The Sound of the Beluga

Lesson Focus: Sound waves, frequencies, and their uses in the human and animal world

Learning objectives:

- Students will describe different uses for sound in the human and animal world.
- Students will graph data on sound frequency and travel time.
- Students will discuss the use of echolocation in animals and humans.
- Students will identify the different ranges of sound wave frequencies.

Enduring Understandings:

- Sound waves are used for many purposes, including communication, by humans and other animals.
- Sound waves are used in sonar and echolocation to determine the location or depth of an object.

Georgia Performance Standards Addressed:

S8CS6 Students will communicate scientific ideas and activities clearly.

- Organize scientific information in appropriate tables, charts, and graphs, and identify relationships they reveal.

S8P4 Students will explore the wave nature of sound and electromagnetic radiation.

- Relate the properties of sound to everyday experiences.

Grade level: 8th Grade

Materials:

- computer (with internet access)
- LCD projector to view at pictures and video
- Copy for each student of
  - Sonar graphing worksheet
  - Animal Ranges Graph worksheet

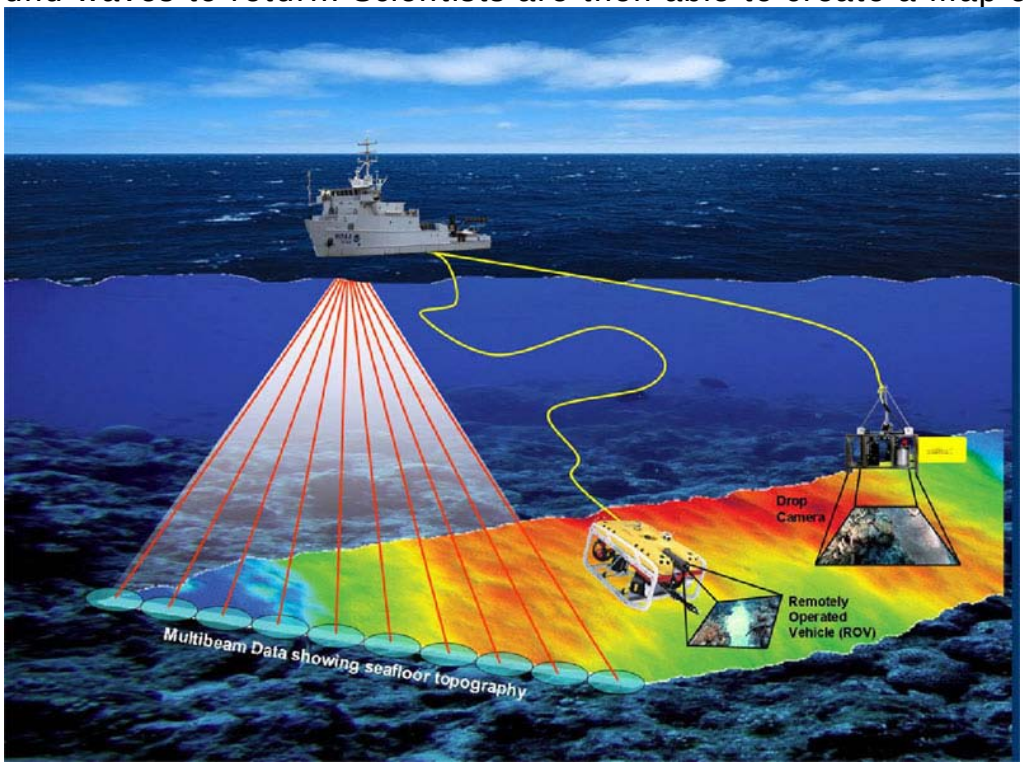
Time needed: 55 minutes

Background information:

Sound waves are longitudinal, mechanical waves. Vibrating objects produce waves that are areas of compression and areas without a compression. Sound waves are mechanical waves because they move through matter and not a vacuum. A sound wave's speed depends on the material it travels through. Sound waves travel faster in denser media; for example, a wave travels faster through water than through air. Sound waves have different **frequencies**, which create the different **pitches** of sounds. The frequency of the sound depends on its **wavelength** and is measured in **Hertz (Hz)**. Humans and animals create different pitches of sound by varying the length of the wave as they produce the sound. The frequency range that humans can detect with their ear is between 20-20,000 Hz while other animals can detect other ranges. The range of 0-

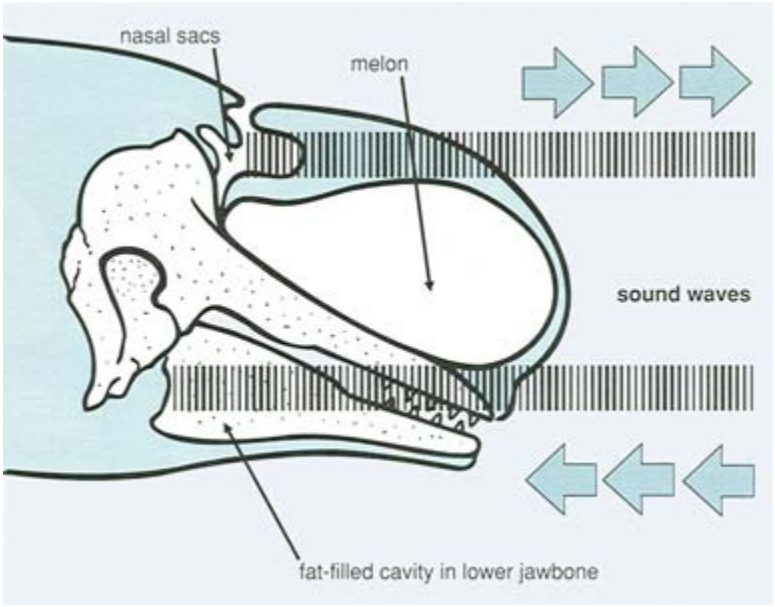
20 Hz, which is below the range of humans, is called **infrasound** while above 20,000 Hz is called **ultrasound**.

Besides using sound to communicate, both humans and animals can use sound waves to determine the location of objects. Many animals, including bats and beluga whales, use **echolocation**. Echolocation is the process of sending out ultrasound waves and interpreting them. The animal emits waves that will bounce off of objects as an echo. The animal then receives this echo to determine where the object is located. Instruments that use echolocation are called **sonar** (SOund NAvigating and Ranging). Sonar is used by scientists to identify objects in the water, determine the location of objects, and determine water depth. Sound waves are used in water rather than radar or electromagnetic waves because sound waves keep their strength better in the water than other types of waves. **Multibeam sonar** is used to determine the depth and features of the ocean floor. Multibeam sonar sends out a fan-shaped coverage of sound in many directions and determines depth by calculating the amount of time it takes for the sound waves to return. Scientists are then able to create a map of the sea floor.



Picture of multibeam sonar from:
http://sanctuaries.noaa.gov/missions/2009nancy_foster/images/mb1_lg.jpg

Toothed whales, such as the beluga whale, orca, and dolphin, use echolocation for navigation and hunting. Beluga whales are found in arctic and sub-arctic regions and usually live in small groups, called pods, of a dozen or so animals. Beluga whales are warm-blooded mammals that breathe through a blowhole on the top of the head. The beluga's melon, a round organ made up of lipids that sits on top of the skull, is important for echolocation. The melon changes shape as the whale produces sounds and directs those sounds into the water. The sounds then echo back to the whale and are received through lipid-filled canals in the lower jaw.



Echolocation in beluga whale: Beluga whales echolocate by producing high frequency clicks that pass through the melon, then receiving and interpreting the resulting echo.

from: http://www.seaworld.org/animal-info/info-books/beluga/communication.htm

Learning Procedure:

1) Play students clips of beluga whale sounds using the national geographic website: http://animals.nationalgeographic.com/animals/mammals/beluga-whale.html. Be sure not to tell or show the students ahead of time what the sound are. (do not turn on projector)
2) Afterwards, write the following questions on the board and have students work in pairs to answer.
    a. What are these sounds?
    b. How might these sounds be used?
    c. How do we use sound in our lives?
    d. How might animals use sound?
3) Then tell the students that the sounds they heard were made by a beluga whale and discuss as a group ways that humans and other animals use sound. List uses for sound on the board. Include any ideas from students, and here are some ideas:
    a. Communication (talking, finding out information, warning of danger)
    b. Music (enjoyment, expressing yourself, art)
    c. Finding the location of items (sonar)
    d. Medical information (ultrasound)
4) Discuss ways that animals and humans use communication: for example, talking and listening to ideas. Different animals have different ranges of frequencies that

they can hear and speak. Humans can hear sounds in the range of 20 to 20,000 Hz. Have student complete Animal Ranges Graph Worksheet. Afterward, have students highlight the area above 20, 000 Hz as ultrasound and below 20 Hz as infrasound. Then, discuss these questions.

   a. Why might humans and animals have different ranges of hearing? (Human's ears are different from other animal's organs to interpret sound)
   b. Which animal has the largest range? (Elephant) Which animals can hear the lowest frequencies? (Elephant) Which animals can hear the highest frequencies? (Cat and bat)

5) Show students pictures of the beluga whales and possibly watch the beluga whale tank at the Georgia Aquarium.
   Pictures and webcam at: (scroll down for pictures):
   http://www.georgiaaquarium.org/exploreTheAquarium/webcam-beluga.aspx
   a. What might be the purpose of the "melon" on top of the beluga's head? (The melon is used to transmit and focus sounds that are produced in the nasal cavity.)
   b. The beluga whale sends out pulses of sound from its melon and uses them to determine where objects are. How might this work? Allow students to discuss in pairs how this would work after reflecting on their own.
6) Write the term echolocation on the board and define it as a class. Draw a detailed way that echolocation works. (See diagram in background). Ask students other ways that echolocation might be useful. Introduce the use of echolocation in sonar to determine objects in the ocean because the sound waves are able to travel through the water.
7) Hand out copies of sonar graphing worksheet to each student.
   a. Ask: Which will take less time for the sound wave to travel from the boat to the ocean floor and back to the surface - a mountain or valley on the ocean floor? (A mountain)
   b. Ask: Why is the 0 time on the top of the chart and not the bottom? (The less time that the sound wave took to go down to the bottom and bounce back up, the closer the object to the surface of the water.)
   c. Have students decide where 0 is on the x-axis (at the left) and label the units on the graph (time goes by 5 secs and location by 1 ft)
8) Show the students how to graph the points from the sonar. Plot the first two points together. Then, students should finish their graphs on their own. Students should answer the questions on echolocation and sonar on their worksheets.
9) Go over questions and drawings of ocean floor as a class.

Evaluation:

1. Evaluate questions from worksheets.
2. Students can describe the various ways sound and echolocation may affect their lives and the lives of animals in a written paragraph.

Extensions:

1. Students can research other animals that use echolocation and other sensory adaptations of animals.

2. Perform NOAA ocean explorer lessons on mapping the ocean floor: http://oceanexplorer.noaa.gov/edu/curriculum/section2.pdf

Resources:

McDougal Littell:
http://www.classzone.com/books/ml_science_share/con_review_06/launchCR_06.htm
-Textbook website used for sound and waves information
NOAA:
http://sanctuaries.noaa.gov/missions/2009nancy_foster/multibeaming.html
http://oceanexplorer.noaa.gov/technology/tools/sonar/sonar.html
-Information on sonar
Georgia aquarium:
www.georgiaaquarium.org
-Provides information on Beluga Whales and other animals
Washington University:
http://faculty.washington.edu/chudler/facts.html
-Information on hearing ranges of animals
Seaworld:
http://www.seaworld.org/animal-info/info-books/beluga/senses.htm
-Information on Beluga Whales
National geographic: http://animals.nationalgeographic.com/animals/mammals/beluga-whale.html

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Lesson developed by: Anna Arias, Immaculate Heart of Mary School

This activity is a product of the Rivers to Reef Teacher Workshop sponsored by the Georgia Aquarium and NOAA Gray's Reef National Marine Sanctuary, in which the authors participated. For more information about this workshop, Georgia Aquarium, or Gray's Reef National Marine Sanctuary, please visit our websites at www.georgiaaquarium.org or http://graysreef.noaa.gov/

Name: _____
Date: _____

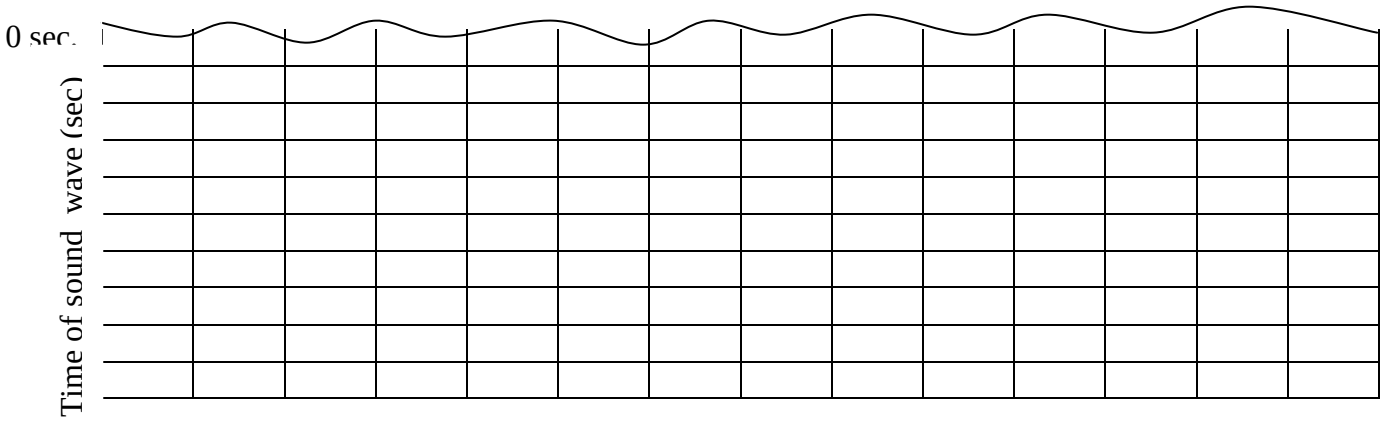
Physical Science
Sonar Graphing

Sonar Graphing

Procedure: Use the data below to plot the depths of the ocean floor. Be sure to finish labeling the axes.

Location	Time of sound wave	Location	Time of sound wave
0 ft	30 sec.	7 ft	45 sec.
1 ft	30 sec.	8 ft	40 sec.
2 ft	33 sec.	9 ft	35 sec.
3 ft	35 sec.	10 ft	30 sec.
4 ft	37 sec.	11 ft	20 sec.
5 ft	40 sec.	12 ft	20 sec.
6 ft	45 sec.	13 ft	20 sec.

Title: _____



Questions:

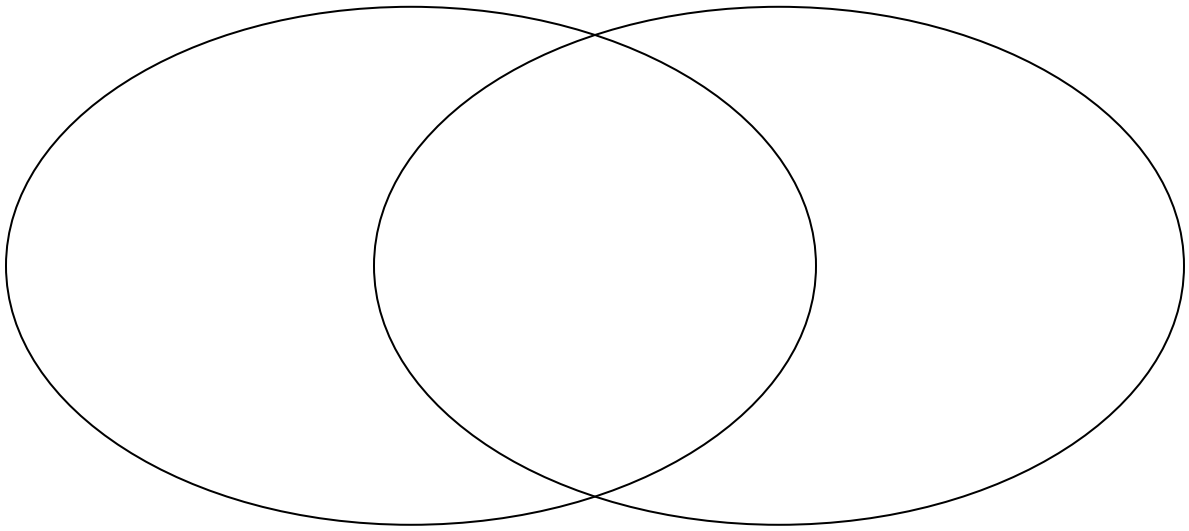
1) What would you need to figure out the depth of the ocean floor at this location?

2) Why would it be important to use sonar in this manner?

3) What else would you need to create a map of the ocean floor at this location?

4) Draw a picture of how the sonar works. Label what is going on.

5) In the Venn diagram, compare and contrast echolocation from beluga whales and sonar from a ship.



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Physical Science
Sonar Graphing

Sonar Graphing – Answer Key

Procedure: Use the data below to plot the depths of the ocean floor.

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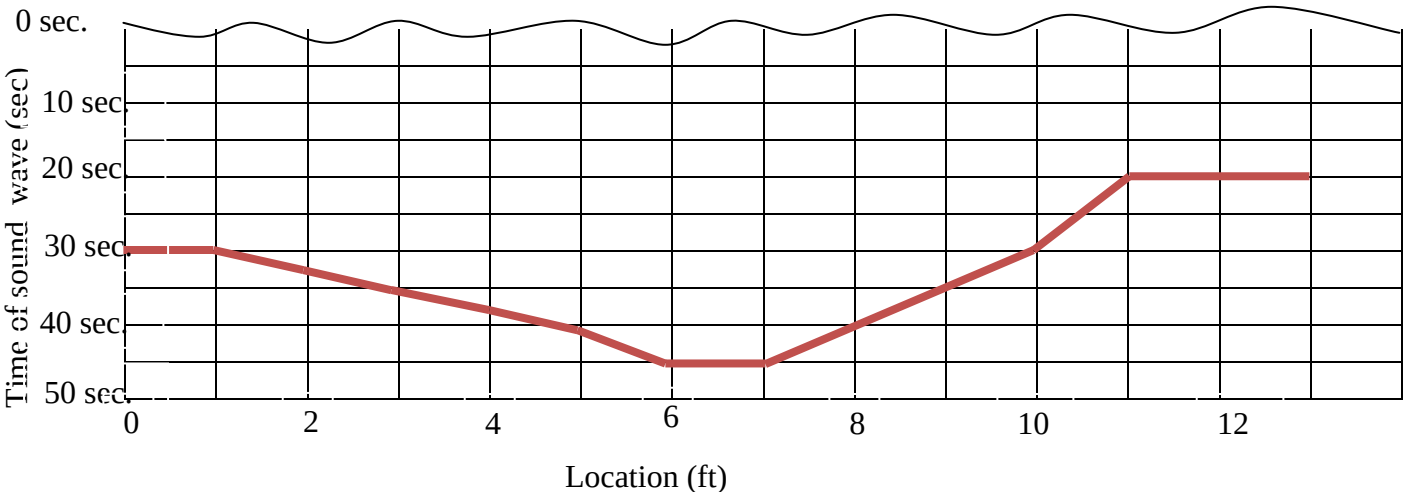
Title: ____ Depth of Ocean Floor_____



Questions:

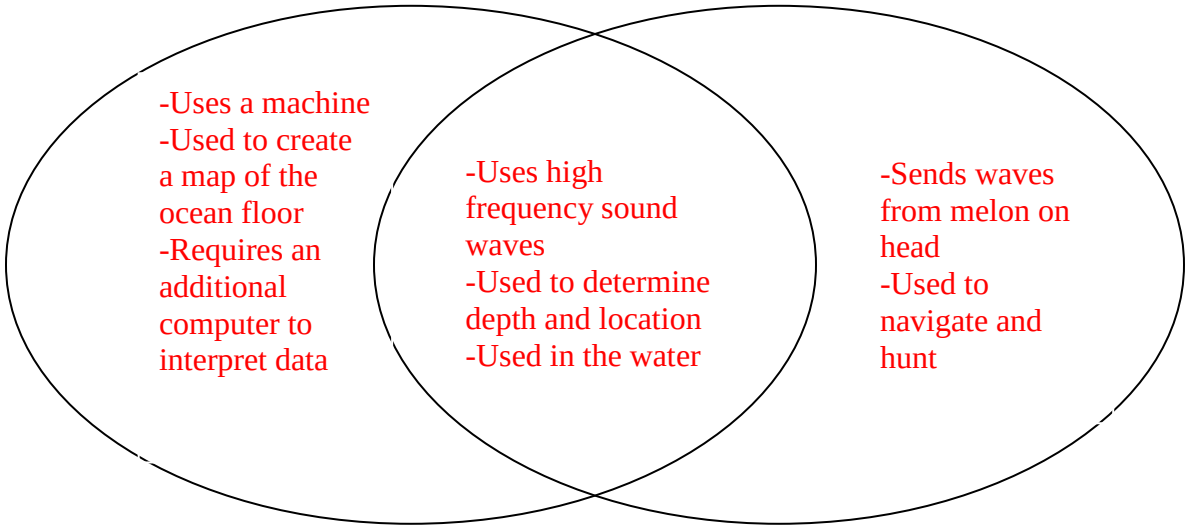
1) What would you need to figure out the depth of the ocean floor at this location?
   The speed of the sound wave and the time it takes the wave to travel from the boat to the ocean floor and back.

2) Why would it be important to use sonar in this manner?
   Sonar allows you to determine what the bottom of the ocean looks like, to see what different animal habitats are like, and to know what types of ships can move in the ocean (other options as well)

3) This sonar reading only shows the depths from one line of sound waves. What else would you need to create a map of the ocean floor at this location?
   You would need to know the sonar readings from several other lines.

4) Draw a picture of how the sonar works. Label what is going on.
   See picture in the background of lesson plan.

5) In the Venn diagram, compare and contrast echolocation from beluga whales and sonar from a ship.

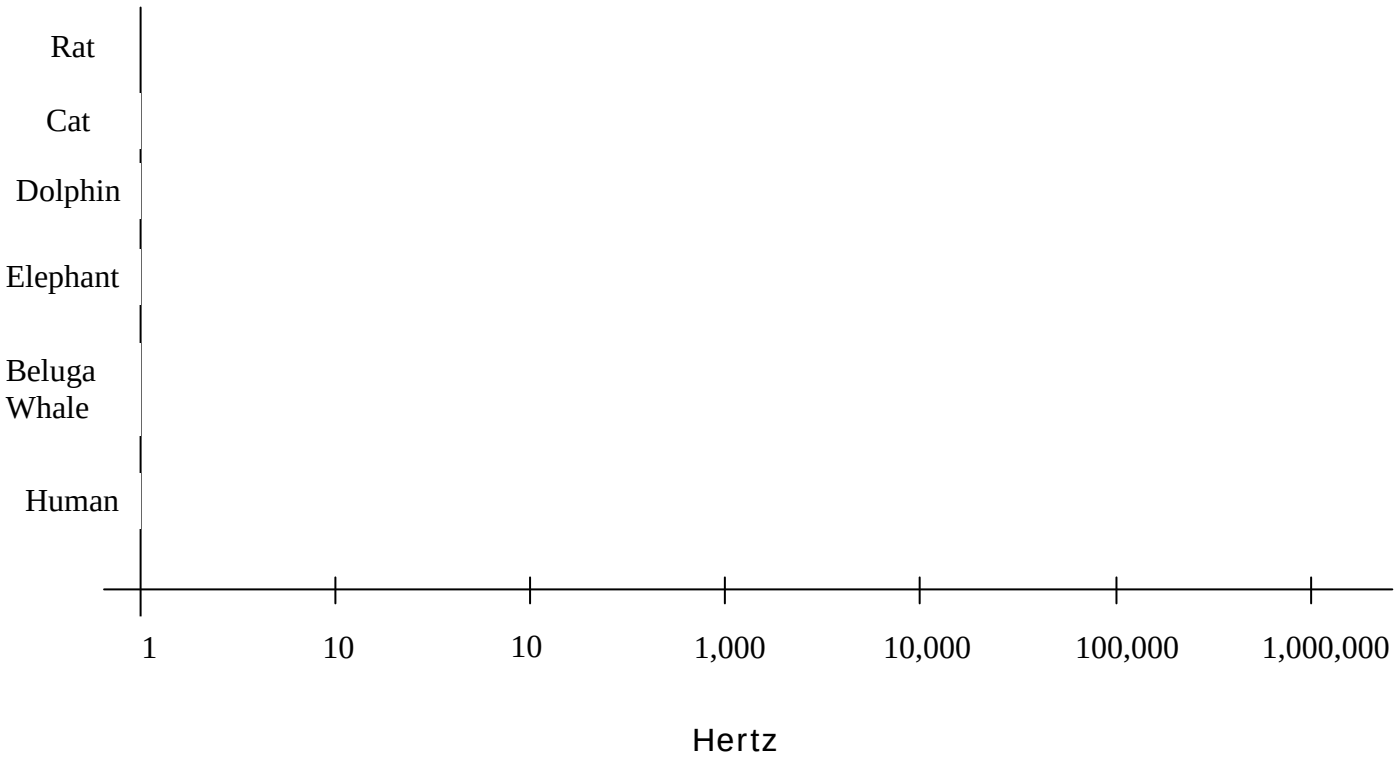


Name: _____
Date: _____

Physical Science
Animal Ranges Graph

Animal Ranges Graph

Create a graph to show the range of hearing for the animals listed below.
Rat = 1,000 to 50,000 Hz
Cat = 100 to 60,000 Hz
Dolphin = 200 to 150,000 Hz
Elephant = 1 to 20,000 Hz
Beluga whale: 1,200 to 120,000 Hz
Human: 20 to 20,000 Hz



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Physical Science
Animal Ranges Graph

Animal Ranges Graph – Answer Key

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