BISHOP MUSEUM
1525 Bernice Street
Honolulu, Hawaii 96813

BISHOP MUSEUM

THE EXPLORERS PROJECT

An education partnership with NASA

Planetarium Program

EDUCATOR'S GUIDE

For

"THE EXPLORERS"

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Forward

Welcome to The Explorers Project. Journey with us aboard ancient Polynesian voyaging canoes and discover the universe through the world's largest optical telescopes atop Mauna Kea in Hawaii. Together we celebrate the spirit of human exploration…

What is The Explorers Project?

The Explorers Project at Bishop Museum is producing planetarium programs at no charge for national distribution through a grant from the National Aeronautics and Space Administration. Each planetarium show includes a teacher guide with student activities. An exciting web site complements each show. Many planetaria across the nation will be showing our programs. In addition, The Explorers Project staff provides inservice training sessions to local educators and planetarians designed to enhance the learning experience of students viewing these shows.

Who is it designed for?

The Teacher Guide was written to assist educators in making their student's planetarium visit more meaningful. The materials contained in this guide may be used without a planetarium visit, however it is designed to complement the show experience. Each show contains audience participation activities to engage students in learning. Curriculum materials are targeted for grades 4 through 12 in science, mathematics and geography.

How are lessons laid out?

Activities require a minimum of preparation and materials. You may choose to do activities before or after a planetarium visit. Use the Viewing Guide to enhance the planetarium experience. Activities may take an hour to several class periods to complete. Each activity stands as an independent lesson. Consult the Reference Section for additional resources.

Contacting The Explorers Project. The Explorers Project offices are located at Bishop Museum, Center for Space Education, Honolulu Hawaii. Our office hours are from 8:00 a.m. to 5:00 p.m. Hawaiian Standard Time, weekdays. We can be reached at:

> *(808) 848-4162*
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>
> *Web Site: www.bishop.hawaii.org/bishop/planet/ips.html*
>
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Activity Matrix: Standards and Skills

Use the matrices below to align The Explorers Project activities to the National Science Standards and Benchmarks. In each matrix, the teacher guide sections are listed along the left edge. If the activities in a given section fulfill a listed standard or include the development of a listed skill, the activity is marked with an "X" in the appropriate column

Science Standards

	Science as Inquiry	Physical Science	-position and motion of objects	-properties of objects and materials	Unifying Concepts and Processes	-change, constancy and measurement	-evidence, models and explanation	Science and Technology	-abilities of technological design	-understanding science and technology	Science in Personal and Social Perspectives
Constellations	x		x		x	x	x				
Make a Martian Sky	x	x	x	x	x	x	x				
Hawaii on the Map			x		x	x	x			x	
O_2 for Mars Mission	x	x		x	x	x	x	x	x	x	
Exploring	x		x		x	x	x		x	x	x
Island Insulation	x	x	x	x	x	x	x				

Mathematics Standards

	Problem Solving	Communication	Reasoning	Connections	Number Relationships	Computation & Estimation	Patterns and Functions	Statistics	Probability	Geometry	Measurement
Constellations	x	x	x								
Make a Martian Sky	x	x	x	x			x				x
Hawaii on the Map	x	x	x	x	x	x	x				x
O_2 for Mars Mission	x	x	x	x	x	x	x	x			x
Exploring	x	x	x	x							
Island Insulation	x	x	x	x	x	x					x

Science Process Skills

	Observing	Measuring	Communicating	Collecting Data	Inferring	Predicting	Making Models	Making Graphs	Hypothesizing	Interpreting Data	Controlling Variables	Defining Operationally	Investigating
Constellations	x		x	x	x		x			x			x
Make a Martian Sky	x	x	x	x	x	x	x		x	x			x
Hawaii on the Map	x	x	x	x			x			x			x
O_2 for Mars Mission	x	x	x	x	x	x	x		x	x	x		x
Exploring	x		x	x	x								x
Island Insulation	x	x	x	x	x	x	x		x	x	x	x	x

Geographic Education National Standards

Use the matrices below to align The Explorers Project activities to the Geographic Education National Implementation Project and Standards. In each matrix, the teacher guide sections are listed along the top. If the activities in a given section fulfill a listed standard or include the development of a listed skill, the activity is marked with an "X" in the appropriate column.

Standard	Consetllations	Make a Martian Sky	Putting Hawaii on Map	Oxygen for Mars Mission	Exploring	Island Insulation
Standard 1: How to use maps and other geographic representations, tools and technologies to acquire, process and report information			X		X	X
Standard 2: How to use mental maps to organize information about people, places and environments.			X		X	X
Standard 3: How to analyze the spatial organization of people, places and environments on Earth's surface.			X			X
Standard 4: The physical and human characteristics of places.			X		X	X
Standard 5: That people create regions to interpret Earth's complexity.						X
Standard 6: How culture and experience influences people's perception of places and regions.			X		X	
Standard 7: The physical processes that shape the patterns of Earth's surface.						X
Standard 8: The characteristics and spatial distribution of ecosystems on the Earth's surface.						
Standard 9: The characteristics, distribution and migration of human populations on Earth's surface.			X		X	
Standard 10: The characteristics, distributions and complexity of Earth's cultural mosaics.					X	
Standard 11: The patterns and networks of economic interdependence on Earth's surface.						
Standard 12: The process, patterns and functions of human settlement.			X		X	
Standard 13: How forces of cooperation and conflict among people influence the division and control of Earth's surface.					X	

Standard 14: How human actions modify the physical environment.					X	
Standard 15: How physical systems affect human systems.						X
Standard 16: The changes that occur in the meaning, use, distribution and importance of resources.					X	
Standard 17: How to apply geography to interpret the past.				X		
Standard 18: To apply geography to interpret the present and plan for the future.					X	

Viewers Guide

Objectives

The Explorers Project activities are meant to be used in conjunction with the planetarium show experience. The Viewers Guide will help prepare your students for their trip to the planetarium and provide a richer experience for them in the lab and classroom. Space science is probably more familiar to you and your students than Polynesian voyaging. It is impossible to investigate the depth of material and understanding of this subject in a 30-minute planetarium show. Therefore, it will be very helpful for you to take some time and prepare your class for their viewing of The Explorers.

Pre Show activities

Before taking your class to the planetarium, learn about the history and importance of voyaging in the Pacific. As in many great explorations, technology plays a very important role in equipping expeditions to succeed. Ancient explorers depended on the best technology of the day to make long distance ocean voyages. The voyaging canoe was the "spacecraft" of the early Polynesians.

Separate pages are provided for duplication as handouts for student use:

1. **The Significance of the Voyaging Canoe by Nainoa Thompson**

2. **Suggested Pre-Show Classroom Questions**

3. **The Importance of Exploration**

4. **Things to Do and Think About**

Post Show Activities and Questions

19 questions for your students to think about after viewing The Explorers.

Three classroom activities/labs for grades 4 through 6

Three classroom activities/labs for grades 7 through 12

Suggested web sites and resources for further investigation

1 - The Significance of the Voyaging Canoe

The voyaging accomplishments of the Polynesians ranks them among the greatest navigators and explorers on earth. The islands of Polynesia cover a triangular area greater than the entire landmass of North America, from Hawai'i in the north, to Rapanui (Easter Island) in the southeast, to Aoteroa (New Zealand) in the southwest. In terms of sheer size of the region over which its culture and languages have spread, Polynesia is the largest nation on Earth.

Every area of traditional Polynesian culture was touched by the voyaging canoe. Its construction, provisioning, and launching brought together the efforts and talents of the entire community. As the highest technological achievement of Polynesian society, the canoe stimulated development and production of traditional arts and crafts and inspired religious ceremonies, rituals, chants and dances in the lives of its people. Sailors, navigators, artisans, priests, chanters, and dancers all contributed to voyaging.

Challenged by their ocean environment and the need to sail to survive, Polynesians developed the intelligence, fortitude, and resourcefulness required to settle the most geographically isolated islands on the planet. Also of critical importance was the courage required to leave the safety of home and explore the vast unknown expanse of the world's largest ocean.

As their ability to explore evolved, the Polynesian culture flourished. Survival of this culture required that traditions be passed from generation to generation. Hawaiians exist today because of that process of education. Within the last 200 years, however, that educational process has fallen in disuse and our understanding of traditions has greatly diminished. Only remnants of a once rich history remain today, and as a result the Hawaiian culture and the Hawaiian people have greatly suffered.

Hawai'iloa, a double hulled voyaging canoe built largely from natural materials, was constructed to take on the challenge of rediscovering and re-establishing those once rich voyaging traditions. Hawai'iloa was built on expertise gained from the past experiences of Hokule'a a performance accurate replica of a Hawaiian voyaging canoe. Hokule'a has sailed 30,000 miles throughout Polynesia over ancient migratory routes.

Together Hokule'a and Hawai'iloa continue to perpetuate the traditions of voyaging through education. Through this education we hope to increase the sense of personal pride among all people who value Hawai'i's heritage, history and culture.

We also hope that the search to understand our traditions will shed light on how the ancient people survived on islands with limited resources. It is our intent that the information gathered will help educate both the children of Hawai'i and children everywhere to understand the needed balance between human needs and our planet's limited resources. Our children are our future. Efforts made to educate them can only contribute to a better future not only for Hawai'i, but the entire planet as well.

Naina Thompson
Sailmaster and Navigator, Polynesian Voyaging Society

2 - Suggested Pre-Show Activities

<u>Questions and Discussion Topics</u>:

1. Why do we explore?
2. Is exploration necessary? Why? Why not?
3. What have been some of the fruits of human exploration down through the ages?
4. What is left for us to explore?
5. Name some of the world's greatest explorers. What impact do their discoveries have on us today?
6. Do other living things explore? If so, name the organisms and their explorations.
7. If you lived on a small island in the middle of the ocean, what might prompt you to explore?
8. Where do you think the people living on islands in the Pacific came from?
9. How might you navigate across an ocean without a compass or map?

3 - The Importance of Exploration

The planetarium show we are going to see explores our spirit of adventure. We are curious beings always wanting to know about things we don't understand. Since before recorded history, people have been walking, hiking and sailing across our world in search of knowledge. Why is knowledge so important to us? Think about it. What does new knowledge give us?

For over 60 thousand years, ancient people have been sailing out into the vast Pacific Ocean. Well before European explorers of the 16^{th} Century set out into the Pacific, the Polynesians had discovered and settled every suitable island across its 63 million square mile surface! No small feat considering they did it without maps, compass or written language. The planetarium show you are about to see is a celebration of the spirit of human exploration. The show spans over 60,000 years of human history, including a look at what is in store for us on the vast cosmic ocean of space. We have taken our first footsteps off our world. Plans are being made to extend that quest to Mars and beyond.

Those of you born in the last 12 years of this millennium will be the voyagers who will come to know distant worlds first-hand. Some of you will live and work on the moon or Mars.

4 - Things to Do and Think About

<u>Suggested Activities and Research:</u>

1. Using the Internet, library and other resources, find the earliest references you can about boat building and ocean exploration.

2. What role did sailing vessels play in the lives of the ancient Egyptians?

3. Trace back the origins of the magnetic compass used in ocean navigation.

4. Learn about the differences and similarities between European navigators like Captain Cook, Magellan and the Polynesians of the South Pacific.

5. It has been three decades since men walked on the moon. Why are we thinking about returning to the moon? What does the moon offer to humankind?

6. We are planning our first missions to explore Mars. What would be the purpose behind going to Mars?

7. What could we learn about our own planet by studying other worlds such as Mars or Venus?

8. Build a model of a Mars colony. You will need to learn about what Mars has to offer and what you'll need to bring from Earth. How many people will live in your colony? What will they need to do in order to survive and prosper?

9. Build a sealed living environment for a small population of insects. It must provide food, oxygen, carbon dioxide removal, physical space and waste recycling systems. This is an area of intense research at NASA and other organizations. Web sites are a good source of information on "closed-loop" or "bioregenerative" systems.

Post Show Activities and Questions

Questions to Think About

1. What was the main idea of <u>The Explorers</u>?
2. How did the early Polynesians and Hawaiians pass down information about navigation?
3. What did the Polynesians use for ocean navigation?
4. How did scientists trace the Polynesian's migration path across the Pacific?
5. How did Polynesian navigation differ from that of European explorers?
6. How could you find your latitude by using the stars?
7. Why does the North Star remain fixed in its position in the night sky?
8. Where do stars rise and where do they set? (direction)
9. How can large ocean swells be used to tell direction?
10. Why are certain sea birds useful in finding land when you are far at sea?
11. What can be learned from Earth orbit that you can't learn from the ground?
12. If you could spend a month aboard the International Space Station, what would you like to do?
13. It will take about 4 months to fly to Mars. What would you do to pass the time?
14. Why are green plants being taken along on long spaceflights?
15. When explorers and trappers ventured into the American West, they lived off the land. How will Mars explorers live off the land on the Red Planet?
16. Why are solar storms dangerous to astronauts in space but not to us here on Earth?
17. Why are mountains on Mars such as Olympus Mons taller than Earth's mountains?
18. Why would you like to go to Mars? If not, why?
19. How are early Polynesian voyages across the Pacific similar to a flight to Mars? How are they different?

Teacher Activity Guide

Activity # 1 Constellations

This activity is designed for grades 4 – 6.

Introduction

Constellations have been used for centuries to find our way around the night sky or as a calendar. Early people placed their gods in the sky. People who navigated the Pacific Ocean in voyaging canoes for thousands of years used the stars to guide them to new island homes. Navigation skills were handed down through chants and story telling. This activity will help students in visualizing certain constellations that were used by the early Polynesians. Other constellations were used to explain the natural world.

Students will be shown the stars making up Scorpius. To the ancient Polynesians they saw a fish hook. Instead of showing students what the fishhook looks like, they must figure the shapes out for themselves and draw what they see as a fishhook. Other constellations are included to see how knowledge was passed down through stories about the night sky.

This activity is best done prior to seeing the planetarium show, The Explorers.

The Story of Maui

Across much of the South Pacific an old story is told of a demigod named Maui who went fishing one day with his brothers. Maui took his magical fishhook with him. The brothers paddled for days in their outrigger canoe. Finally they arrived at just the right spot and Maui threw his magical fishhook into the sea. He told his brothers not to look back at what he was doing or the magical spell would be broken.

There was a mighty tug on his line. His brothers were very curious and wanted to look back and see what Maui had caught but did as they were told and stared straight ahead. Maui had hooked the bottom of the ocean and was pulling up a new land. Just as the tops of the highest mountains broke the surface, his brothers could not stand it any longer and looked back. The spell was broken and the line broke with a snap. Maui’s magical fishhook flew up into the night sky where it is still visible today as Maui’s fishhook, or Scorpius. And the mountaintops became the beautiful Hawaiian Islands.

Oral traditions and chants like this one were used to pass down history and important events in the lives of the people. If you didn’t have a written language, paper and pencil, how would you preserve your history and accumulated knowledge? This would be a good question for discussion with your students.

Name ____________________
Period ________
Date_____________________

Constellations- Stories in the Sky

Introduction:

For thousands of years people have looked at stars in the night sky and imagined they saw animals, gods or familiar shapes. In the planetarium show, The Explorers, Polynesians, people who live in the vast Pacific Ocean, used stars to navigate by. Just like them, you will make a picture out of a group of stars to form a constellation. Constellations are groups of stars that form some kind of picture if you connected the dots (stars) with lines.

What you will need:

1. Colored pencils, pens or crayons
2. Constellation handout sheets

What to Do:

1. Pick a constellation you wish to create.
2. Draw and color in your constellation turning it into a picture.
3. Imagine you live on an island in the middle of the Pacific Ocean. Make up a story about a constellation that tells how to find your island home using the stars.
4. Take your constellation sheet to the planetarium and see if you can find the constellations you have drawn.

Questions:

1. Why do you think people try to see pictures in the night sky?

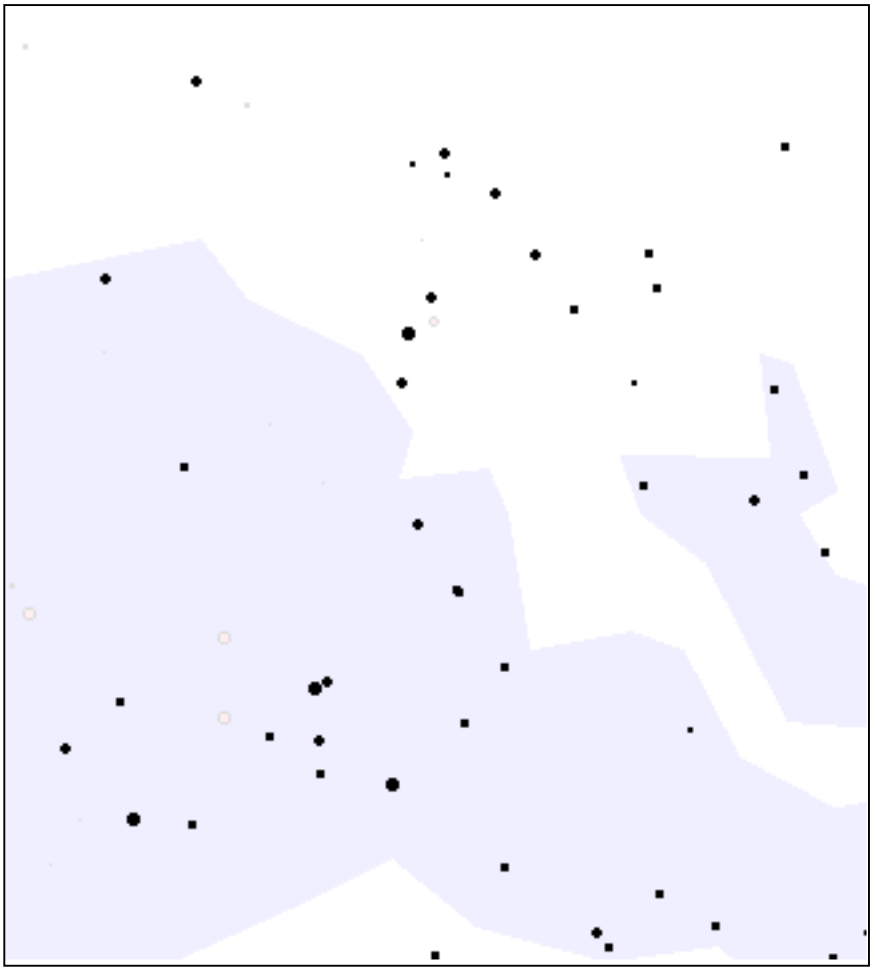
2. Many people see a water cup or dipper in the Big Dipper. What else could it be? Draw a picture of your guess. Look at other classmate's pictures. What did they see?

3. Do you think you can see the same constellations at the same time of night every night of the year? Why? Why not?

Name ______________________

A Magical Fishhook or a Scorpion?

The Constellation Scorpius looks like a scorpion to some people. The Polynesians saw something different, a magical fishhook that was used to pull up the bottom of the ocean and form the beautiful Hawaiian Islands. Draw the magical fishhook using the stars below.



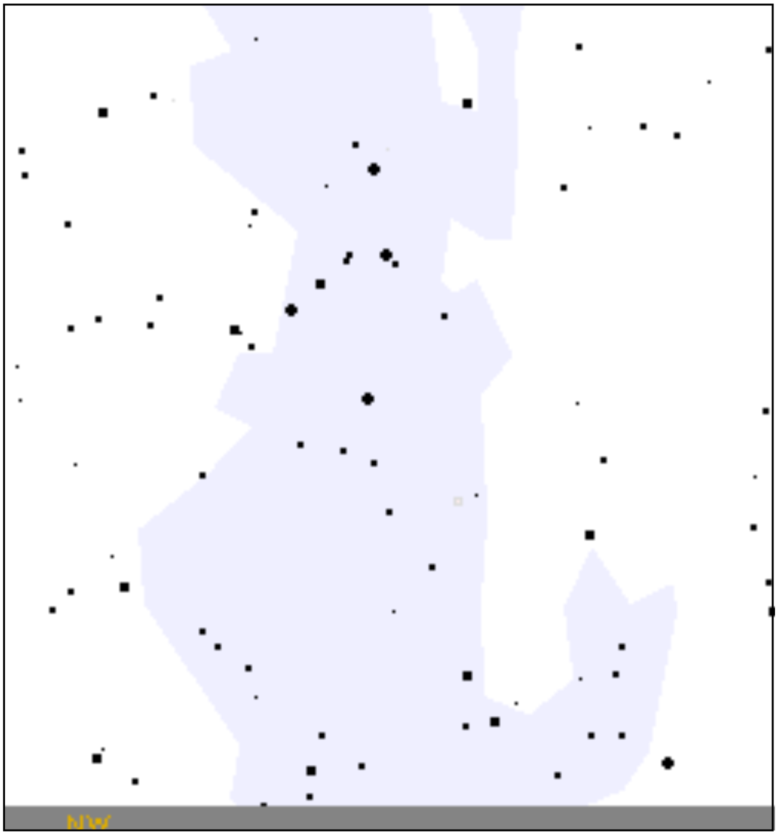
(South East Sky in the spring around midnight)

Name_________________

An Evil Queen or a Beautiful Sea Bird?

In the Northern sky circling the North Star is the wicked Queen, Cassiopeia. But to the Hawaiians this group of stars looked like their friend the Ewa Bird, pronounced “Eva”. Do you see the bird? Birds were very important in finding land. The Ewa bird otherwise called the Frigate bird nests on land at night. If voyagers at sea saw a Frigate bird it meant land must be close by. Draw the Ewa bird using the stars given below.

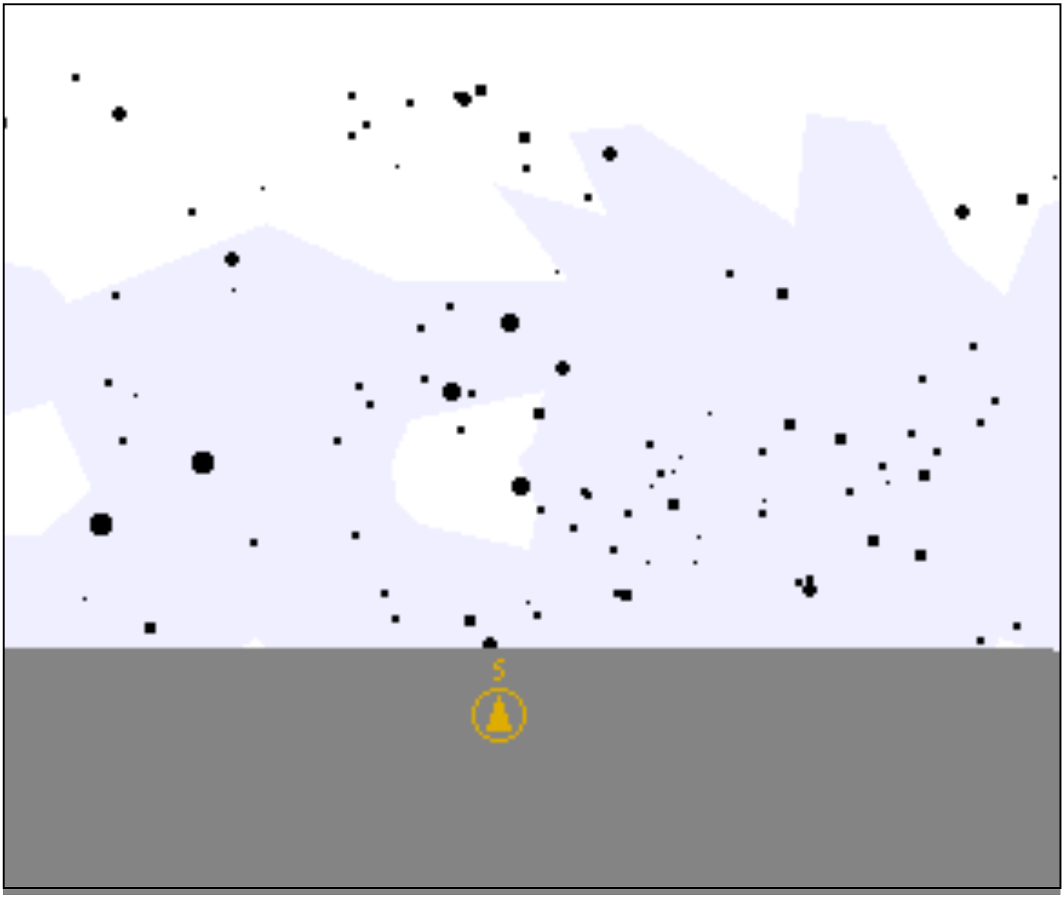
(Winter sky looking Northwest. Gray is the ground. The Milky Way runs straight up.)



Name______________________

Stars to Steer By

If you didn't have a compass with you out on the open ocean, how could you tell direction? The Hawaiian navigators of old used a group of stars that points South. Find the stars we call the Crux or Southern Cross. The Hawaiian name for this group of stars is called Hani-aka-malama. Draw the Southern Cross from the stars below.



From Hawai`i, the Southern Cross points directly South to Tahiti.

Teacher Activity Guide

Activity #2 **Make a Martian Sky in Your Classroom**

This activity is suitable for grades 4 – 6.

Introduction

The Explorers takes us to the red planet, Mars. The color red is due to the high iron oxide content of the soil, better known as rust. Dust storms are annual events on Mars and stir up large amounts of dust particles in the atmosphere. Martian sunsets are tinted pinkish red because of this atmospheric dust.

This experiment may be done as a teacher demonstration or in student groups as a lab exercise. After the experiment, direct your students to the World Wide Web to see actual Pathfinder spacecraft images taken on the surface of Mars showing colorful sunsets. We see similar sunsets here on earth after large volcanic eruptions. Millions of tons of volcanic ash and gasses are shot high into the stratosphere and circle the earth producing beautiful red sunsets for several years after the event. Looking straight up just before the sun sets you will notice the sky is dark blue. Looking off toward the horizon the sky changes to oranges and reds just as it does in the experiment.

Changing the amount of milk you put in the water bowl easily modifies this experiment. A large Martian dust storm can be simulated and compared with a less severe one.

NASA has posted pictures on the WWW showing brilliant red Martian sunsets. Point your computer at:

http://www.jpl.nasa.gov/marsnews/img/august27.html

Name ____________________
Period ________
Date_____________________

Make a Martian Sky in Your Classroom

Introduction:

Sunsets on the planet Mars are very red. We have red sunsets on Earth as well. What causes sunsets to be like this? In this experiment we will make a Martian sunset and explore why this happens.

1. What you will need:

Water
Small cup of milk (10 ml.)
Eyedropper
Flashlight
Wide, clear glass bowl, a punch bowl or small fish bowl will work.

2. What to do:

Fill the bowl with water and add 10 to 15 drops of milk with the eyedropper. Shine your flashlight down from the top of the bowl.

3. My Observations:

In the space below write down what you saw when the light was shined down from the top.

___

Now shine the light from the side and look straight at the beam from the other side of the bowl.

What did you see from this angle? ______________________________
Did the color of the light change?

4. Doing More:

Try changing the amount of milk in the bowl and seeing if the colors change. Record what you did and what you discovered by changing the amount of milk. Record what you did and the results in the space below.

What I did: ______________________________

My results: ______________________________

____

____

Watch a sunset and look for different colors in the sky and clouds as the sun nears the horizon. Notice how sunsets can vary from evening to evening. What do you think would happen to the colors at sunset if there were a brush fire or forest fire in your part of the world? What could a volcanic eruption do to sunsets?

Surf the World Wide Web:

Go to NASA's Mars Pathfinder web site and look at actual pictures taken of Martian sunsets. What can you tell about the amount of dust in the Martian sky from these pictures? Here's the web address –

http://www.jpl.nasa.gov/marsnews/img/august27.html

Take your own pictures of colorful sunsets and share them with students from other places around the world via the WWW.

Teacher Activity Guide

Activity #3 **Putting Hawaii on the Map**

This activity is designed for grades 6 – 8.

Introduction:
Sometime between 200 and 400 AD, Polynesian voyagers discovered the Hawaiian Islands. They came from the Marqueses and Cook Islands thousands of miles to the South. They were able to sail back and fourth between Tahiti, the Marqueses Islands and Hawai`i on twin hull voyaging canoes. To understand how hard these voyages must have been we are going to do an activity that will show students just how isolated and remote the Hawaiian Island group really is.

Students will be working with the concepts of latitude and longitude in this activity. Some additional instruction may be needed if these skills are new to the students.

Name ____________________
Period ________
Date_____________________

PUTTING HAWAI'I ON THE MAP

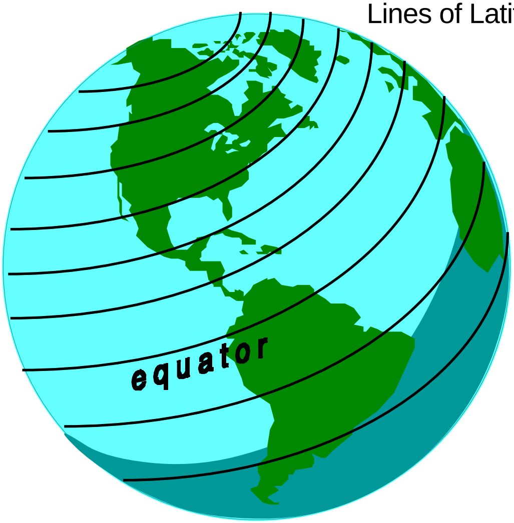
Introduction:

Thousands of years ago people called Polynesians explored the Pacific Ocean on voyaging canoes. Around 1800 years ago the Polynesians sailed North from the Cook and Marqueses islands in the South Pacific and discovered Hawai`i. They were able to navigate thousands of miles between remote islands of the Pacific.

To understand how hard these voyages must have been, we are going to do an activity that will show just how isolated and remote Hawai`i is from the rest of the world. If you saw the planetarium show The Explorers, you have seen how we think the Polynesians accomplished such impressive navigational feats.

Key Concepts:

The Hawaiian Islands are located in a subtropical, oceanic environment far from other large landmasses such as North America or Asia. Look at a globe and find Hawai`i. We will be working with two words that you may not know about, latitude and longitude. Latitude and longitude lines on a map are used to describe a position on the earth. Here's how.



Lines of **latitude** run parallel to each other from pole to pole. The latitude line that runs around the world dividing the two hemispheres is called the Equator. There are 90 degrees of latitude from the equator to the North Pole and 90 degrees of latitude from the equator to the South Pole. Hawaii is 20 degrees north of the equator so its latitude is said to be 20 degrees North. Seattle Washington is 47 degrees North Latitude. Sydney Australia is about 35 degrees South Latitude. Each degree of latitude is further broken down into minutes. There are 60 minutes in each degree. One minute of latitude anywhere on earth is equal to one nautical mile.

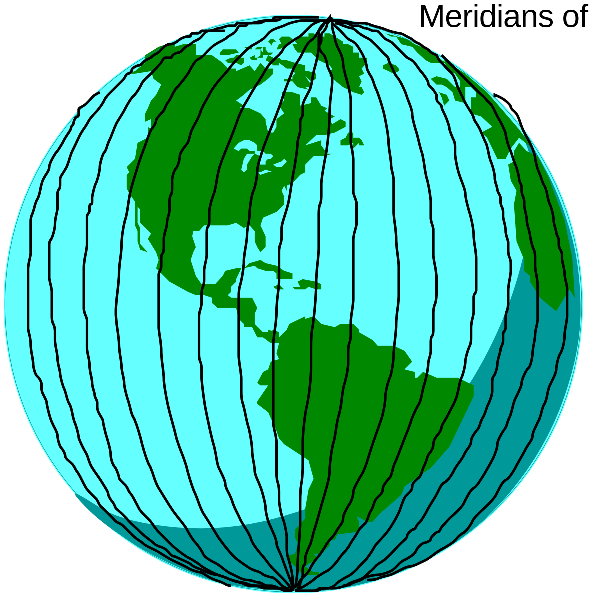
Just remember that Latitude is a measure of how far north or south of the equator you are. Question- If one minute of latitude is equal to one nautical mile (6070 feet), how many nautical miles is it from the equator to the North Pole?

1 nautical mile = 1 minute of latitude
60 nautical miles = 1 degree of latitude

_______ nautical miles = 90 degrees of latitude
(distance between equator and North Pole)

Look on a globe and find your latitude. ___________ degrees North Lat.

Lines that run from pole to pole are called **Meridians**. Are they the same distance apart all along their length? No. They are the farthest apart at the equator and touch at the poles. Meridians of longitude begin their numbering from a place in the British Isles at a place called Greenwich. The line that runs from North to South Pole through this town is called The Prime Meridian or – 0 degree longitude line. From the Prime Meridian, longitude lines move westward, usually in 10-degree increments all the way to the 180-degree meridian, which is halfway around the world. Remember that a globe or ball can be divided up into 360 degrees. The first 180 degrees is called West Longitude. Hawaii is about 150 degrees West Longitude, or 150 degrees west from Greenwich England.



Meridians of Longitude

At the 180-degree mark we begin counting back towards England. Japan is about 135 degrees East Longitude. We continue counting East Longitude all the way to England again.

Degrees of Longitude are also split into smaller units, again called minutes of Longitude. As with Latitude, there are 60 minutes of Longitude in each degree. Each minute of Longitude IS NOT equal to one nautical mile (except at the equator).

Now that you have seen examples of latitude and longitude, how do we put all this together to give the location of a city or island? Here's how a geographic position is written: Refer to a map or globe to follow along. Let's find the latitude and longitude of Denver Colorado. First find the nearest latitude line just below Denver. That would be the 39-degree North latitude line. The city is just a little bit above the 39-degree line. (44 minutes of latitude to be exact. 60 minutes = one degree) Now look for the closest meridian. It just so happens that Denver sits almost exactly on the 105 degree West longitude line. So, Denver's position is written like this –

39 degrees 44 minutes North Latitude by 105 degrees 0 minutes West Longitude. You may also see it written this way – $N39^0$ 44', $W105^0$,00'

Here's another example. What city is located at $N35^0$ 41'- $E139^0$ 44' ?

(Find the answer written at the bottom of the next page)

Objectives

At the end of this activity, you should be able to:

1. Locate the tropics and Hawai`i on a world map.
2. Label the Hawaiian Islands on a grid of latitude and longitude.
3. Describe the general location of the Hawaiian Islands to the nearest large landmass.

Materials

You may work by yourself or with another student. You will need the following things to do this activity:

1. Student Activity Sheet #1 and #2 (get from teacher)
2. Hawaiian Islands map (get from teacher)

Materials Con't:

1. Crayons or colored pencils
2. World map or globe
3. World Atlas (optional)

What To Do:

1 Before starting this activity, you will review what latitude and longitude are. In the spaces provided write the definitions for these two terms:

LATITUDE: ____

____

____

LONGITUDE: ____

____

____

2. Using the map of Hawai`i, find and record the latitude and longitude for the following cities:

Lihue on the island of Kauai-	Lat. _________________	
	Long.________________	
Honolulu on Oahu-	Lat. _________________	
	Long.________________	
Hilo on the Big Island-	Lat. _________________	
	Long.________________	

3. Cut out the four islands from the Student Activity Sheet #1 and place them on the map grid using the Lat., Long provided in the Clue Box. Try not to use a map or globe to do this. Check those around you and see if other teams placed their islands where you did. How accurate are your placements?

4. Now refer to the Islands Map to double check your placement and glue the cutouts to the grid. Finish your Hawai`i map by coloring and labeling the islands and surrounding ocean.

Label List (Use this list to label your map)

Geographic Information

1. Pacific Ocean
2. The direction North (use arrow)

Islands:

1. Kauai
2. Ni`ihu
3. Oahu
4. Molokai
5. Lana'i
6. Maui
7. Kaho'olawe (Ka-ho-o-la-ve)
8. Hawaii (The Big Island)

Cities and towns:

1. Hilo
2. Kahluli
3. Honolulu
4. Kaunakakai
5. Kilauea
6. Lahaina

(Answer to name of city- Tokyo)

Student Activity Sheet #1

Put Hawaii on the map by cutting out the island shapes on Activity Sheet #2 and placing them on the geographic grid. Use the coordinates (Lat,Long) give to help you. Do not look at the Hawaiian Island map until you have tried placing all the islands. Then check the map before you glue the islands to the grid. Label your map with the information given in #4 on the previous page.

Answer the following questions:

1. What is the approximate latitude and longitude of the southernmost tip of the Big Island?

___

2. Is the southernmost tip of the Big Island the southernmost point in the USA? Explain?

___

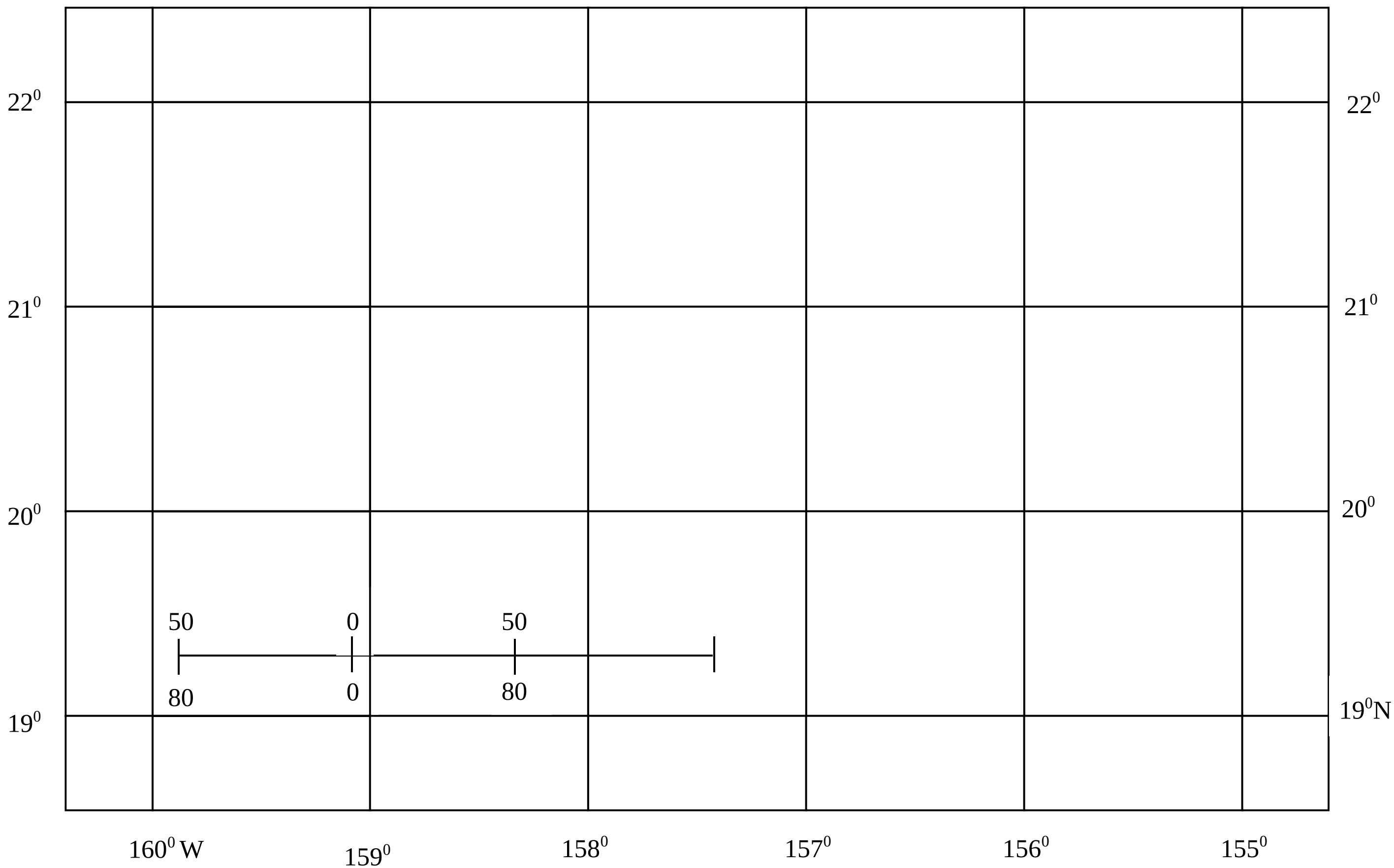
3. Using the map scale provided, how long are the Hawaiian Islands, from Ni'ihau to Hawaii? ____________ miles.

Use a World Map to find out:

4. Are the Hawaiian Islands located in the Tropics? ________________________
5. Are the Hawaiian Islands north or south of the equator? _________________
6. Which ocean surrounds the Hawaiian Islands? _________________________
7. How far is it to the closest continent from Hawaii? _______________________
8. How far is it from Hawai`i to Japan? _______________ miles, from Hawai`i to San Francisco? _______________ miles.
9. Using a world globe, determine the latitude of the Tropic of Cancer? ___________degrees N.
10. Is Hawai`i above or below the Tropic of Cancer? _______________________
11. If you live between the Tropic of Cancer and the Tropic of Capricorn, what kind of climate do you experience? ____________________________________

Let’s Put Hawai’i on the Map!

Student Activity Sheet - 1

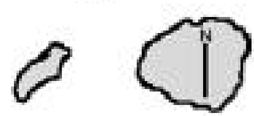


Let’s put Hawai’i on the Map Activity sheet #2

Clues:	A.	22^0N, 160^0W
	B.	$21^0$30’N, 158^0W
	C.	21^0 N, 157^0W
	D.	19^0 30’N, 155^0 30’W

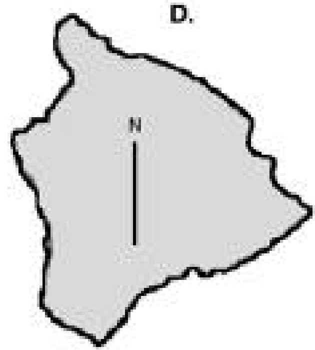
B.

A.



C.

D.



Teacher Activity Guide

Activity #1 **Oxygen for a Mars Mission**

This activity is designed for grades 7-12.

Introduction

A proposed flight to Mars might take 1000 days! It will be impractical for crews to take bottled breathing oxygen. NASA has developed what is called the Mars Reference Mission. The Mars Reference Mission is a starting point for planning and refining such an undertaking. Students are asked to calculate the amount of oxygen (air) they consume while at rest, during moderate exercise and strenuous exercise. Students are given the amount of oxygen the green plants can produce in a 24-hour period. The challenge is to allow for enough green plant biomass to make oxygen for the crew while keeping the weight down to a minimum. This lesson will combine the use of good laboratory and math skills in figuring out the answers. There are no hard and fast "correct" answers.

There are other issues this activity brings up that students might want to investigate further. For example, the green plants will not only scrub the cabin atmosphere of $C0_2$ and add 0_2; they will be the primary food source for the crew. The plants might also be used to purify wastewater. How many more kilograms of green plant mass will be needed for such activities? Regenerative, closed loop system research is an exciting area of research at NASA and one students may want to design as an extra credit or science fair project. (See the Reference Section for web sites on Regenerative, closed loop system research.)

BISHOP MUSEUM THE EXPLORERS PROJECT

Name ______________________
Period ________
Date_______________________

Oxygen for a Mars Mission

Introduction:

A proposed flight to Mars might take 1000 days! It will be impractical to carry enough bottled breathing oxygen for the entire mission. How is oxygen placed in our atmosphere? Green plants live in a mutually beneficial relationship with animals on earth. Through a process called Photosynthesis, green plants, in the presence of sunlight, convert carbon dioxide and water into oxygen, plant tissues and glucose (a sugar). So, as they do here on earth, plants must accompany us on our voyages into space.

Objective:

To measure the quantity of oxygen a person will need under varying levels of activity and from this, calculate the amount of green plants we must take on a Mars mission to support a crew of 7 people.

Materials and Tools checklist:

1. 1 – two liter soft drink bottle
2. One meter of flexible plastic tubing (from hardware or aquarium store)
3. Permanent marker pen
4. Paper strips
5. Cellophane tape
6. Water
7. Large glass container or aquarium (able to hold several gallons of water)

Procedure:

Step 1. Building a spirometer*. Obtain the materials in the Materials and Tools checklist and begin by calibrating the two-liter soft drink bottle. Stand the bottle upright and pour 100-ml of water in the bottle with a beaker or graduated cylinder. Cap the bottle and turn it upside down. Mark the water level labeling it-100 ml. Repeat this procedure until the bottle is filled and you have 20, 100ml graduations marked on the bottle.

* Spirometer- a device used to measure the lung capacity or what is called “tidal volume”.

Step 2. Make paper mouthpieces by rolling a strip of paper around one end of the plastic tubing. Use a small strip of tape to hold the mouthpieces together. Make a new mouthpiece each time a new person uses the apparatus.

Step 3. Partially fill a large glass container or aquarium with water. Fill the 2-liter bottle with water and invert it in the aquarium. Support the bottle by holding it with one hand around the neck. Insert the air hose into the bottle’s neck.

Attach a mouthpiece to the other end of the plastic tube and have an “astronaut” fully exhale a normal breath of air through the tube and into the 2-liter bottle. This volume of air exhaled into the bottle is called tidal volume. This is the lung capacity of the subject in cubic centimeters or milliliters. Water will be driven out of the bottle. Read the volume of air trapped inside the bottle by using the calibration marks you placed on the bottle’s side in Step #1 and record the amount in table #1 under the “No Exercise” column.

You must determine the respiration rate for the individual being tested. To do this count the number of respiration’s for one minute. Capture the exhaled breath of the first respiration in the spirometer and continue to count respirations. Record the respiration count in table #1 in the “No Exercise Respiration Rate” space.
You might want to use a swimmer’s nose clip to ensure all the exhaled air goes into the calibrated 2 liter bottle.

No Exercise Oxygen Demand:

Step 4. Measure the tidal volume of several members of your team. (We are assuming that exhaled volume is equal to inhaled volume) Begin with the person sitting at rest. Record each person’s tidal volume and record the data below in the “No Exercise” section.

Attach a clean mouthpiece to the tube, fill the bottle with water and repeat the experiment using a different person. How many people should you do? Is there a difference between males and females? Does a person’s size make a difference in how much air they exhale? These are all variables you must take into consideration before deciding how much plant material to take along on the Mars flight.

Moderate Exercise Oxygen Demand:

Step 5. After recording "No Exercise" volumes and respiration rates, refill the bottle with water and have your test subjects perform a moderate amount of activity such as lifting small weights for a minute or two. Immediately after exercise, have each "astronaut candidate" exhale through the mouthpiece, record the volume and determine their respiration rate. Do this several times and record the results in the Moderate Exercise column.

Strenuous Work Oxygen Demand:

Step 6. Repeat the procedure a third time, but have the test subjects run in place for several minutes and then take your measurements. Record your results in the "Strenuous Work" column.

Calculate the averages for tidal volume and respirations for each column. Record your results below each column.

Analysis:

Step 7. Discuss possible ways to determine how much air an average "astronaut" will need during each 24-hour day while on a Mars mission. Plan for one hour per day-per astronaut, doing moderate exercise to keep in shape. Plan for 2 astronauts performing space walks 2 hours per week to maintain the ship (Strenuous exercise). The remainder of the time will be non-exercise or rest rates of air consumption. Now calculate the total air needed for a 24-hour period for a crew of 7 people.

Green Plant Oxygen Production:

Assume that the green plants chosen for this mission can generate 5 liters of oxygen per pound of plants per day.

Your task is to calculate how many pounds of plants must be taken long on the mission just for breathing purposes. Remember, there is no "right" answer. Plan for a safety factor. What if the mission is extended? What if the crew has to make extended repairs that require strenuous exertion? If a person gets sick, will their body demand more oxygen? The ultimate test will be making the voyage to Mars… Think about other factors impacting spacecraft/life support systems design?

Data Table 1

24 hour Oxygen Requirements for flight crew of 7 astronauts

Subject Name	No Exercise	Moderate Exer.	Strenuous Exer.
	Rest Tidal Vol.: Respiration Rate:	Mod. Exer. Tidal Vol.: Respiration Rate:	Stren. Exer. Tidal Vol.: Respiration Rate:
	Rest Tidal Vol.: Respiration Rate:	Mod. Exer. Tidal Vol.: Respiration Rate:	Stren. Exer. Tidal Vol.: Respiration Rate:
	Rest Tidal Vol.: Respiration Rate:	Mod. Exer. Tidal Vol.: Respiration Rate:	Stren. Exer. Tidal Vol.: Respiration Rate:
	Rest Tidal Vol.: Respiration Rate:	Mod. Exer. Tidal Vol.: Respiration Rate:	Stren. Exer. Tidal Vol.: Respiration Rate:

Averages	Rest Tidal Volume:	Moderate Exercise Tidal Volume:	Strenuous Exercise Tidal Volume:
	________________	________________	________________
	Respiration Rate:	Respiration Rate:	Respiration Rate:
	________________	________________	________________

Conclusions:

From the data above, calculate the total oxygen/air demand for the crew on a daily basis.

1. Daily oxygen/air volume requirement for 7 astronauts ______________ liters per day.

2. Total mass of plant material needed to produce daily crew oxygen/air requirement :_______________ pounds.

3. Compare your results with other teams. What might account for differences?

Teacher Activity Guide

Activity #2 **Exploring**

This activity is designed for grades 7-12.

Introduction

Exploration is the hallmark of our species. We are curious and it is this curiosity that drives us to venture into the unknown. While much exploration has been done in the name of seeking riches or nationalistic expansion, many great explorers have voiced more altruistic motivations, that of seeking great unknowns.

By the early part of the 20th Century, most of the planet had been explored. Two frontiers remain the deep oceans and space. Both place high demands on explorers probing their secrets.

"The Explorers" planetarium program provides a unique look at human exploration of the Pacific Ocean over the past 60,000 years. Voyages of Polynesian people and their antecedents have gone on relatively unnoticed by the rest of the world. It is an intriguing story of triumph and ingenuity in the face of staggering odds. Long distance voyaging was done without the use of compass maps sextants or written language. It s hoped that students first see "The Explorers" in order to understand and gain knowledge about why we explore. It also serves as a starting point for this activity.

Objectives:

1. In this activity your students will plan and execute an exploration.
2. Students will design a human habitat for the site of their exploration.
3. Students will make a presentation about their expedition.

In this activity, students will plan and carry out an exploration. This activity can be adapted to a variety of situations. “Exploring” can be a classroom activity where students choose where or what they would like to explore. Or, students may choose to study an exploration of the past such as the Lewis and Clark expedition, Apollo 11’s flight to the moon or a dive to the deepest place in the ocean back in 1961 aboard the Treaste. “Exploring” could also be conducted out in the field. Try to find a place unfamiliar to the students.

Procedure:

- Have students research explorations of the past. Where and why did they go? What did they accomplish? What were the challenges and hardships they faced?

- Have students imagine that they are an explorer of the past, present or the future. Where would they like to explore?

- Students must define their goals. (Why are they exploring and what do they hope to accomplish).

- Students research and plan their expedition.

- Suggest students write a descriptive story or keep an expedition journal of their expedition. Encourage creativeness and imagination in storytelling. They must state the outcome. Were they successful? If not, why not?

- Students build a model of their expedition craft. Explain the rationale for their design.

- Have students draw a map of the new territory they have explored.

- What would it take to survive in this new environment? What are the challenges?

- Be creative. The student activity page can be helpful in directing them through this activity.

Names ____________________________

____

____

____

Period __________

Date ___________

EXPLORING – Student Worksheet

Introduction:

You and your expedition team members are about to embark on a journey of your choosing. If you could set out to explore some new frontier, where would it be? How would you do it? Why would you go? These kinds of questions have challenged people for thousands of years.

Begin your quest into the unknown by going through this checklist with your team members. The objective is to be creative, have fun and learn what all explorers come to know through their journeys into the unknown.

Checklist:

1. Where or what are you going to explore?

2. Name your expedition.

3. List your expedition goals. What do you want to accomplish? Why are you doing this?

4. What will you need to be able to do to accomplish your goals?

5. What will be your mode of travel? Describe or diagram your exploration vehicle(s).

Student Worksheet, Con't.

6. List all the challenges you might face.

7. Brainstorm ways to solve these challenges.

8. Make a list of possible resources to be used in your research.

9. How many expedition staff will be needed to carry out your plan? What roles will each play? What qualifications do they need?

10. Map out your journey.

11. What navigation equipment will you need?

12. Create a timeline for the expedition.

13. Draw your conclusions and write down the results of your expedition's work. Prepare a presentation to display and communicate what you did and what you learned.

Teacher Activity Guide

Activity #3 **Island Insulation**

This activity is designed for grades 7-12.

Introduction

Students conduct two experiments to test the effects of latitude and the surrounding ocean on air temperature.

Key Concepts

Due to the subtropical latitude of the Hawaiian Island chain there are relatively small variations in day length and solar radiation. The surrounding ocean further moderates seasonal temperature variations. The Hawaiian Islands are the most isolated group of high islands in the world.

Objectives

Students will be able to:

1 Demonstrate the relationship between the latitude of the Hawaiian Islands and the intensity of solar energy the Islands receive.

1 Explain the effect of latitude and the surrounding ocean on air temperature on isolated islands and coastal maritime regions.

Time

Two class periods

Subject Areas

Science, Social Studies, Math

Materials

1 2 clip lights or desk lamps

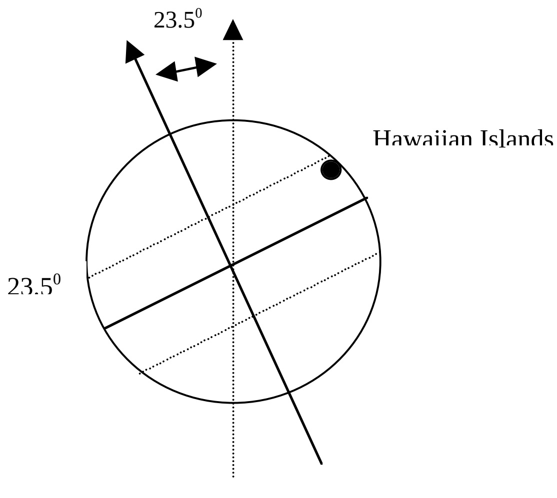
1 4 sheets of legal size white paper

1 4 outdoor thermometers
1 2 jars with cork top (or use putty for top)
1 1 cup of dark soil
1 Earth globe
1 World map

Teacher Background

Located more than 3.200 km (2,000 miles) from the nearest continental landmass, the Hawaiian Islands are the most isolated high islands in the world. The surrounding ocean and the subtropical latitude of the islands create a relatively stable climate with a warm year-round growing season at low elevations. Large bodies of water, such as the Pacific Ocean, heat up in the summer and cool down in the winter much more slowly than large landmasses. There are several reasons for this. First, land surfaces are usually opaque. The sun's rays reach rock, building, or tree and penetrate no further. The ocean is not as opaque, so a ray of sunlight reaching its surface will spread its energy through several meters of water. Furthermore, the ocean has a very shiny surface. When the sun's rays reach this shiny surface, they are often reflected away, while they would be easily absorbed by dense, dark vegetation or soil. In addition, land surfaces tend to remain stable, so the sun only warms the top layer. The ocean, on the other hand, is constantly churning and mixing. No sooner does the sun heat one layer than it is replaced by cooler water from below, so there is a much larger area and volume to be heated. The ocean surrounding the Hawaiian Islands thus helps to insulate them from seasonal changes in temperature.

Many coastal regions of the earth do not undergo extreme temperature variations from season to season because of the moderating ocean effect. Compare seasonal high and low temperatures for cities like Seattle Washington or San Francisco, California, to cities in the continental interior like Fargo North Dakota or Denver Colorado.



The latitude of the main Hawaiian Islands, about 19^0 – 22^0 (degrees) north of the equator, is and other factor in the moderate seasonal temperature changes in the islands.

Each day the Earth makes one full rotation around its axis. The axis does not run straight up and down, but is tilted 23.5^0 relative to the sun. As the

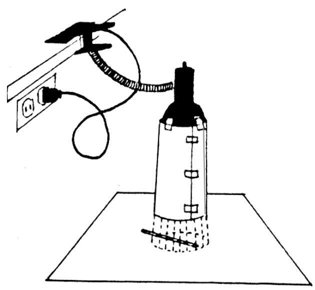
Earth orbits the sun, the equator receives constant exposure to solar energy. The Tropics of Cancer and Capricorn, at 23.5^0 north and south, respectively, mark the boundaries between tropical and temperate regions. Because the Hawaiian Islands are just south of the Tropic of Cancer and not directly on the equator, they do experience some seasonal shift in day length. The approximate difference between the longest and shortest days in the Islands is only two and a half-hours. In fact, in most places in Hawai'i, the difference between the temperature of the hottest day in summer and the coldest day in winter is not as great as the difference between daytime temperature and nighttime temperature. Night is the winter of the tropics!

Teaching Suggestions

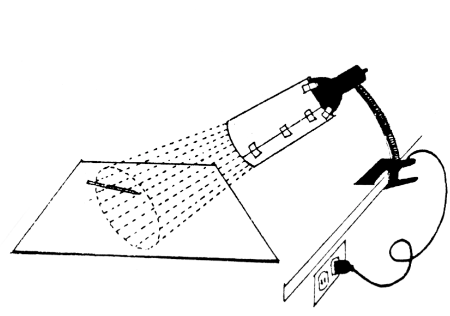
1. Ask a student volunteer to locate the Hawaiian Islands on a map or globe and measure the distance to the nearest continental land mass. Give students the scale of the map and ask them to figure the kilometers or miles from Hawai'i to other large land areas.

2. Review the orbit of the Earth around the sun. Use a globe, balloon or other prop to demonstrate the tilt of the Earth's axis. As students to predict which hemisphere will receive the most sun during which season.

3. Have groups of students test the effect of the angle of the sun (determined by latitude and season) on temperature. Have each group roll a sheet of paper around a clip light or desk lamp. Students should place a thermometer on a sheet of paper and hold the lights about 8 cm (3 in) above the paper; one light at an angle and one shining directly over the paper. (See illustration). Ask students to record the temperature before turning on the lights.

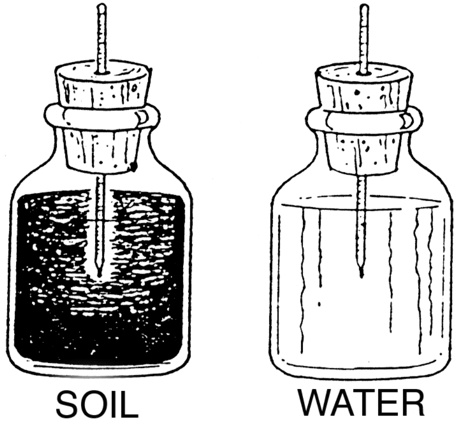


4. Discuss the differences: Which lighted area was larger? Which area was warmer? Compare this to the direct rays of the sun over the tropics and the indirect rays of the sun in temperate regions. Locate the tropics and temperate regions on a map.



5. To test the effect of the surrounding ocean on air temperature in Hawai'i, fill two identical large clear jars, one with dark soil and one with water. Put

thermometers through stoppers that fit securely into the bottles. (If corks are not available, use putty.) Place the stoppers in the bottles and record the temperatures. (See illustration)



6. Put the two bottles in the sunshine and have students record the temperatures every ten minutes for a 30-minute period.
7. Put the bottles in a cool cabinet and continue to record the temperatures every ten minutes for another half-hour.

8. Discuss the results. Which material absorbed heat more quickly? Which lost heat more quickly? (The soil should absorb and loose heat more quickly.) Explain that because there is so much water in the ocean, the water takes even longer to change temperature than the water in the bottle does. Discuss the moderating effect the ocean has on air temperature in Hawai'i and how this contributes to the Island's warm, year-round growing season. How could the results of this experiment explain the kind of climate found in the center of continents?

9. Ask students to write the results of the two experiments, summarizing the effect of latitude and the surrounding ocean of air temperature in Hawai'i. Make the experiment relevant to your geographic location. Have students use the results of their experiments to explain why temperature ranges are greater near the interior of large landmasses in temperate zones.

BISHOP MUSEUM THE EXPLORERS PROJECT

Reference Section

Polynesian Voyaging and Hawaiian Culture - World Wide Web Sites

Polynesian Voyaging Society
http://leahi.kcc.hawaii.edu/org/pvs/pvs.html

Bishop Museum, Honolulu, Hawai'i
http://www.bishopmuseum.org

Exploration/Geography – World Wide Web Sites

The Explorers Club
http://www.explorers.org

Math and Science Education Resource World Wide Web Sites

The National Science Education Standards
http://www.nap.edu/readingroom/books/nses/html

Eisenhower National Clearinghouse for Mathematics and Science Education
http://www.enc.org

Aerospace Education and NASA World Wide Web Sites

University of California at Santa Barbara, Alexandria Digital Library
http://alexandria.ucsb.edu/other-sites/

NASA, Search for Habitable Planets
http://www.kepler.arc.nasa.gov/

The Mars Society
http://www.marssociety.org

NASA's Spacelink
http://spacelink.nasa.gov/.index.html

NASA Home Page
http://www.nasa.gov

NASA Goddard Space Flight Center Space Science Education Home Page
http://www.gsfc.nasa.gov/education/education_home.html

NASA SpaceLink Mission to Planet Earth Home Page
http://spacelink.nasa.gov/products/Our.Mission.to.Planet.Earth/

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