Deep Sea Salvage Operations

Deep Sea Salvage - Description of Module

Shipwrecks are salvaged world wide for accident investigation, antique exploration and some other purposes. It is a million dollar industry that uses sophisticated navigation procedures, deep sea diving procedures, equipments and cutting edge technology.

Deep Sea Salvage operations modules introduces students to the general procedures used in shipwreck salvage operations. It also teaches students basic concepts in navigation e.g. latitude, longitude, bearings etc. Hydrostatic pressure, underwater navigation using SONAR are also discussed in this module.

Topics Covered

- Shipwreck Operations 10 min.
- Locate Points on Maps 05 min.
- Latitudes and Longitudes 10 min.
- Hands-on Activity – 1 20 min.
- Compass and Bearings 15 min.
- Hands-on Activity – 2 15 min.
- Bearings to Calculate Distance 10 min.
- Hands-on Activity – 3 45 min.
- Hydrostatic Pressure 30 min.
- SONAR 15 min.
- Class Project – Lets Scratch 45 min
How would you locate the exact location of Titanic which is not directly visible from the surface

How was the Titanic Wreck Located?

Researchers had last reported position radioed by Titanic’s Radio Officer to start with

Then why did it take 73 years to discover the wreck?

The answer to this question lies in the State of Technology

‘Dr. Ballard noted that his crew had paid out 12,500 feet (3,810 m) of the sonar's tow cable at the time of the discovery of the wreck, giving an approximate depth of the seabed of 12,450 feet (3,795 m).’

Crushing Pressure at this depth makes human dives impossible

Pressure at this depth is 378 atm. = 5567 PSI

Even if you reach this depth, its pitch black; sunlight cannot reach these unfathomable depths
When technology provided answers to all these questions, successful effort was made by Dr. Robert Ballard and his team. They used:

- Side scanning SONAR (Sound Navigation and Ranging) to “see” underwater objects
- After mapping the wreck, they used Underwater Robotic Vehicle (ROV) ‘Alvin’ for the manned dives to the wreck

Titanic Sank Somewhere in Between Europe and America
But where exactly?

Location of the Titanic Wreck
Here lies Titanic

41°43′55″N
49°56′45″W

What do these numbers represent?

Latitude and Longitude

Latitude

• For Geographical Mapping Purpose, Earth is divided into 180 parts from North Pole to South Pole
• Each division equals 1 degree
• There are 90 divisions above and 90 Divisions below the Equator
• Each Division line is known as Latitude
• Latitudes range from 0 degree to 90 degree North (North Pole)
• And from 0 degree to 90 degree South
Latitude – Pictorial Representation

Latitudes to Remember – Tropics and Polar Circles

Longitude

- For Geographical Mapping Purpose, Earth is divided into 360 parts from East to West round the globe
- Each division equals 1 degree
- Each Division line is known as Longitude
- Longitude range from 0 degree (Greenwich Meridian) to 180 degree East
- And from 0 (Greenwich Meridian) degree to 180 degree West

What is Greenwich Meridian? Search and post your answers on Openclassroomserver or write in your Project Journal
With Latitude and Longitude, we can locate ANY point on the Earth.

Equator and Prime Meridian

Relation between Latitude, Longitude and Surface Distance

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Surface distance per 1° change in latitude</th>
<th>Surface distance per 1° change in longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>110.574 km</td>
<td>111.320 km</td>
</tr>
<tr>
<td>15°</td>
<td>110.649 km</td>
<td>107.551 km</td>
</tr>
<tr>
<td>30°</td>
<td>110.852 km</td>
<td>96.486 km</td>
</tr>
<tr>
<td>45°</td>
<td>111.132 km</td>
<td>78.847 km</td>
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<tr>
<td>60°</td>
<td>111.412 km</td>
<td>55.800 km</td>
</tr>
<tr>
<td>75°</td>
<td>111.618 km</td>
<td>28.902 km</td>
</tr>
<tr>
<td>90°</td>
<td>111.694 km</td>
<td>0.000 km</td>
</tr>
</tbody>
</table>

Try to find out distance between following two points:

- Miami: 25°N 82°W
- Seattle: 47°N 122°W
- Virginia Beach: 36°N 75°W
- San Francisco: 37°N 122°W
What did you just learn? What is the use of previous exercise?

Development of Earth – Maps and Charts

Maps and charts represent development of spherical Earth in 2-D form.

Check on Learning

- **Latitudes** divide Earth from North to South in 180 equal parts
- 0 degrees latitude is also known as **Equator**
- 0 degrees longitude is also known as **Prime Meridian**

Maps & Charts are used to represent Earth in 2-D.
Hands-on Activity 1

Treasure Hunt

This activity teaches use of coordinates to locate specific locations on the Earth.

• Use Google maps to locate following coordinates of some famous shipwrecks around the globe
• Type given coordinates in the search bar in Google maps and locate the point on the map.
• Note down the details of locations in the observation column (e.g. vicinity to any country, island, or any specific sea feature like Mariana Trench etc.)

Watchdog: Bridge Control…Bridge Control … This is Watchdog …
Bridge Control: Copy Watchdog…go ahead
Watchdog: Cruise located at Green090
Bridge Control: Copy Watchdog…Green090…Confirm…
Watchdog: Green090, position locked…over and out

• What do you think is going on in this situation?
• What do you think is Green 90?
Compass

What is the use of compass?

Compass is a navigational instrument for determining direction relative to the Earth’s magnetic poles.

Navigation Prior to Compass

Which navigational tools were in practice before invention of compass?

With the help of stars like the Pole star and constellations like Big Dipper (Ursa Major)

But these techniques had inherent limitations as far as intercontinental travels were concerned.

Using Compass

Red marking on compass dial indicates Magnetic North of the Earth

- 4 Cardinal Points N E W S
- 4 Quarters, each measuring 90°
- Angular bearing is measured clockwise
- e.g. 113 ESE
Bearing in Ship Navigation

• In marine navigation, **starboard** bearings are ‘green’
• and **port** bearings are ‘red’
• e.g. ship navigation, a target directly off the starboard side would be ‘Green090’ or ‘G090’

Check on Learning

True or False

• Compass uses principle of Earth’s magnetic field  **True**
• The pole star, Big Dipper, Little Dipper can be used for finding out directions **True**
• Green 45 represents bearing of an object on the left side of the ship  **False**
• The correct procedure to use compass to measure bearing is by keeping it on iron table and then reading the bearing  **False**

Hands-on Activity- 2

SOS
Hands-on Activity 2

SOS

Watchdog: Bridge Control…Bridge Control … This is Watchdog …
Bridge Control: Copy Watchdog…go ahead
Watchdog: Cruise located at Green090
Bridge Control: Copy Watchdog…Green090…Confirm…
Watchdog: Green090, position locked…over and out

Use compass to find out bearings of other ships

If coordinates of two points are known, we can calculate linear distance between those two points
If Point 1 has coordinates (a1, b1)  
If Point 2 has coordinates (a2, b2)  

Then the distance between these two points is given by -

\[ \cos^{-1}\left( \cos[a1] \cos[b1] \cos[a2] \cos[b2] + \cos[a1] \sin[b1] \cos[a2] \sin[b2] + \sin[a1] \sin[a2]\right) \frac{360 \times 2\pi \times r}{\sin[a1] \sin[b1]} \]

\[ r = \text{Radius of Earth} \]

360 * 2\pi * r

Example

Let's calculate distance between San Francisco and Paris

San Francisco  
N 37° 37'  
W 122° 22'

Paris  
N 48° 44'  
E 02° 23'

West Longitude means negative values of b  
South Latitude means negative values of A
Hands-on Activity 3
Around the World in 30 Minutes

• You are provided with a world map showing latitudes and longitudes
• Plot following locations on the given map
• Join all the points and see if you get any shipping route
• Also calculate distance between the two points and hence total distance between point of origin and final destination

Till now we have learned-
• How to locate point on the maps with the help of coordinates
• How to use compass to measure bearings
• How to calculate distances between points using bearings

Now Let us DIVE

But WAIT............ What about the tremendous water pressure down there?
Pressure at the Titanic Wreck site is 378 atm. This is 378 times the current pressure of air in this room.

This pressure is called Hydrostatic Pressure.

Hydrostatic Pressure increases with the depth of ocean.

We need strong cover that can withstand this pressure.

Hydrostatic Pressure

- Water exerts pressure on everything that sinks in it.
- Pressure increases with depth.
- It can be calculated by $\rho \times g \times h$.

Where $\rho$ is density of water (kg/m$^3$), $g$ is gravitational acceleration (m/s$^2$), and $h$ is depth (m).
Using the formula for hydrostatic pressure, calculate the pressure at the following locations and prepare a bar chart:

- Lake Superior – 180 meters
- Calypso Deep (Mediterranean) – 5267 meters
- Java Trench in Indian Ocean – 7258 meters
- Puerto Rico Trench in Atlantic – 8605 meters
- Marian Trench in Pacific – 10,911 meters

We have reached the bottom of the Ocean.

Hey…But it is pitch black here, I can’t see anything.

**NOW WHAT?**

Let’s use SONAR……

What is that?

SONAR is an acronym for…

**Sound Navigation and Ranging**
Sound waves transmitted by sender bounce back from the object in their path and are detected by the receiver.

Formula to Calculate Distance of an Object Using SONAR

\[ \text{Velocity} = \frac{\text{Distance Traveled}}{\text{Time}} = \frac{2 \times r}{\text{Time}} \]

Why the distance between the object and source of sound multiplied by 2?

**Speed of Sound**

Speed of Sound depends on the density of material it is travelling in.

- Speed of Sound in air at 20 deg C = 343 m/s
- Speed of Sound in water at 20 deg C = 1484 m/s
- Speed of Sound in water can be calculated by

\[ 4388 + (11.25 \times \text{temperature (in } ^\circ\text{F}) + (0.0182 \times \text{depth (in feet)}) + \text{salinity (in parts-per-thousand}) \].

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Simulate an Underwater Glider in SCRATCH
Review of Topics

- Overview - Shipwreck Salvage Operations
- Locate Points on Maps
- Latitudes and Longitudes
- Compass and Bearings
- Bearings in Ship Navigation
- Hydrostatic Pressure
- SONAR
- Class Project using SCRATCH