Name:______________________________
Date:_____________

Video Questions Note Sheet

Instructions: As you watch the video, listen for answers to the questions below that will help guide our future discussion.

1. What is sonar? How does it work?

2. What pieces of technology are involved in the process of sonar?

3. How do the sound waves received when the sea floor is flat differ from those received when the seafloor is rocky?

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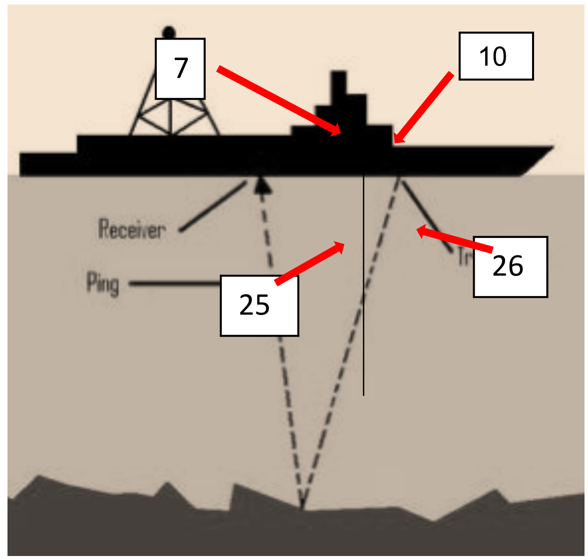
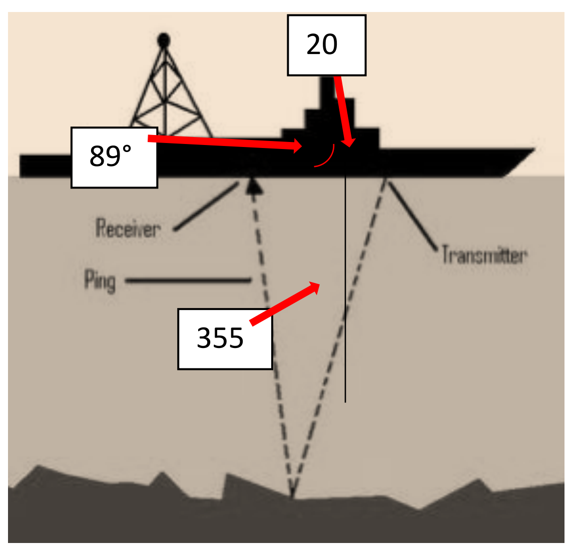
Trigonometry Worksheet Name:_______________________

Date:____________

1. Using any of the math methods we learned in class today, calculate the depth of the ocean given the dimensions (in feet) in the image:



2. Using any of the math methods we learned in class today, calculate the depth of the ocean given the dimensions (in feet) in the image:



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3. Describe how sonar (technology) assists us in solving problems. Give at least three examples.

Geography Background Comparing Pangea to Continents Today

Pangea	**Continents Today**
A huge piece of land • Some plants and animals were there • After breakup the plants and animals were isolated? • Drifting continents meant climate changes—loss of some species? How do they know about it? • Fossils are similar in different places in world First theory was continental drift (1920s) Later plate tectonics became the accepted reason for breakup of Pangea • Relatively new theory (early 1960s)	7 of them • Some are so far from others that plants and animals are isolated • Some are joined or near each other so plants and animals spread they are still moving • Causes earthquakes—humans lose possessions, valleys formed, • Cause volcanoes—humans lose possessions, air pollution, loss of animal habitat, loss of plants, climate changes? How can we measure the changes? • Sonar can measure what is under the surface of the ocean so it can be mapped—changes can be observed • GEOSAT satellites map the plate boundaries—changes can be observed

Life and climate http://www.livescience.com/38218-facts-about-pangaea.html

Having one massive landmass would have made for very different climactic cycles. For instance, the interior of the continent may have utterly dry, as it was locked behind massive mountain chains that blocked all moisture or rainfall, Murphy said.

But the coal deposits found in the United States and Europe reveal that parts of the ancient supercontinent near the equator must have been a lush, tropical rainforest, similar to the Amazonian jungle, Murphy said. (Coal forms when dead plants and animals sink into swampy water, where pressure and water transform the material into peat, then coal.)

"The coal deposits are essentially telling us that there was plentiful life on land," Murphy told Live Science.

Pangaea existed for 100 million years, and during that time period several animals flourished, including the Traversodontidae, a family of plant-eating animals that includes the ancestors of mammals.

During the Permian period, insects such as beetles and dragonflies flourished. But the existence of Pangaea overlapped with the worst mass extinction in history, the Permian-Triassic (P-TR) extinction event. Also called the Great Dying, it occurred around 252 million years ago and caused most species on Earth to go extinct. The early Triassic period saw the rise of archosaurs, a group of animals that eventually gave rise to crocodiles and birds, and a plethora of reptiles. And about 230 million years ago some of the earliest dinosaurs emerged on Pangaea, including theropods, largely carnivorous dinosaurs that mostly had air-filled bones and feathers similar to birds.

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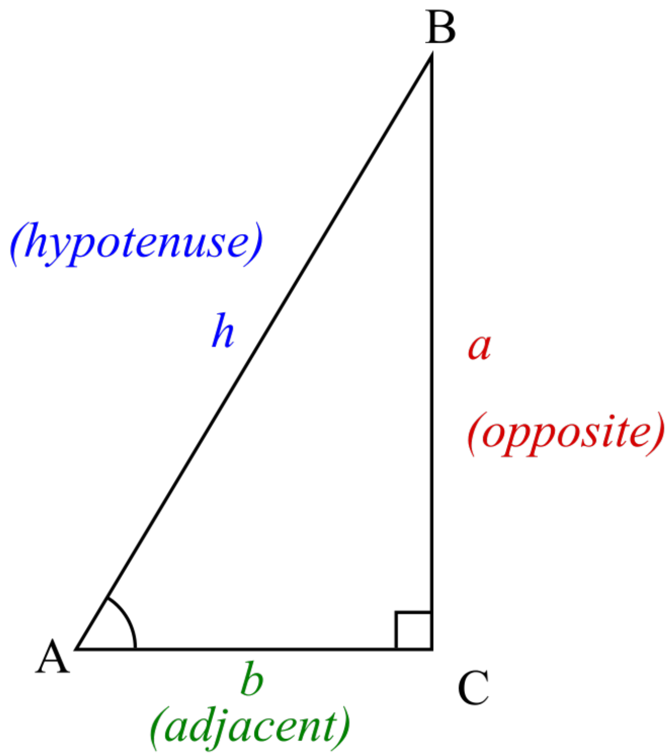
Mathematics Background on Trig Ratios and Sine and Cosine

Trigonometric Ratios	Pythagorean Theorem
$\sin(\theta) = \frac{opposite}{hypotenuse}$ $\cos(\theta) = \frac{adjacent}{hypotenuse}$ $\tan(\theta) = \frac{opposite}{adjacent}$	$a^2 + b^2 = c^2$
Law of Sines	**Law of Cosines**
$\frac{A}{\sin(a)} = \frac{B}{\sin(b)} = \frac{C}{\sin(c)}$	$c^2 = a^2 + b^2 - 2ab\cos(C)$

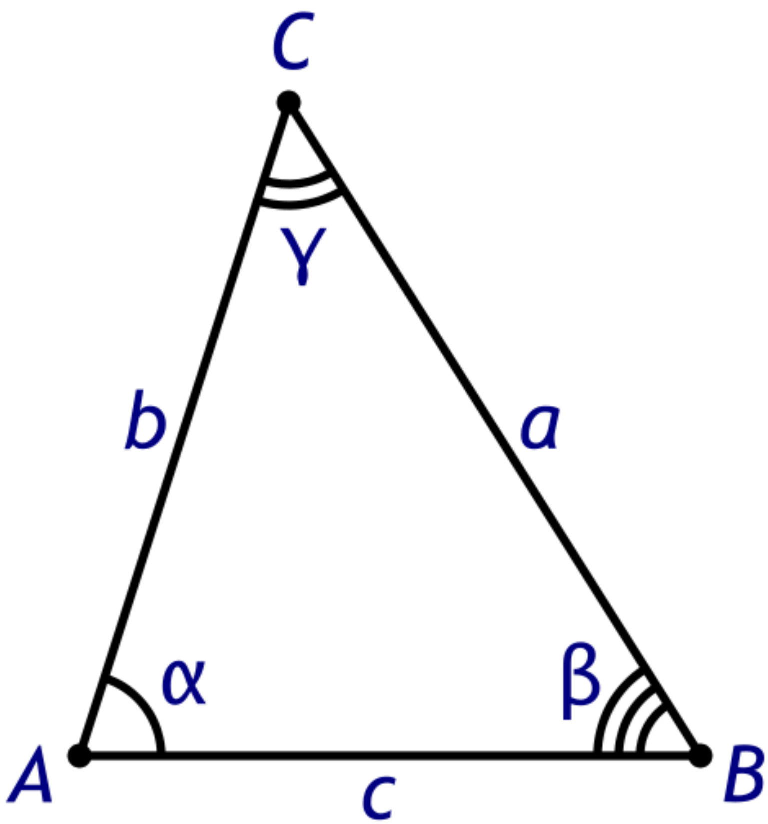
Labeling the triangles correctly is crucial. Typically lower case letters (a, b, c) are used to represent the sides of a triangle and upper case (A, B, C) or Greek letters (α, β, γ (Alpha, Beta, Gamma)) are used to denote angles. Corresponding letters should reside opposite each other. Please see pictures below.

The trigonometric ratios and the Pythagorean Theorem are only appropriate to use when solving right triangles.
It is important to note that the Pythagorean Theorem always refers to the legs as sides *a* and *b* and the hypotenuse as side *c*.
It is also important to note, in the trig ratios, that the opposite and adjacent sides are relative to the angle. Please reference the right triangle below. (top picture) This triangle is labeled with respect to angle A, as marked, so that the opposite side is *a* and the adjacent side is *b*. If we were looking to use angle B in the trig ratios, the opposite side would be *b* and the adjacent side would be *a*.
Outside the context of solving triangles, Greek letter Theta (θ) is often used as the generic angle name in trigonometry formulas. This is most common in cases where you only need to reference one angle.
The phrase SOH CAH TOA is very common when teaching trig ratios. It stand for Sine: opposite, hypotenuse, Cosine: adjacent, hypotenuse, Tangent: opposite, adjacent.

Unlike trigonometric ratios and the Pythagorean Theorem, the Laws of Sine and Cosine can be applied to any triangle as long as the appropriate information is known.
This means that if we are solving a non-right triangle, there is no hypotenuse that must be labeled side *c*.
There is no set convention for labeling acute, obtuse, scalene, isosceles, or equilateral triangles.
It is important to note that any two ratios can be compared when using law of sines. Also, since there is no distinction between the sides, law of cosines can be used to solve for the third side as long as the other two sides are known as well as the angle that corresponds to the third side.



B
(hypotenuse)
h
a
(opposite)
A
b
(adjacent)
C



C
γ
b
a
α
β
A
c
B

Learning about Sonar

The First Studies of Underwater Acoustics: The 1800s

In 1826 on Lake Geneva, Switzerland, Jean-Daniel Colladon, a physicist, and Charles-Francois Sturm, a mathematician, made the first recorded attempt to determine the speed of sound in water. In their experiment, the underwater bell was struck simultaneously with ignition of gunpowder on the first boat. The sound of the bell and flash from the gunpowder were observed 10 miles away on the second boat. The time between the gunpowder flash and the sound reaching the second boat was used to calculate the speed of sound in water. Colladon and Sturm were able to determine the speed of sound in water fairly accurately with this method.
J. D. Colladon, Souvenirs et Memoires, Albert-Schuchardt, Geneva, 1893.

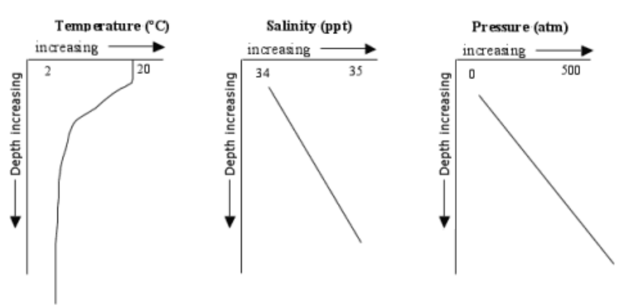
https://dosits.org/?s=first+studies

How Fast Does Sound Travel?

We know that sound travels. How fast does it travel? Sound travels about 1500 meters per second in seawater. That's approximately 15 football fields end-to-end in one second. Sound travels much more slowly in air, at about 340 meters per second, only 3 football fields a second.

Unfortunately, the answer is really not quite that simple. The speed of sound in seawater is not a constant value. It varies by a small amount (a few percent) from place to place, season to season, morning to evening, and with water depth. Although the variations in the speed of sound are not large, they have important effects on how sound travels in the ocean.

What makes the sound speed change? It is affected by the oceanographic variables of temperature, salinity, and pressure. We can look at the effect of each of these variables on the sound speed by focusing on one spot in the ocean. When oceanographers look at the change of an oceanographic variable with water depth, they call it a profile. Here we will examine the temperature profile, the salinity profile, and the pressure profile. Similar to the profile of your face that gives a side view of your face, an oceanographic profile gives you a side view of the ocean at that location from top to bottom. It looks at how that characteristic of the ocean changes as you go from the sea surface straight down to the seafloor. The spot we are going to explore is in the middle of the deep ocean.



Here are basic profiles for a site in the deep, open ocean roughly half-way between the equator and the North or South pole. In these profiles, temperature decreases as the water gets deeper while salinity and pressure increase with water depth. Here we are referring to the ocean pressure due to the weight of the overlying water (equilibrium pressure), not to the pressure associated with a sound wave, which is much, much smaller. In general, temperature usually decreases with depth, salinity can either increase or decrease with depth, and pressure always increases with depth.

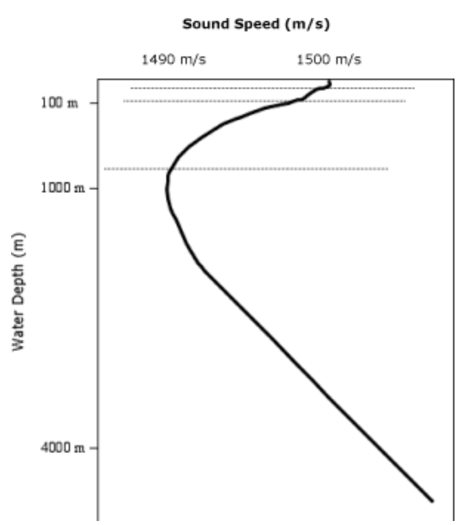
Depth profiles from the open ocean of temperature, salinity and density. Copyright University of Rhode Island.

From these profiles, you can see that temperature changes a large amount, decreasing from 20 degrees Celsius (°C) near the surface in mid-latitudes to 2 degrees Celsius (°C) near the bottom of the ocean. On the other hand, salinity changes by only a small amount, from 34 to 35 Practical Salinity Units (PSU), approximately 34 to 35 parts per thousand (ppt). Finally, pressure increases by a large amount, from 0 at the surface to 500 atmospheres (atm) at the bottom.

The speed of sound in water increases with increasing water temperature, increasing salinity and increasing pressure (depth). The approximate change in the speed of sound with a change in each property is:

Temperature 1°C = 4.0 m/s
Salinity 1PSU = 1.4 m/s
Depth (pressure) 1km = 17 m/s

Knowing that the speed of sound increases with increasing temperature, salinity, and pressure, what would you guess the typical sound speed profile looks like?



Profile of speed of sound in water. Note the sound speed minimum at 1000 meters.

Here is a typical sound speed profile for the deep, open ocean in mid-latitudes. Did you guess correctly?

The decrease in sound speed near the surface is due to decreasing temperature. The sound speed at the surface is fast because the temperature is high from the sun warming the upper layers of the ocean. As the depth increases, the temperature gets colder and colder until it reaches a nearly constant value. Since the temperature is now constant, the pressure of the water has the largest effect on sound speed. Because pressure increases with depth, sound speed increases with depth. Salinity has a much smaller effect on sound speed than temperature or pressure at most locations in the ocean. This is because the effect of salinity on sound speed is small and salinity changes in the open ocean are small. Near shore and in estuaries, where the salinity varies greatly, salinity can have a more important effect on the speed of sound in water.

It is important to understand that the way sound travels is very much dependent on the conditions of the ocean. The sound speed minimum at roughly 1000 meter depth in mid-latitudes creates a sound channel that lets sound travel long distances in the ocean.
The SOFAR Channel Section provides more information on how the sound speed minimum focuses sound waves into the channel.

https://dosits.org/?s=sound+movement

Answer Key

Question 1 Solution (30 points)

The most obvious method to solving this problem should be the Pythagorean Theorem, but if students correctly use another method from the lesson, points should not be deducted.

$7^2 + b^2 = 25^2$
$b^2 = 25^2 - 7^2$
$b^2 = 265 - 49$
$b^2 = 576$
$\sqrt{b^2} = \sqrt{576}$
$b = 24$

or

$10^2 + b^2 = 26^2$
$b^2 = 26^2 - 10^2$
$b^2 = 676 - 100$
$b^2 = 576$
$\sqrt{b^2} = \sqrt{576}$
$b = 24$

Question 2 Solution (35 points)

Students will work this question on their own because it is a harder question. Like Question 1, there are many ways to solve this using combinations of the formulas in the lesson. One simple way is shown below.

$$\frac{355}{\sin(90)} = \frac{a}{\sin(89)}$$
$$\frac{355}{\sin(90)} * \sin(89) = a$$
$$355 * \sin(89) = a$$
$$355 * .99985 = a$$
$$354.946 = a$$

Question 3 Scoring Guide (15 points)

Spelling and Grammar (5 points)

Content—at least 3 valid uses of sonar (10 points)

Pangea Cutouts

Eurasia
Africa
India
Greenland
North America
Antartica
South America
Australia