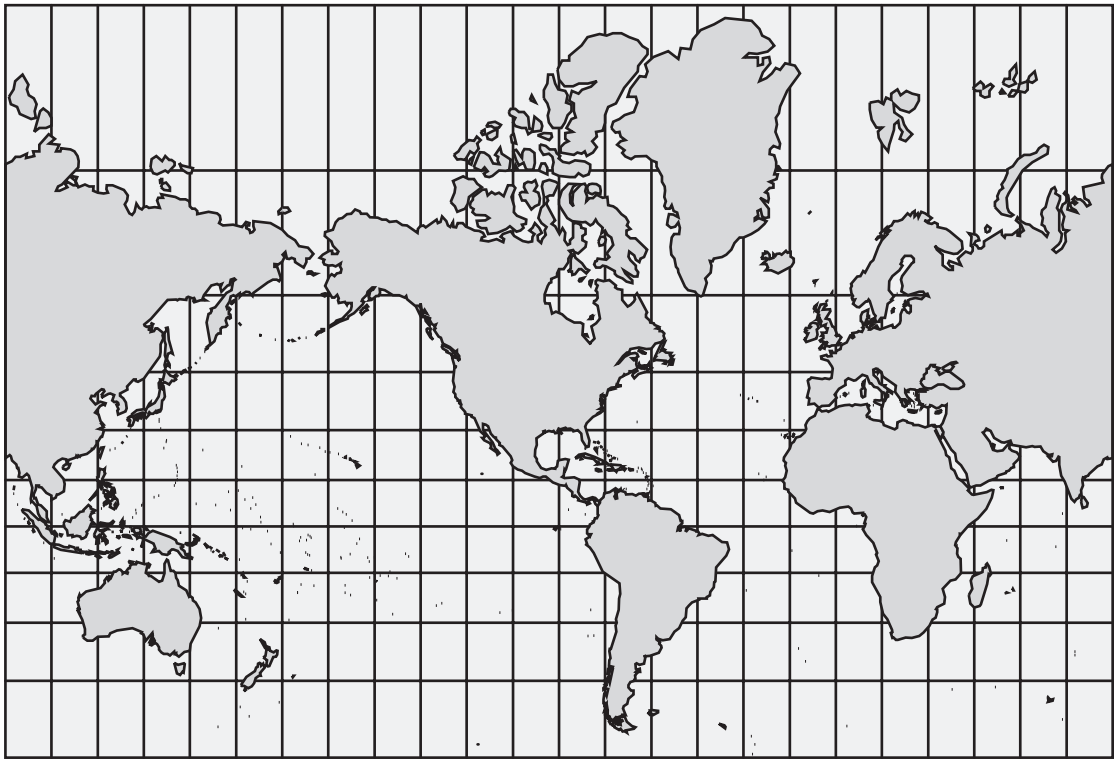
If a balloon bomb took approximately six days to cross the Pacific Ocean traveling at approximately 120 miles per hour and landed somewhere in the United States, how many miles did one of these weapons travel? You may do your calculations below or on an additional sheet of paper. Circle your answer.

Name_____ **Date**_____

Worksheet 3B, Lesson 3: Bombs Away

Instructions

Locate the position of the jet streams on the planetarium dome. On the map of the world below, draw and label the positions of the polar jet in blue and subtropical jet in red. Identify the lines of latitude by labeling them with their proper values. It may be necessary for your teacher to rotate the cylinder to view the southern hemisphere. (Keep in mind that the jet streams meander or change position and altitude from day to day.)



Questions

1. Near what degree(s) of latitude are the subtropical jets located?_____

2. Near what degree(s) of latitude are the polar jets located? _____

3. Draw arrows on the world map above to indicate positions of the various wind systems.

Name_____ **Date**_____

Worksheet 3C, Lesson 3: Bombs Away

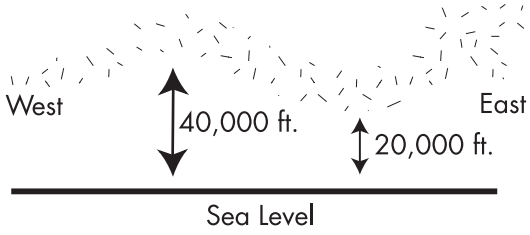
4. Where are the jet streams located with respect to the wind systems?

5. How does the jet stream affect the movements of air masses and frontal systems over the United States?

6. If you were a pilot of a commercial airliner, would it be a good idea to fly in the jet stream? Why or why not?

Minds-on

Look back at the answer to the question on Activity Worksheet 3A. Japan is not that far from the United States. But how do you suppose a balloon bomb could have traveled such a great distance? (Refer to the diagram on the right). You may answer below and on the back of this sheet, if necessary.



Lateral View of the Jet Stream

Lesson 4: Sailing with Columbus

Objective

To locate the positions of wind systems and to infer their influences on the voyages of Christopher Columbus.

Process Skills

Describing • observing • drawing • inferring • working cooperatively • communicating

Preparation

Set up the STARLAB dome and projector with the Weather Cylinder. Position the projector to 90° latitude so that longitude values are visible near the horizon. Have sailing ship cutouts ready to distribute. It might be helpful to review the coordinate system with your students. Point out the **prime meridian**, **lines of longitude** and **latitude** and the **equator**. Position the prime meridian straight overhead. Explain that longitude is measured east (to the right) or west (to the left) of the prime meridian. Explain that latitude is measured north or south of the equator.

Procedure

After the students are seated and ready, begin the lesson.

By the 15th century, navigation of the high seas had become quite reliable. Ships were better designed, stronger and equipped with various instruments that assisted sailors in finding their latitude by observing the altitude of the sun or Pole Star. Better compasses and a growing knowledge of the earth's wind systems and climate made early navigators increasingly confident to take on the challenges of the oceans. It became well known that the northeast trade winds could be counted on from about 30° to about 10° north of the equator and above the trade winds one would find the westerlies. It is important to remember that winds are named for the direction from which they blow. Today we are going to retrace the path that Christopher Columbus followed to the New World which started August 3, 1492 and ended on March 15, 1493.

Procedure

Arrange the students into groups of four or five (optional). Pass out Worksheets 4A and 4B and have them work cooperatively to answer the questions. You may want your students to work independently. If arrow pointers are available, give one to each group or have students share them. Distribute sailing ship cutouts. Have one group plot positions on the dome at a time. The other students can be plotting coordinates on Worksheet 4A. When the students are ready to work, start the cassette tape of ocean sounds.

Extensions

1. After the coordinates of Columbus' voyage are plotted on the dome, connect the positions with a brightly colored fluorescent yarn. Stick the yarn to the dome using tape or poster putty. Turn on a black light to enhance the voyage of Columbus.
2. Plot the paths of other famous explorers and associate the wind systems with those paths. If the Ocean Currents Cylinder is available, associate the paths of various explorers with the direction of flow of the currents.
3. Discuss the importance of the Beaufort Scale (for indicating wind velocity). The diagram on the next page may be duplicated for use in the classroom.

MATERIALS

- STARLAB Portable Planetarium
- Weather Cylinder
- cassette tape of ocean sounds
- colored pencils or crayons
- worksheets
- arrow pointers
- cutouts of sailing ship (directions on next page)

Optional

- clipboards
- black light
- bright fluorescent colored yarn
- a red light system or red covered flashlights

The Beaufort Scale

FYI

The Beaufort Scale was devised by Sir Francis Beaufort, an English admiral, for the purpose of estimating wind velocity. This 19th century scale is based on the force with which the wind blew on sails of a vessel. Divided into 13 categories defined by the numbers 0 to 12, the scale was later applied to a more specific range of wind speeds and indicators.

Scale #	Wind Velocity (km/hr)	Description of Wind	Indicators
0	*0 to 1.5*	*Calm*	*Smoke goes straight up*
1	*1.6 to 5*	*Light air movement*	*Smoke drifts*
2	*6 to 11*	*Slight breeze*	*Leaves rustle*
3	*12 to 19*	*Gentle breeze*	*Leaves and twigs are moving*
4	*20 to 29*	*Moderate breeze*	*Small branches move, dust and paper fly*
5	*30 to 39*	*Fresh breeze*	*Ripples on water, small trees sway*
6	*40 to 50*	*Strong breeze*	*Large branches move*
7	*51 to 61*	*High wind*	*Trunks of trees bend, hard to walk*
8	*62 to 74*	*Gale*	*Twigs are broken off*
9	*75 to 87*	*Strong gale*	*Chimneys and shingles carried away*
10	*88 to 101*	*Whole gale*	*Trees may be uprooted*
11	*102 to 120*	*Storm*	*Damage is widespread*
12	*Over 120*	*Hurricane*	*Any disaster may be expected*

How to Make Ship Cutouts

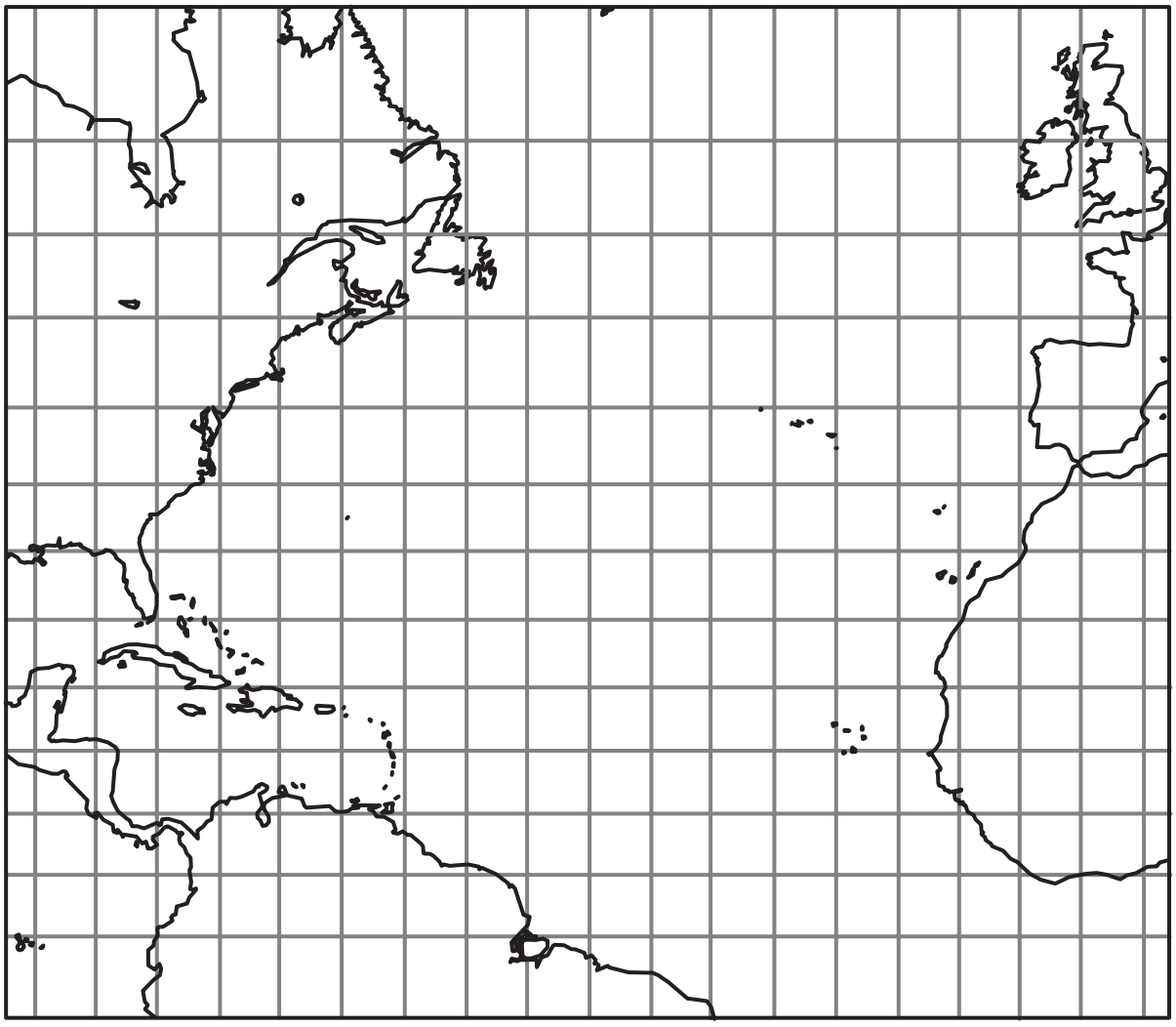
Use the template below to make your ship cutouts. It may be wise to use a copying machine to enlarge the ship model to a larger size. Painting the ship models with three coats of glow-in-the dark paint will add a neat special effect when used in the subdued light of STARLAB. Laminating the cutouts will increase their usefulness. Use poster putty or duct tape to stick the ship models to the dome.

Name_____ **Date**_____

Worksheet 4A, Lesson 4: Sailing with Columbus

Instructions

Draw arrows on the world map below to represent the location of the northern hemisphere wind systems, the north-east trade winds and the westerlies. Use colored pencils or crayons to draw the trade winds arrows in blue and the westerlies arrows in red. Next, your group will be assigned a set of coordinates to plot on the dome. (Take extreme caution if using a two-step ladder to reach certain coordinate locations. Have someone stand next to you to help in case you lose your balance.) These coordinates will represent points in Christopher Columbus' voyage to the New World (see next page). As the coordinates are called out, each group should plot that position on the world map on this worksheet. After plotting the coordinates on the map, this worksheet or the dome, answer the questions below.



Questions

1. What wind system did Columbus take advantage of on his first voyage to the New World? Between which degrees of latitude is this wind system located?

Name_____ **Date**_____

Worksheet 4B, Lesson 4: Sailing with Columbus

2. What wind system did Columbus take advantage of on his return voyage? Between which degrees of latitude is this wind system located?

3. Why do you think Columbus did not sail back to Spain on the same course he sailed to the New World?

4. What role do you think ocean currents may have played on Columbus' path to the New World?

5. Do you think ships that cross the ocean today pay attention to the direction the wind blows? Why?

Date	Columbus' First Voyage 1492	Location
Aug. 3, 1492	*Santa Maria, Nina and Pinta set sail from Palos, Spain.*	*37 N, .41 W*
Aug. 12	*Columbus reaches the Canary Islands.*	*28 N, 15 W*
Sept. 24	*The ships encounter variable winds and calm.*	*26 N, 40 W*
Oct. 7	*A mistaken sighting of land.*	*25 N, 60 W*
Oct. 12	*Land is sighted. Columbus goes ashore on San Salvador.*	*24 N, 74 W*
Dec. 24	*Santa Maria is shipwrecked off the coast of Hispaniola (Haiti).*	*19 N, 72 W*
Jan. 16, 1493	*Columbus begins return voyage home.*	*23 N, 60 W*
Feb. 8	*Encounters strong headwinds.*	*33 N, 40 W*
Feb. 13-14	*Nina and Pinta separated by a storm.*	*37 N, 30 W*
Feb. 15	*The Nina reaches Santa Maria Island in the Azores.*	*36.5 N, 25 W*
Mar. 3	*Nina arrives in Lisbon, Portugal and waits for the Pinta for 10 days.*	*38.4 N, 09 W*
Mar. 15	*Nina arrives at its home port of Palos, Spain. The Pinta* returns a few hours later.	*37 N, .41 W*

A Current of Air Answer Key

A Current of Air — Worksheet 1A

Question 1

The wind system at latitude 0° is known as the **equatorial doldrums**. The air at this location rises as a result of solar heating.

Question 2

The wind systems located between the equator and latitudes 30° N and S are known as the **northeast** and **southeast trade winds**. These latitudes are known as **horse latitudes**. The curved nature of these wind systems is influenced by the Coriolis effect.

Question 3

The wind systems located between latitudes 30° and 60° N and S are known as the **westerlies**. The westerlies assist in moving weather eastward across the United States and Canada.

Question 4

The wind systems located between latitudes 60° and 90° N and S are known as the **polar easterlies**. The air at the poles is very cold and heavy and the only way it can move is downward or toward the equator. The movement of air away from the poles is deflected to the west by the Coriolis effect.

Question 5

Both the subtropical jet streams (near latitudes 30° N and S) and the **polar jet streams** (near latitudes 60° N and S) move from west to east.

Question 6

Air rotates clockwise in a high pressure system. Air in a low pressure system rotates counterclockwise. The interaction of the wind and water in these pressure systems influences the **direction of flow** of the ocean currents.

Stormy Weather — Worksheet 2B

Question 1

Hurricanes in the northern hemisphere tend to form below latitude 30° N in the warm waters of the Atlantic Ocean.

Question 2

The are located below latitude 30° N. Warm, moist tropical air is very characteristic of the trade winds.

Question 3

The cool, heavy nature of the air in the Bermuda High, in addition to its clockwise direction of rotation, prevented the hurricanes from crossing its position.

Question 4

Emily and Andrew moved to the east because of the westerlies. They may have been influenced by the clockwise rotation of the Bermuda High or even the west to east movement of the subtropical jet stream.

Question 5

The warm rising air of a low pressure system has a lot to do with the formation of a hurricane. Wind systems and pressure systems have a major impact on the path of a hurricane. A high pressure system can block the movement of a hurricane, change its path and contribute to its eventual end.

Bombs Away — Worksheet 3A

Answer

A balloon bomb was expected to cross the Pacific Ocean and reach the United States in about six days or 144 hours. The Japanese predicted the balloons would travel approximately 120 miles per hour. Multiply 144 hours times 120 miles per hour and you get 17,280 miles.

> **Note**
>
> *If your students doubt this distance, ask them to wait until Worksheet 3C before discussing their answers.*

Bombs Away — Worksheet 3B

Question 1

The subtropical jets are located near latitudes 30° N and 30° S.

Question 2

The polar jets are located between latitudes 50° and 60° N and 50° and 60° S.

Question 3

Student work is done on the Worksheet 3B.

Bombs Away — Worksheet 3C

Question 4

The jet streams of both hemispheres are located between the northeast trade winds and the westerlies and between the westerlies and polar easterlies.

Question 5

The jet streams assist in moving air masses and frontal systems from west to east over the United States and Canada.

Question 6

It would not be a good idea to fly into the powerful winds of the jet stream. The strong head winds would reduce air speed, cause extreme turbulence and affect airline schedules.

Minds-on

The jet stream actually varies in altitude and meanders from side to side. Because of this, if a balloon bomb managed to stay in the jet stream, it would have traveled a much greater distance than if the jet stream traveled in a straight line. Considering all of the up, down and side to side movements of the balloon, and where it might have landed in the United States, the balloon could have logged 17,280 miles!

Sailing With Columbus — Worksheet 4A

Question 1

Columbus made his first voyage to the New World with assistance from the northeast trade winds. This wind system is located between latitudes 0° and 30° N and S.

Question 2

Columbus took advantage of the westerlies on his return voyage. This wind system is located between latitudes 30° and 50° N and S.

Sailing With Columbus — Worksheet 4B

Question 3

If Columbus had tried to sail back to Spain on the same path that he took to come to the New World, he would have been sailing against the trade winds.

Question 4

Not only did Columbus take advantage of the trade winds to reach the New World, he also used the Canary and North Equatorial Currents to give him an additional "push."

Question 5

Ships crossing the ocean today definitely pay attention to the direction the wind blows. Even large super tankers and cruise ships use more fuel when they travel against the wind.