U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service

Lesson 2: Ocean Exploration

Overview

Lesson 2 gives students a brief overview of the history of oceanography. They will learn some of the important events in the history of oceanography including dates of voyages and inventions which will also serve as preparation for the Bowl. In the student activity, students will learn some common terminology and information relating to navigation.

Lesson Objectives

Students will:

1. Identify the dates of important voyages and inventions in the history of marine science

2. Define key units of measurement in navigation and convert measurements among different units

3. Define common navigation terminology including the parts of a ship

Lesson Contents

1. Teaching Lesson 2
    a. Introduction
    b. Lecture Notes
    c. Additional Resources

2. Teacher's Edition: Understanding Exploration

3. Student Activity: Understanding Exploration

4. Student Handout

5. Mock Bowl Quiz

Standards Addressed

National Science Education Standards, Grades 9-12
History and nature of science

Ocean Literacy Principles
The ocean is largely unexplored

DCPS, High School
Environmental Science
E.1.10.Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data (focus here is on mastery of unit conversion)

Lesson Outline[1]

I. Introduction

Before presenting the PowerPoint lecture for this lesson (File: Lesson 2 –Navigation.ppt), play a quick *Price is Right* style of game where students guess the dates of some important landmarks in marine exploration:

1. Invite four volunteers to the front of the room in a line.

2. Starting from the left, ask the first student to guess the year of the first Key Event listed below without going over. Other students must guess a different year.

3. Once all students have guessed, reveal the correct year. The student who was closest without going over gets to stay at the front and the rest of the students must return to their seats.

4. Repeat the procedure with the remaining three Key Events. The student who guesses the last landmark closest without going over wins a prize.

Key Events

1. A team led by Dr. Robert Ballard discovers *The Titanic*, the most famous shipwreck in modern history. **Answer: 1985**

2. Edward Beebe is lowered in a manned diving vessel connected to a ship called a bathyscaphe to a depth of 3,028 feet, marking the advent of manned exploration of the sea. **Answer: 1934**

3. Harry Hess first proposes the idea of seafloor spreading. **Answer: 1960**

4. The Challenger begins its circumnavigation of the globe in the first great oceanographic expedition. **Answer: 1872**

II. Lecture Notes

Use the PowerPoint for Lesson 2 (File: Lesson 2 – Navigation.ppt) as a lecture for the students. Distribute the Student Handout before you begin for students to take notes on key information.

III. Additional Resources

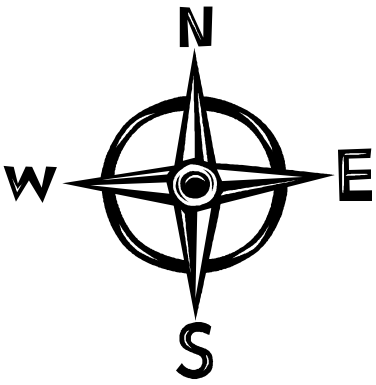
1. Background information:
   http://www.allhandsondeck.org/victory/
   http://www-istp.gsfc.nasa.gov/stargaze/Llatlong.htm
   http://www.ion.org/satdiv/education.cfm

[1] Unless otherwise indicated, all websites provided or referenced in this guide were last accessed in November 2010.

Understanding Exploration

Overview
The student activity is designed as a series of questions and answers to prepare students for some basic concepts and definitions that come up at the NOSB. The students may use their handouts to answer the questions.

Background
If you have ever driven a car or served as a "co-pilot" for one of your friends by directing him as he drives a car, you are probably generally familiar with navigation on land. You may have said things like "Turn left when you reach the intersection." or "Slow down! The speed limit here is only 25mph."



But navigation in the water is a little bit different. Ocean explorers use different units of measurement and speed and different terminology to determine and describe their locations.

Where on Earth are you?
If your friend gave you a call (while you were on dry land) and asked for your location, you might say "On the corner of 16th St and Park Rd" and your friend would know where to find you.

To be more specific, you could tell your friend your "coordinates," or your location's latitude and longitude. Any location on Earth is described by these coordinates, which are actually two angles, measured in degrees, called "minutes of arc" and "seconds of arc." These are denoted by the symbols (°, ', "). So a location of 25° 40' 1" means an angle of 25 degrees, 40 minutes and 1 second (don't confuse this with the notation for feet and inches).

A degree contains 60 minutes of arc and a minute contains 60 seconds of arc. On the globe, lines of longitude ("meridians") extend from pole to pole, like the segment boundaries on a peeled orange. The meridian that passes through the former Royal Astronomical Observatory in Greenwich, England (now a museum) marks zero longitude and is known as the "Prime Meridian."

Lines of latitude run in the opposite direction of longitude. The equator marks 0 degrees latitude and all other latitude lines north of the equator are denoted with N, and all latitude lines south of the equator are denoted by S.

While coordinates may not be very practical for your common navigational purposes on land, oceanographers use them as part of their everyday system of navigation.

Telling time
If you need to be somewhere at 3:00pm, you probably use your watch or your cell phone to keep track of time so you know when you need to leave. The time that you see on your clock or phone is known as the Local Time (LT). Local time is a measure of the position of the Sun relative to a locality. At 12 noon local time the Sun passes to the south and is furthest from the horizon (in the northern hemisphere).

But suppose we wanted to time an event that happens in space, like the time when a star or new planet is first discovered. To do that, we need to decide upon a single, universal time that is not tied to a particular location on Earth. This is known as Universal Time (UT), which refers to the "Coordinated Universal Time" (UTC) scale. This time scale is determined by precise atomic clocks and is kept by laboratories around the world, including the US Naval Observatory[2].

As you cross time zones moving westward, your local time jumps to one hour earlier. For example, if you live on the East coast and call your friend in California before you leave for school in the morning, she'll probably be upset that you disturbed her in the middle of the night! California's local time is three hours earlier than the local time on the East coast. As you can imagine, if you move far enough West, you actually move to an earlier day.

The International Date Line is a special time zone boundary that mostly follows the line of longitude 180°. The line ensures that we always match the correct date at each location when crossing time zones. Anyone crossing that line gains a day (crossing westward) or loses a day (crossing eastward).

Putting it all together
Navigation and time can be a little confusing! Have students use information from the PowerPoint presentation, the student handout, and any additional resources you may wish to provide to answer the following questions.

Answer Key
Part 1: How deep can you go?

1. How many feet are in a statute mile?
   5,280ft

2. How many feet are in a nautical mile?
   6,076ft

3. Which is longer, a statue or nautical mile?
   A nautical mile

[2] For more on UTC, see the Navy's website: http://www.usno.navy.mil/USNO/astronomical-applications/astronomical-information-center/universal-time

By how many feet?
796ft

4. What defines a nautical mile?
   The distance over water that is equal to one minute of latitude or 6,076 feet.

5. The Titanic rests at a depth of about 12,500 feet.
   a. How deep is that in meters?
   3,810 meters
   b. How deep is that in fathoms?
   About 2,083 fathoms

6. Sperm whales can dive to depths over 1,000 meters which is deeper than ½ mile (statute) below the surface.

   a. What is a depth of 1,000 meters in fathoms?
   About 547 fathoms
   b. What is a depth of 1,000 meters in statute miles?
   0.62 statute miles
   c. What is a depth of 1,000 meters in nautical miles?
   0.54 nautical miles

7. The deepest spot of the ocean, Challenger Deep, lies within the Mariana Trench at approximately 35,840ft.
   a. How deep is that in miles (statute)?
   6.8 statute miles

Part 2: How fast can you go?

8. A NOAA Fishery Research Vessel or FRV can travel up to about 10 knots. How fast is this in terms of speed on land in miles per hour?
   About 11.5 mph

9. The average speed of a blue whale is 13 mile per hour. Which is faster: a blue whale or a NOAA FRV?
   The blue whale is a little bit faster.

Part 3: Around the world

10. What is your latitude at:
    a. The Equator: **0 degrees**
    b. The Tropic of Cancer (northern boundary of the tropics): **23.5 degrees north**
    c. The Tropic of Capricorn (southern boundary of the tropics): **23.5 degrees south**
    d. The North Pole: **90 degrees north**

e. The South Pole: **90 degrees south**

11. What is your longitude at:
    a. The Prime Meridian: **0 degrees longitude**
    b. The International Dateline: **180 degrees longitude**

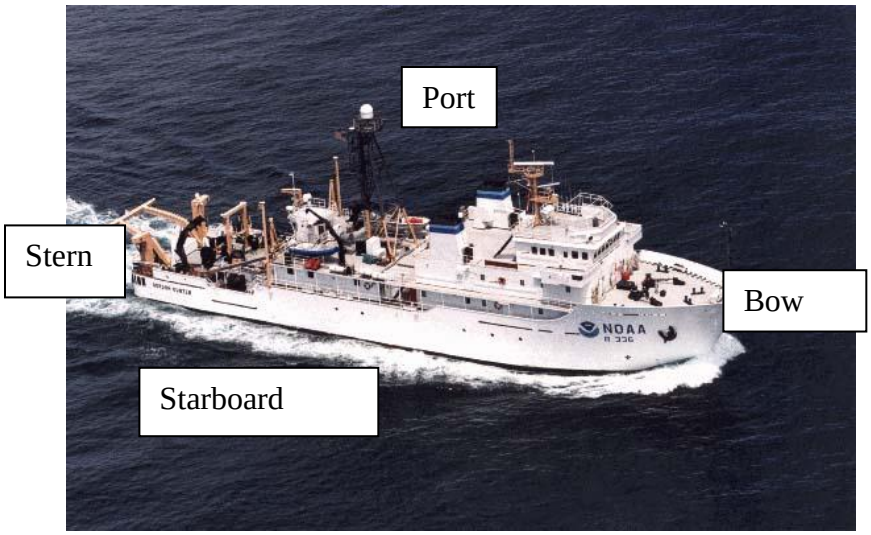
12. In which hemisphere are North and South America?
    Western

13. You and your crew of NOAA scientists are at 20 degrees North latitude. Are you above or below the Tropic of Cancer?
    Below. The Tropic of Cancer is around 23 degrees North.

14. You and your crew are traveling West near the island of Fiji. An unidentified vessel is traveling west near the island of Samoa. Which boat is a day ahead of the other?
    You and your crew are ahead because you are to the left of the International Date Line (traveling west across it).

15. The latitude of the White House is approximately: 38° 53' 55.133" N. Explain what this notation means.
    This means an angle of 38 degrees, 53 minutes and 55.133 seconds north (of the equator).

16. Examine the photo of the NOAA ship *Gordon Gunter*, used to study Gulf of Mexico marine ecosystems. Label the following parts of the ship: Port, Starboard, Stern, Bow[3]



[3] Photo: NOAA, http://oceanexplorer.noaa.gov/technology/vessels/gunter/media/gunter.html

Understanding Exploration

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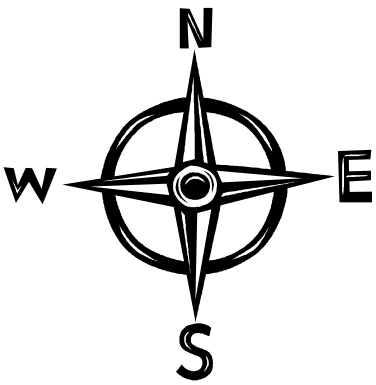

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Putting it all together

Navigation and time can be a little confusing! Use the information you have learned, your student handout, and any other sources provided by your teacher to answer the following questions.

Part 1: How deep can you go?

1. How many feet are in a statute mile?

2. How many feet are in a nautical mile?

3. Which is longer, a statue or nautical mile? By how many feet?

[4] For more on UTC, see the Navy's website: http://www.usno.navy.mil/USNO/astronomical-applications/astronomical-information-center/universal-time

4. What defines a nautical mile?

5. The Titanic rests at a depth of about 12,500 feet.
    a. How deep is that in meters?

    b. How deep is that in fathoms?

6. Sperm whales can dive to depths over 1,000 meters, which is deeper than ½ mile (statute) below the surface.

    a. What is a depth of 1,000 meters in fathoms?

    b. What is a depth of 1,000 meters in statute miles?

    c. What is a depth of 1,000 meters in nautical miles?

7. The deepest spot of the ocean, Challenger Deep, lies within the Mariana Trench at approximately 35,840 feet. How deep is that in miles (statue)?

Part 2: How fast can you go?

8. A NOAA Fishery Research Vessel or FRV can travel up to about 10 knots. How fast is this in terms of land speed in miles per hour?

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Part 3: Around the world

10. What is your latitude at:
    a. The Equator:
    b. The Tropic of Cancer (northern boundary of the tropics):
    c. The Tropic of Capricorn (southern boundary of the tropics):
    d. The North Pole**:**
    e. The South Pole:

11. What is your longitude at:
    a. The Prime Meridian:
    b. The international Dateline:

12. You and your crew of NOAA scientists are at 20 degrees North latitude. Are you above or below the Tropic of Cancer?

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14. The latitude of the White House is approximately: 38° 53' 55.133" N. Explain what this notation means.

15. Examine the photo of the NOAA ship *Gunter*, used to study Alaska marine mammals, sea birds, and fish and label the following parts of the ship: Port, Starboard, Stern, Bow[5].

[5] Photo: NOAA, http://oceanexplorer.noaa.gov/technology/vessels/gunter/media/gunter.html

Tips for the Bowl - Navigation[6]

Definitions

Equator: The latitude line at 0 degrees.

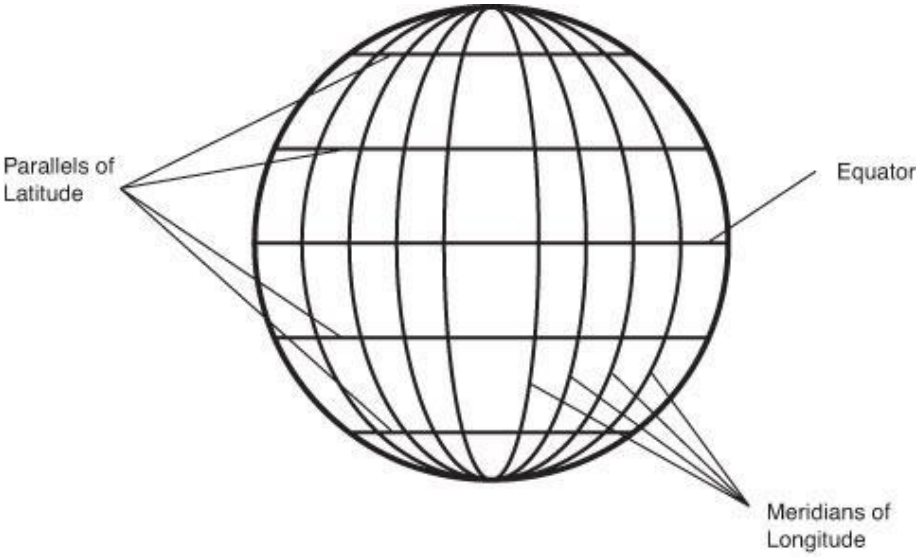
Prime Meridian: The 0 degree longitude line that runs through Greenwich, England that marks the starting point of every time zone in the world.

International Date Line: The International Date Line is a special time zone boundary, most of it following the line of longitude 180°. The line makes sure that in crossing time zones we always match the correct date at each location. Anyone crossing that line gains a day (crossing westward) or loses one day (crossing eastward).

Coordinated Universal Time (UTC): A single world-wide time system used for events like observations made by scientific spacecraft or eruptions on the Sun. Measured by atomic clocks. For more information: http://www.srh.noaa.gov/jetstream/synoptic/time.htm.

Longitude: The measurement of location east or west of the Prime Meridian.

Latitude: The measurement of location north or south of the equator. Starting from the equator, you can measure 90 degrees northward and 90 degrees southward. The South Pole is at 90 degrees S (south), and the North Pole is at 90 degrees N (north).



[6] Photo: NOAA, http://oceanservice.noaa.gov/education/lessons/plot_course.html

Tropic of Cancer: The northernmost latitude at which the sun can appear directly overhead at noon. It is located around 23.5 degrees North latitude of the equator.

Tropic of Capricorn: The equivalent of the Tropic of Cancel south of the Equator is located around 23.5 degrees South latitude. The region between the two, centered at the equator is known as the Tropics.

Ship Terms
Port: The left side of the ship (remember this by knowing the words "left" and "port" each have 4 letters.)

Starboard: The right side of the ship

Stern: The back of the ship

Bow: The front of the ship

Chronometer: A mechanical device for keeping time independent of ship's motion that can be used to determine longitude through celestial navigation.

Units of Measurement
1 degree = 60 minutes
1 minute = 60 seconds
1 second = ~ 30 meters on surface of the Earth

Speed, Length and Depth Measurements
Statute Mile: Unit of length used to measure distance on land: 5,280 feet.

Nautical Mile: A unit of measurement used to measure distance over water that is equal to one minute of latitude or 6076 feet.

Fathom: A unit used to measure water depth. Measures 6 vertical feet (2 yards) in water.

Knot (kt or kn): The internationally accepted measure of maritime (a ship's) speed.
1 knot = 1 nautical mile per hour

Ocean Exploration

1. Which of the following explorers led the first ocean expedition around the world?
   w. Vasco da Gama
   x. Christopher Columbus
   y. James Cook
   z. Ferdinand Magellan

2. What is the name of the first "modern" submarine, which used a rudder system for vertical movement?
   w. The Nautilus
   x. The Aquarius
   y. Seasat
   z. Jason

3. In what time period was the modern SCUBA system invented?
   w. The 1920s
   x. The l930s
   y. The 1940s
   z. The 1960s

4. Who is the first person credited with showing latitude and longitude on a map of the sea using grid divisions in terms of degrees, minutes and seconds?
   w. Pytheas
   x. Ptolemy
   y. James Cook
   z. Vasco da Gama

5. Short answer: In what year did Dr. Robert Ballard discover the remains of the shipwrecked Titanic?
   Answer: 1985

6. What happens as you travel west across the International Date Line?
   w. You lose a day
   x. You add a day
   y. Nothing happens
   z. You add two days

7. Short answer: What units are typically used to measure the speed of a ship?
   Answer: Knots

8. Short answer: Which is longer – a statute mile or a nautical mile?
   Answer: Nautical mile

9. Which of the following did the earliest explorers use to measure their latitude during voyages?
    w. A chronometer
    x. The International Date Line
    y. The North Star
    z. A GPS navigational system

10. Team Challenge Question

You and your team of explorers located a shipwreck near the British Virgin Islands at a latitude of 18° 33" 9' N and a depth of 900ft.

1. Explain the meaning of the 18° 33" 9'N notation. (4pt)

2. Are you above or below the Tropic of Cancer? (2pt)

3. Note the depth of your discovery in fathoms. (1pt)

ANSWER

You and your team of explorers located a shipwreck near the British Virgin Islands at a latitude of 18° 33" 9' N and a depth of 900ft.

1. Explain the meaning of the 18° 33" 9'N notation. (4pt)
   This refers to the latitude of the site (2pt). It means an angle of 18 degrees, 33 minutes and 9 seconds (2pt).

2. Are you above or below the Tropic of Cancer? (2pt)
   Below. The Tropic of Cancer is at 23 degrees North.

3. Note the depth of your discovery in fathoms. (1pt)
   150 fathoms because 1 fathom = 6ft.