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

Lesson 23: Technology

Overview

This lesson describes advanced technologies for underwater exploration and navigation. In the activity, students simulate the use of sonar for ocean floor mapping by poking a stick through holes in the lid of the box and taking depth measurements of a hidden object inside the box. Students draw a colored contour map of their object and guess its identity.

Lesson Objectives

Students will:

1. Define and distinguish among common marine technology such as AUVs and ROVs
2. Simulate the use of sonar to identify a hidden object in a box
3. Create a contour map of their hidden object using a standard depth coloration scheme

Lesson Contents

1. Teaching Lesson 23
    a. Introduction
    b. Lecture Notes
    c. Additional Resources
2. Teacher's Edition: Mapping the Ocean Floor
3. Student Activity: Mapping the Ocean Floor
4. Student Handout
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Standards Addressed

National Science Education Standards, Grades 9-12
Science and technology
Science in personal and social perspectives

Ocean Literacy Principles
The ocean is largely unexplored

DCPS, High School
Environmental Science
E.2.1 Understand and explain that human beings are part of Earth's ecosystems, and that human activities can, deliberately or inadvertently, alter ecosystems.

Lesson Outline[1]

I. Introduction

Introduce the lesson with the following brief acronym game:

1. Break students into 4-5 teams.
2. Display a technology-related acronym that students may or may not have seen before. (If they haven't seen it, encourage them to give their best guess!)
3. Give teams two minutes to write out the full words for the acronym.
4. After two minutes have passed, have teams display their answers. Teams who answer correctly receive the number of points indicated.
5. Play five rounds and reward the winning team.

Acronyms

1. AUV – Autonomous Underwater Vehicle (2pt)
2. GIS – Geographic Information System (2pt)
3. GPS – Global Positioning System (2pt)
4. SCUBA – Self-Contained Underwater Breathing Apparatus (3pt)
5. DART – Deep-ocean Assessment and Reporting of Tsunamis (4pt)

DART Buoy used to detect disturbances that could trigger tsunamis

Photo: NOAA

Tie-breaker

If two or more teams have the same score after five rounds, show the SONAR acronym. The first team to correctly spell out the answer (Sound Navigation And Ranging) wins.

II. Lecture Notes

Present the lecture for Lesson 23 using the included PowerPoint presentation (File: Lesson 23 – Technology II.ppt).

III. Additional Resources

1. Background information: http://oceanexplorer.noaa.gov/technology/technology.html; http://oceanservice.noaa.gov/geodesy/gps/

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

Mapping the Ocean Floor

This exercise was created and adapted with permission by **SEAS: Student Experiments at Sea**. The original lesson is "Activity 4: Mapping the Unknown" and can be found at the following link: http://www.ridge2000.org/SEAS/for_teachers/curriculum/unit1.html. You can find other marine science activities and information at the main SEAS website: http://www.ridge2000.org/SEAS/index.html.

There are two alternative activities for this lesson.

1. A GPS activity owned and included with permission by the Cooperative Institute of Oceanographic Satellite Studies, SMILE Highschool Teacher Workshop Activities. Find more great SMILE activities on the web at: http://cioss.coas.oregonstate.edu/CIOSS/teacher_activities.html. (Files: GPS_Technology.pdf, GPS_Worksheet.pdf, GPS_AnswerKey.pdf and States_Map.pdf).

2. Another activity to consider if students have computers and internet access is one by NOAA which has students simulate data analysis from an ROV (File: ROV_Activity.pdf).

Overview

In this activity, students simulate the process of sonar to identify a hidden object in a mystery box. Students use a "sonar stick" (created from Shish kabob sticks or thin pencils) to collect their own data about the shape of an unknown object placed in a shoebox. They will poke the sonar stick through holes in the box where their object is hidden and take depth measurements of the object along a grid. Using the data they collect, they will make a colored contour map and guess the identity of the object.

Background

Maps of the seafloor are needed for safe navigation, study of marine life, and research and exploration of the world's ocean basins. Sonar (SOund Navigation and Ranging) is one type of technology that scientists use to map the ocean floor. Through use of sonar, scientists send sound waves from a vessel on the ocean surface down to the sea floor. The sound waves "bounce" off the sea floor and are reflected back to the surface. The amount of time that passes from the time the sound wave is sent and the time that its echo

Sample map of a coral reef ecosystem made with sonar data. The blue and green colors refer to the deepest areas and the yellow and red to the shallowest areas.

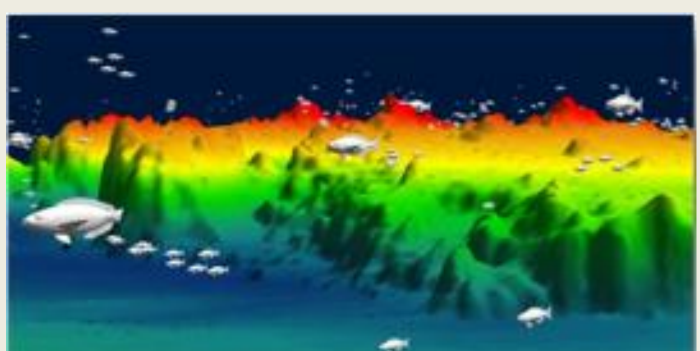

Photo: NOAA

is detected tells scientists the approximate depth between the vessel and the ocean bottom. The vessel moves along at specified locations sending a continuous stream of sound waves. In this way, a profile of the sea floor and its features—like valleys, ridges and trenches—is determined. Scientists then use the data they collect to make maps of these features (see picture on previous page)[2].

Before scientists had sonar, they relied on a system of weights and cables that they dropped all the way to the ocean floor to take measurements! Imagine dropping a weighted line to the bottom of the ocean and measuring its length to get a depth measurement. Some areas of the ocean are several miles deep. If you were over one of those locations, it would take a long time to take just one depth measurement. It would take several measurements over a long time period to create a map of the ocean floor[3]!

In today's activity your students must use a similar technique to map and determine the identity of an unknown object. Place an object into a shoebox at the front of the room. Students will use their Sonar Stick to measure the depth of the object at the locations marked on the grid on top of the box. They will then make a colored profile map of the object to guess its identity.

Materials

- A cardboard printer paper box
- A sharp pencil
- Shish kabob sticks, or long, thin pencils will work (enough for 2 per group)
- Colored pencils
- Printouts of the attached contour maps (1 per group)
- A "mystery" object (see below)

Procedure

To introduce the primary activity, you may want to lead students through a simple example of contour mapping. First, remind students that the ocean floor, like the land we see around us, is not flat but composed of geological features like mountain chains and trenches. Ask students to describe how scientists use maps to display these three dimensional features in a two dimensional format. Some students may be familiar with the concept of a contour map. Explain that scientists create contour maps by measuring the relative heights of different features and marking each height range with a different color on a two-dimensional map. After you have completed the demonstration, complete the Sonar Stick activity (procedures described below).

Demonstration procedures

1. Start with a simple example. Draw Figure 1 on the board. This is a side-view of a hill that is completely covered by water. Explain to students that a contour map can be

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[2] Photo: http://sanctuaries.noaa.gov/missions/2009tortugas/mapping.html
[3] For more information, see: http://woodshole.er.usgs.gov/operations/sfmapping/bathyhist.htm

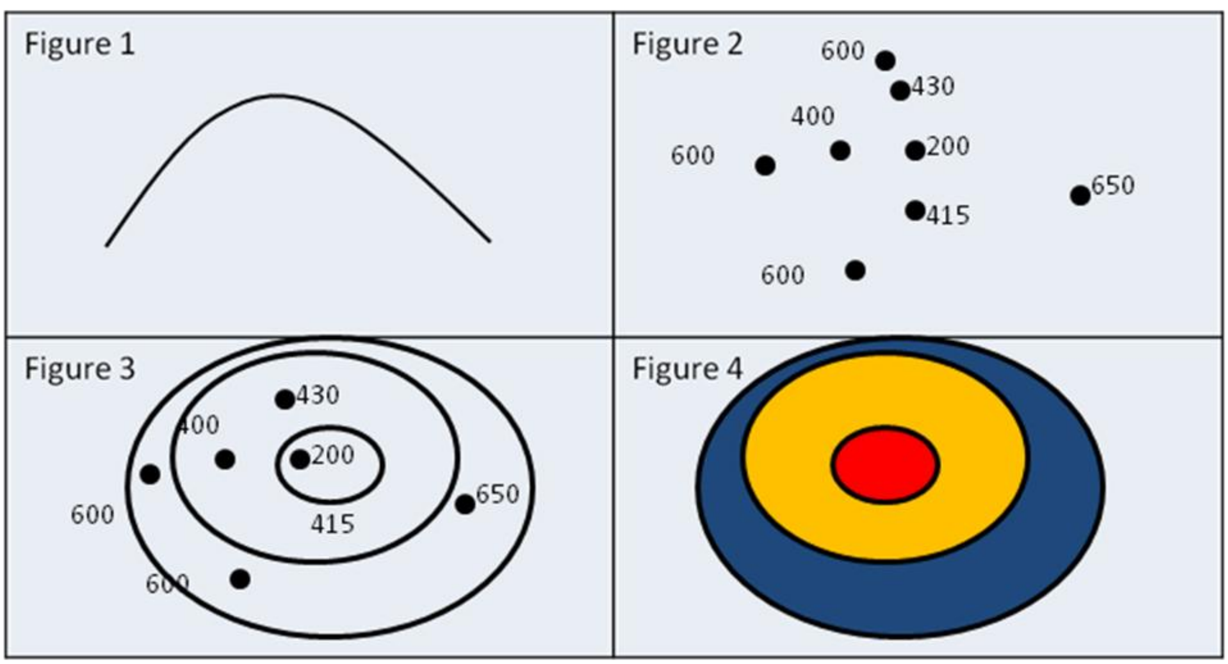
drawn by plotting dots that represent different elevations on the hill, then drawing lines between dots of similar elevation.

2. Create the plot in Figure 2 for the students on the board next to Figure 1. These dots represent the depth (in meters) from the surface of the water to various points on the hill in Figure 1. Higher numbers refer to deeper points in the ocean and lower numbers to shallower points. For example, the distance from the surface to the highest point on the hill is 200m. The distance from the surface to the lowest point on the hill is 650m.

3. Ask a student to come to the board to "connect the dots" by drawing lines around points of similar elevation. The map should look like Figure 3.

4. Next, tell students that scientists use colors to make these contour maps easily understandable. Red usually refers to the elevations that are closest to the ocean surface, followed by orange, yellow and green. Blue and purple usually refer to the parts of the terrain that are deepest in the ocean. (You might want to write this key on the board or ask students to write it in their notes.)

5. Remember that the hill from Figures 1-3 is on the ocean floor. Ask a student to come to the board and color the space in between each contour line according to relative depth using the color scheme you just described. The map should now look like Figure 4. Though it might vary based on the specific colors you choose, the "warm" colors should represent the shallower points of the hill and the "cool" colors the deeper points.



Student activity procedures

1. Place a high relief object into the cardboard box. (Don't let students see!) The object should be easily identifiable by shape, like a sneaker or a doughnut. Anchor the object in place with duct tape.

2. Place the top back on the box and glue the Mystery Boxtop Grid to the top.

3. Make notches along each shish kabob stick with a marker at 0.25 inch intervals for 12 inches from the bottom of the stick. The students will use these "sonar sticks" to take measurements.

4. Use a sharpened pencil to poke holes in each dot along the box-top grid. This is where students will insert their kabob sticks to take measurements.

5. Hand out the student activity sheets and sonar sticks to groups and go through the instructions with students.

6. Remind the students about the concept of a colored contour map from your demonstration at the beginning of class.

7. You may then want to demonstrate the sampling technique on the mystery box by completing a few measurements for them to get started.

8. Once all groups have finished their maps ask each group to quickly describe their guess about the identity of the object and their justification. If not all groups agree, ask how you might resolve these differences and get a more precise idea of the object's appearance (e.g., make a higher resolution map by taking more measurements closer together).

Answer key

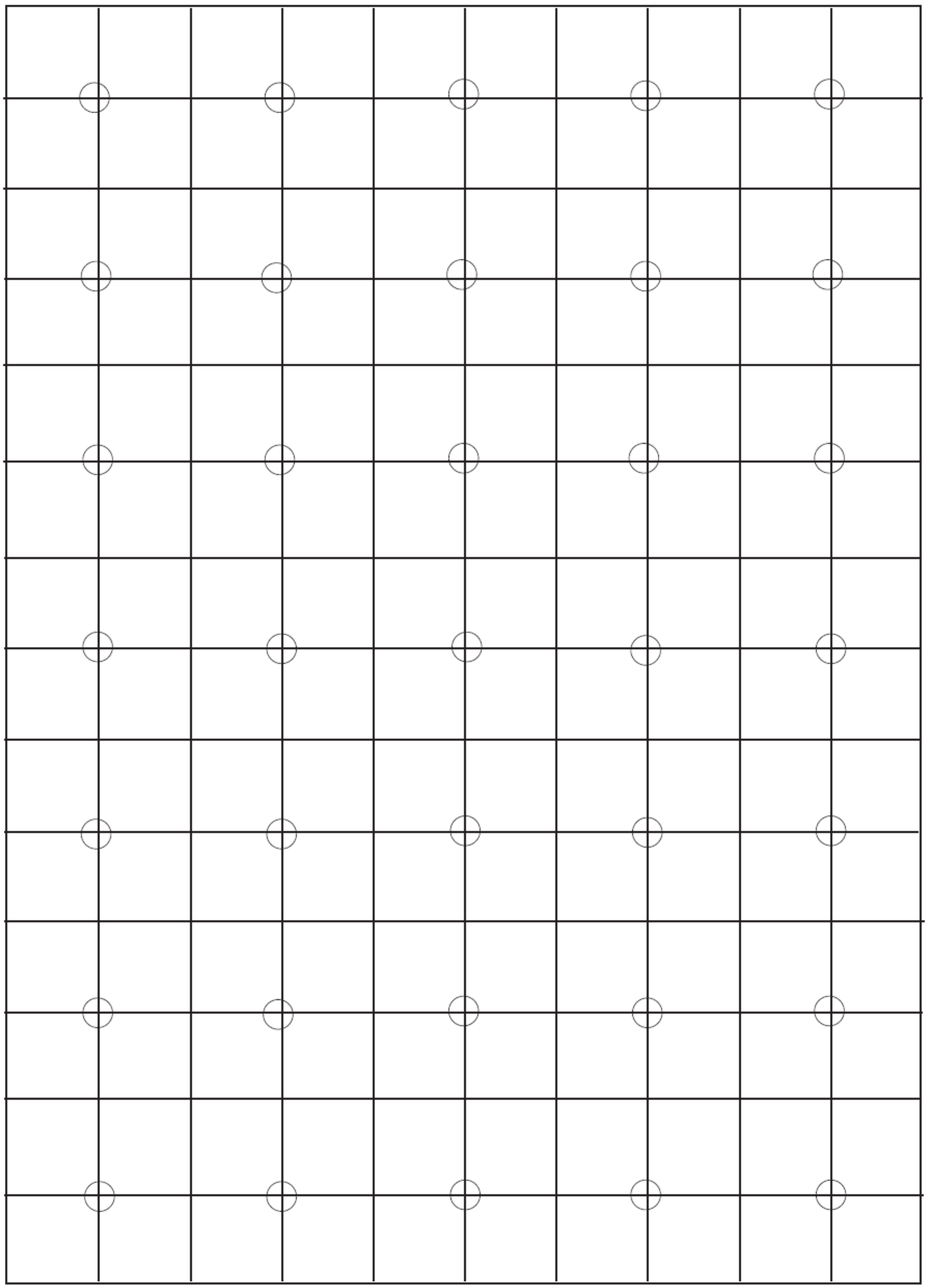
1. What do you think is the identity of your object? What is your evidence?
   Answers vary.

2. How confident do you feel in your prediction? Explain any sources of uncertainty in your prediction.
   Sources of uncertainty may include: measurements may not be exact using the shish kabob stick; points on the data grid might be too far apart so that key features are missed during sampling; sampling with the sonar stick might cause the object to shift in the box.

3. Do you think that you have enough data to accurately identify the contents of the box? Explain.
   Answers vary. Students should explain the possibility that the grid points could be too far apart to gain a precise view of all the contours on the object.

4. How would you modify the procedure to gain more confidence in your prediction? How would you get a more precise "view" of the object? (You can't open the box!) **Answers include: increase the number of data points by choosing a grid with more points; sampling the same locations multiple time for accuracy; using a more precise measuring tool.**

Mystery Boxtop Grid



Mapping the Ocean Floor

Maps of the seafloor are needed for safe navigation, study of marine life, and research and exploration of the world's ocean basins.

Sample map of a coral reef ecosystem made with sonar data. The blue and green colors refer to the deepest areas and the yellow and red to the shallowest areas.

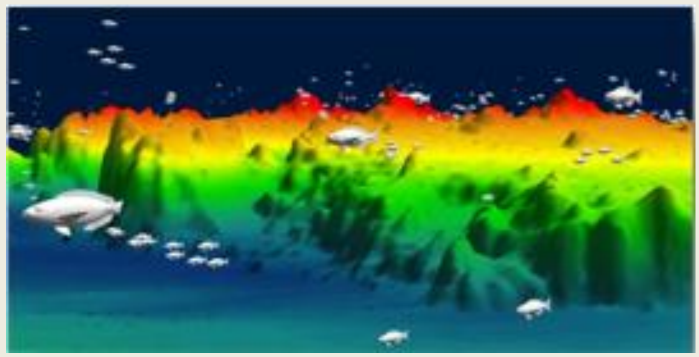


Photo: NOAA

Sonar (SOund Navigation and Ranging) is one type of technology that scientists use to map the ocean floor. Through use of sonar, scientists send sound waves from a vessel on the ocean surface down to the sea floor. The sound waves "bounce" off the sea floor and are reflected back to the surface. The amount of time that passes from the time the sound wave is sent and the time that its echo is detected tells scientists the approximate depth between the vessel and the ocean bottom. The vessel moves along at specified locations sending a continuous stream of sound waves. In this way, a profile of the sea floor and its features—like valleys, ridges and trenches—is determined. Scientists then use the data they collect to make maps of these features (see picture above)[4].

Before scientists had sonar, they relied on a system of weights and cables that they dropped all the way to the ocean floor to take measurements! Imagine dropping a weighted line to the bottom of the ocean and measuring its length to get a depth measurement. Some areas of the ocean are several miles deep. If you were over one of those locations, it would take a long time to take just one depth measurement. It would take several measurements over a long time period to create a map of the ocean floor[5]!

In today's activity you and your team of scientists must use a similar technique to map and determine the identity of an unknown object. Your teacher has placed this object into the Mystery Box at the front of the room. You will use your Sonar Stick to measure the depth of the object at the locations marked on the grid on top of the box. You will then make a colored profile map of the object (your teacher will help you) to guess its identity.

Procedure

1. Starting at one corner of the box top, gently slide the Sonar Stick through one of the holes into the box, keeping the Sonar Stick as vertical as possible. Remember, the

[4] Photo: http://sanctuaries.noaa.gov/missions/2009tortugas/mapping.html
[5] For more information, see: http://woodshole.er.usgs.gov/operations/sfmapping/bathyhist.htm

surface below may have deep sediment or it may be pliable. As you slide your stick into the box, try to stop as soon as you feel a surface inside.

2. Read the first number showing on the Sonar Stick above the lid of the box. This number is the numerical depth of the object. Write this number in the corresponding box on your **Color Map** handout.

3. Repeat steps 1 and 2 for all holes on the box lid.

4. When you have recorded all the numeric depths on the map, determine a color code scheme for your readings. Scientists usually assign blue or purple to the deepest areas, followed by green, yellow, orange and red for respectively shallower depths. Red is typically the shallowest. Study the numbers you have found and develop a color code for your depths, following the same order that scientists use.

5. Once you have decided which number ranges will be represented by which colors (for example 1-2=red, 3-4=orange and so forth) write the color key into the columns on your data sheet.

6. Using the color key you have created, color in your contour map.

Questions

1. What do you think is the identity of your object? What is your evidence?

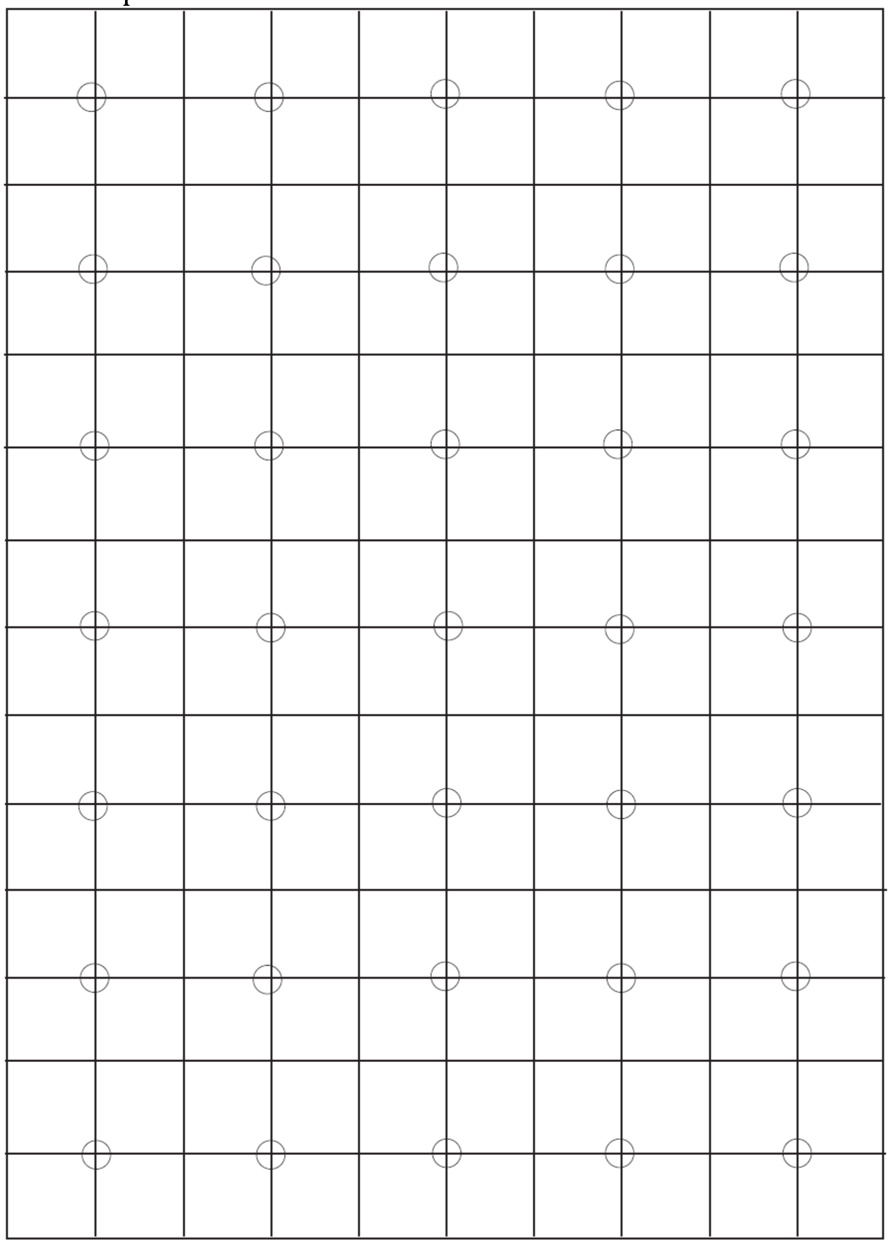
2. How confident do you feel in your prediction? Explain any sources of uncertainty in your prediction.

3. Do you think that you have enough data to accurately identify the contents of the box? Explain.

4. How would you modify the procedure to gain more confidence in your prediction? How would you get a more precise “view” of the object? (You can’t open the box!)

Data Sheet

Color map



Color key

Color	Depth range

What to Know for the Bowl – Technology II

During your teacher's presentation, fill out the empty spaces in the technology table below.

What is it called?	How does it work?	What is it used for?
AUV		
ROV		
HROV		
GIS		
GPS		
SONAR		
Loran-C		

Technology II

1. What is the difference between an AUV and an ROV?
   w. An ROV is tethered while an AUV is untethered
   x. An AUV is a satellite while an ROV is a submersible
   y. An ROV is manned on-board while an AUV is driven by a computer
   z. An AUV collects physical data while an ROV is used to track marine life

2. Reminder question: DART buoys are used to
   w. Take pictures of deep sea life
   x. Collect sea surface temperature data
   y. Detect tsunamis
   z. Measure pH

3. Short answer: This technology has been largely replaced by GPS:
   Answer: Loran-C

4. Which of the following describes two types of sonar:
   w. High beam and low beam
   x. Rapid and slow beam
   y. Forward and back scan
   z. Multibeam and side-scan

5. Short answer: What does the acronym SONAR stand for?
   Answer: Sound Navigation and Ranging

6. GIS software is used for the following:
   w. Mapping of point data
   x. Mapping of line data
   y. Mapping of spatial data layers
   z. All of the above

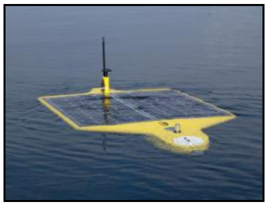
7. Short answer: What does GPS stand for?
   Answer: Global Positioning System

8. Short answer: What does GIS stand for?
   Answer: Geographical Information System

9. Reminder question: The first satellite dedicated for ocean studies was
   w. Oceansat
   x. Seasat
   y. Aquarius
   z. Aquabot

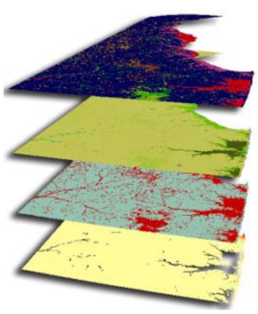
10. Team Challenge Question

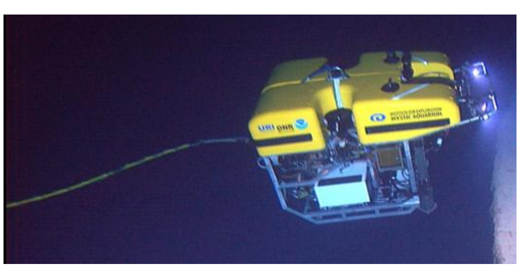
Identify the following pieces of technology used to study the ocean. A brief description of each is given. (5pt)


a.Unmanned, untethered, self-guiding submersible


b. For manned exploration of underwater environments for extended periods without being in an enclosed vehicle

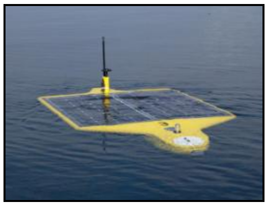
c. These buoys help track Tsunamis


d. Computer system that allows users to create specialized maps


e. Unmanned, tethered submersible

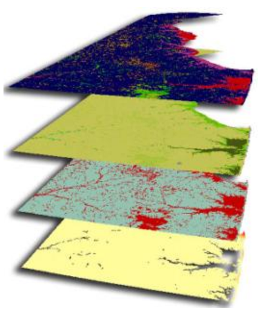
ANSWER

Identify the pieces of technology used to study the ocean[6]. (1pt each)


a. **Autonomous Underwater Vehicle or AUV**


b. **SCUBA**


c. **DART buoy**


d. **GIS or GIS layers**

[6] Photo(a): NOAA, http://oceanexplorer.noaa.gov/explorations/08auvfest/background/auvs/media/solar_auv.html
Photo(b): NOAA, http://oceanexplorer.noaa.gov/technology/diving/scuba/media/tankbc.html
Photo(c): NOAA, http://www.noaanews.noaa.gov/stories2008/20080310_buoy.html
Photo(d): NOAA, http://oceanexplorer.noaa.gov/technology/tools/mapping/media/gis_layers.html
Photo(e): NOAA, http://www.noaanews.noaa.gov/stories2005/s2370.htm

e. **Remotely Operated Vehicle or ROV**