Grade Level: 6-8
Time Estimate: 3-5 days

GEOMETRY / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, examples, and activities to help students learn and understand basic geometric concepts regarding triangles and quadrilaterals. Using data collected from the OCEARCH Global Shark Tracker™, students will learn how to practice geometry in real life situations.

Part 1. Basic Shapes and Properties
Part 2. All about Angles
Part 3. The Pythagorean Theorem
Part 4. Angles and Ship Navigation
Part 5. Review
Activity 1. Shark Measurements
Activity 2. Shark Stories

Goals & Objectives

The students will:

- classify triangles and quadrilaterals;
- use a protractor to measure angles;
- use angle measurements to classify acute, obtuse and right;
- differentiate between complementary and supplementary angles;
- demonstrate the Pythagorean Theorem using real life models.

// STANDARDS

This lesson aligns with the following Common Core Math Standards
Grade 6 Math: NS.B.3, EE.A.2, EE.B.5
Grade 7 Math: EE.B.4A, G.A.3, G.B.5
Grade 8 Math: EE.A.2, G.B.6, G.B.7, G.B.8

This lesson aligns with the following TEKS:
Grade 5 Math (Revised): 1A, 1C, 1D 3A, 3K, 4B, 5
Grade 6 Math: 1A, 6A, 6B, 8B, 8C, 11A, 11C, 11D, 12A
Grade 6 Math (Revised): 1A, 1C, 1D, 3E, 8A
Grade 7 Math: 1A, 6A, 6B, 9A, 13A, 13C, 13D, 14A
Grade 7 Math (Revised): 1A, 1C, 1D, 3A, 3B, 11C
Grade 8 Math: 7C, 9A, 14A, 14C, 14D, 15A
Grade 8 Math (Revised): 1A, 1C, 1D, 6C, 7C

Helpful Tips

1) The content in this lesson is based on the conservation work of OCEARCH™ and the Global Shark Tracker™. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker™ is also available as an app for iPhone and Android.
2) This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3) Vocabulary words will be underlined as they first appear in the lesson plan. A complete list of vocabulary words is included as well.
4) Answers to questions and prompts for discussions will appear in *italics*.
5) Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6) A student handout with examples from the lesson is included on pages 21 and 22. Print it out for students to work out example problems as a class.
7) Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
8) Email all questions about this lesson to info@OCEARCH.org.

Vocabulary

Acute angle – Classification of an angle measuring less that 90°.
Angle - the space between two intersecting lines or surfaces at or close to the point where they meet. Usually measured in degrees.
Bearing - A measurement of direction between two points taken with a compass. Expressed as an angle.
Complementary angles – Two angles with a sum of 90°.
Congruent – Identical in form. For example, two angles are congruent if they are of the same measurement. This also can be expressed for measurement of the sides of a shape
Degree – The unit used to measure angles.
Equilateral triangle - A triangle in which all sides are equal in length.
Full rotation – Classification of an angle measuring 360°.
Geometry - a branch of mathematics dealing with points, lines, angles, and shapes.
Hypotenuse – The longest side of a right triangle, opposite the right angle.
Isosceles triangle – A triangle with two sides of equal length.
Legs – The two sides of a triangle that come together to form a right angle.
Obtuse angle - Classification of an angle measuring more than 90° but less than 180°.
Parallel – Two or more lines that never intersect and are an equal distance apart.
Protractor – A tool used to measure angles.
Pythagorean Theorem – States that the square of the hypotenuse is equal to the sum of the squares of the other two sides. Equation: $a^2 + b^2 = c^2$
Quadrilateral – A four sided polygon. Examples include a rectangle, square, and rhombus.
Reflex angle – Classification of an angle measuring more than 180° but that less than 360°.
Right angle – Classification of an angle measuring 90°.
Scalene triangle – A triangle with no equilateral sides.
Straight angle – Classification of an angle measuring 180°.
Supplementary angles - Two angles with a sum of 180°.
Triangle – A polygon with three sides.
Vertex – The point of a polygon where two sides intersect.

GEOMETRY
/ PRE-LESSON ASSESSMENT

Use the following short answer, multiple choice, and true/false questions as an introduction/warm-up to the lesson topics. You can do this in a verbal or written format, as a game, individually, or as a whole class! A handout is provided if you wish to hand the questions out in a quiz format.

The questions do not need to be graded. They are intended to give the students an idea of what they will be learning and to see what they already know.

1. True or False — An equilateral triangle has three equal sides.
Answer: *True*

2. True or False — Parallel lines will never touch.
Answer: *True*

3. True or False — There are only two different types of triangles.
Answer: *False*

4. Which of the following are examples of quadrilaterals? (Choose all that apply)
   a. Square
   b. Sphere
   c. Rhombus
   d. Triangle

Answer: *a, c*

5. Protractors measure angles in
   a. Feet
   b. Degrees
   c. Minutes
   d. Inches

Answer: *b*

6. What can the Pythagorean Theorem can be used for? (Choose all that apply)
   a. Find the measurements of all three angles of a triangle.
   b. Determine the length of a side of a right triangle if the adjacent side and hypotenuse are known.
   c. Determine if a triangle is a right triangle if all side lengths are known.
   d. Find the hypotenuse of a triangle

Answer: *b, c, d*

Name: ___________________________________ Date: __________________

Geometry

Select the correct answer(s) to each of the following questions.

1. True or False An equilateral triangle has three equal sides.

2. True or False Parallel lines will never touch.

3. True or False There are only two different types of triangles.

4. Which of the following are examples of quadrilaterals? (Choose all that apply)
   a. Square
   b. Sphere
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   d. Triangle

5. Protractors measure angles in
   a. Feet
   b. Degrees
   c. Minutes
   d. Inches

6. What can the Pythagorean Theorem can be used for? (Choose all that apply)
   a. Find the measurements of all three angles of a triangle.
   b. Determine the length of a side of a right triangle if the adjacent side and hypotenuse are known.
   c. Determine if a triangle is a right triangle if all side lengths are known.
   d. Find the hypotenuse of a triangle

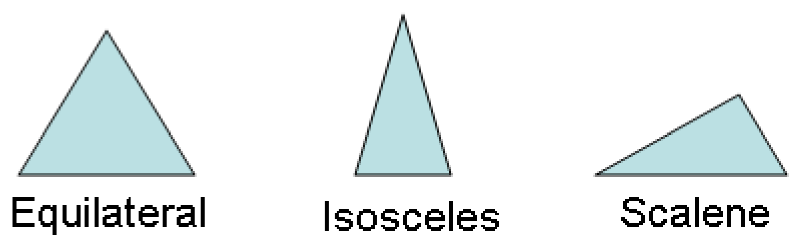
GEOMETRY / LESSON PLAN

INTRODUCTION **3-5 mins**

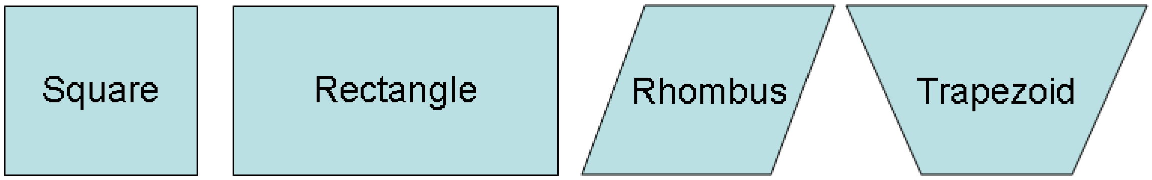
Geometry is a branch of mathematics dealing with points, lines, angles, and shapes. In this lesson, we are going to classify two dimensional figures by examining their properties – focusing mainly on the number of sides and the angles making up the shape. Figures can have as few as three sides, i.e. a triangle, and as many as one hundred sides, i.e. a hectogon, or more! For this lesson, we will be concentrating on triangles and quadrilaterals.

Part 1. Basic Shapes and Properties (15 – 20 minutes)

Triangles are shapes with three sides. If all three sides are equal, or congruent, it is classifies as an equilateral triangle. If two sides are congruent it is an isosceles triangle. Lastly, if none of the sides are congruent it is a scalene triangle. *Look around the classroom. Can you find any triangles? Do any have congruent sides? Classify them!*

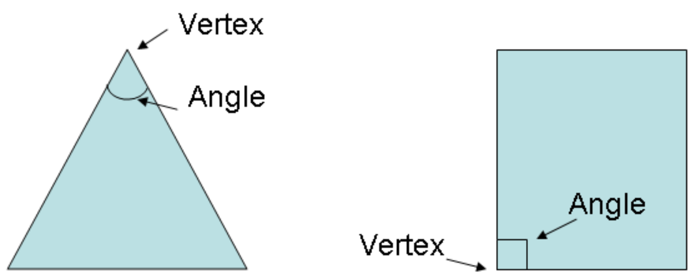


Quadrilaterals are shapes with four sides. There are many types of quadrilaterals which can be classified further based the lengths of their sides. Parallelograms are quadrilaterals with two pairs of parallel sides. Examples include a square, rectangle and rhombus. A trapezoid is a quadrilateral with only one pair of parallel sides. *How many quadrilaterals can you find in the classroom? Are any parallelograms? Are any trapezoids? Are there any that have no parallel sides?*



Part 2. All About Angles (45 – 60 minutes)

In addition to having three sides, triangles have three vertices. Quadrilaterals have four vertices to go with their four sides. A vertex is a point where two sides meet, or intersect. The figure formed by the vertex is called an angle. Angles are measured in degrees (°) and allow us to further classify figures.

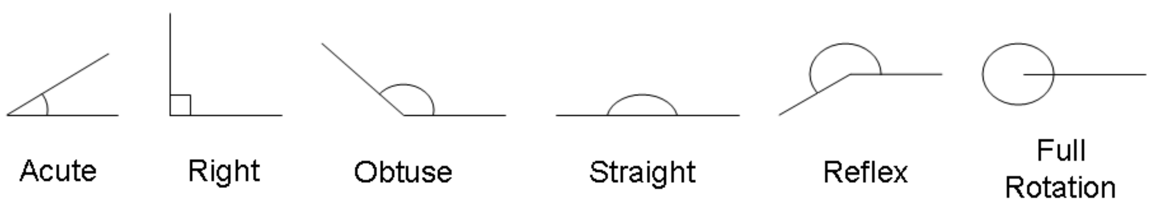


How to Classify Angles

Angles are classified by how many degrees they measure.

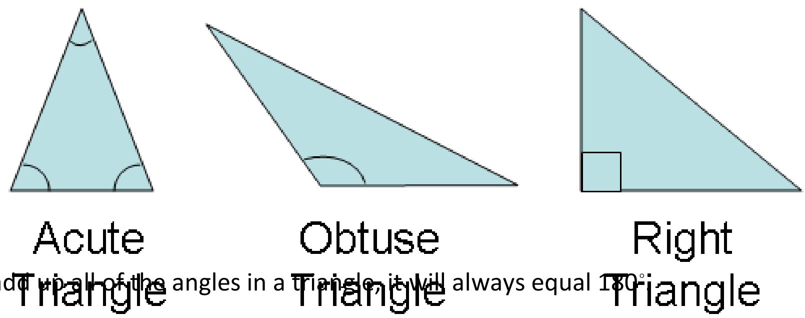
- An acute angle is less than 90°.
- A right angle is exactly 90°.
- An obtuse angle is greater than 90° but less than 180°.
- A straight angle is exactly 180°.
- A reflex angle is between 180° and 360°.
- A full rotation is360°.

Consider the following images to better understand:



Using Angles to Classify Triangles

Triangles have three angles, which can be used to further classify the figure. If all three angles are acute, the triangle is called an acute triangle. If two angles are acute and one is obtuse, it is an obtuse triangle. If the figure has a 90° angle it is called a right triangle.

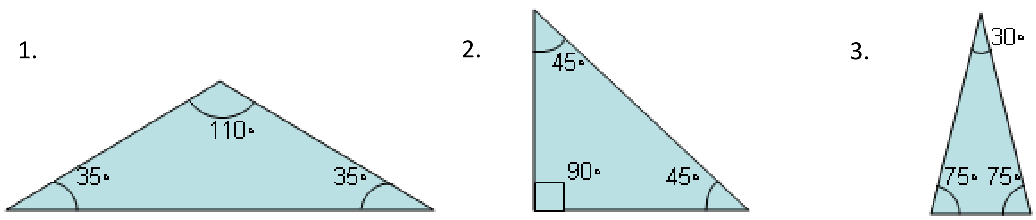


If you were to add up all of the angles in a triangle, it will always equal 180°.

Practice Problems

The following examples are included on the student handout titled "Practice Problems". Classify the following three triangles and prove that the sum of their angles equals 180°.

1. 2. 3.



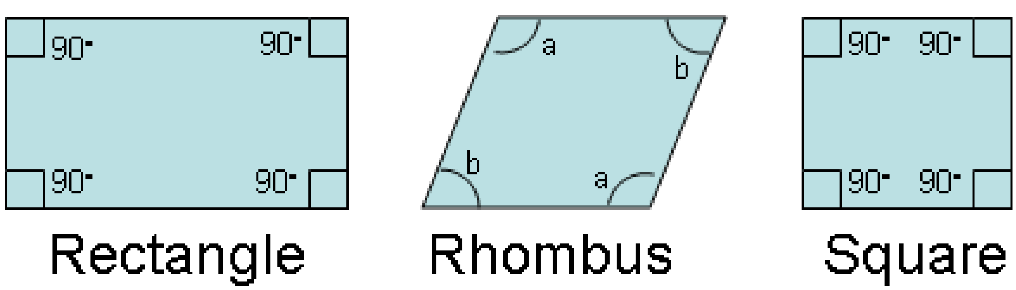
$35° + 35° + 110° = 180°$ Obtuse triangle

$45° + 45° + 90° = 180°$ Right triangle

$75° + 75° + 30° = 180°$ Acute triangle

Using Angles to Classify Parallelograms

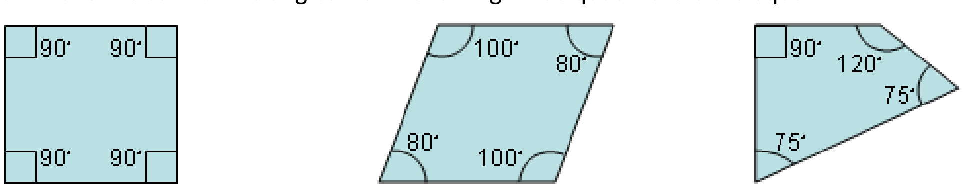
In parallelograms, the angles opposite each other are equal. Parallelograms with all right angles are rectangles. *What do you call a parallelogram with all right angles as well as all congruent sides? A square!*



If you were to add up all of the angles of a parallelogram, it will always equal 360°.

Practice Problems

The following examples are included on the student handout titled "Practice Problems". Prove the sum of the angles from following three quadrilaterals is equal to 360°.



$90° + 90° + 90° + 90° = 360°$

$100° + 100° + 80° + 80° = 360°$

$90° + 120° + 75° + 75° = 360°$

In Class Activity – Drawing Triangles and Quadrilaterals!

(5 – 15 minutes; optional)

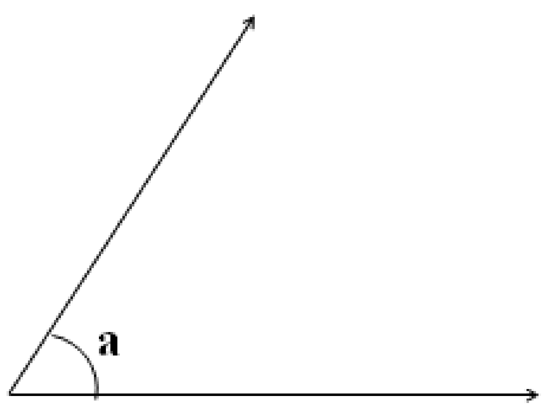
Call out "triangle" and have students draw a triangle and hold up for all of the class to see. Everyone's triangle will look different. Next, call out "isosceles triangle" for students to draw and hold up. Everyone's triangle should look a little more similar. Next, call out "obtuse isosceles triangle". Every student should have a triangle looking even more similar. Continue calling out figures for students to draw, starting with a general figure and continuing to get more specific. Don't forget to include quadrilaterals!

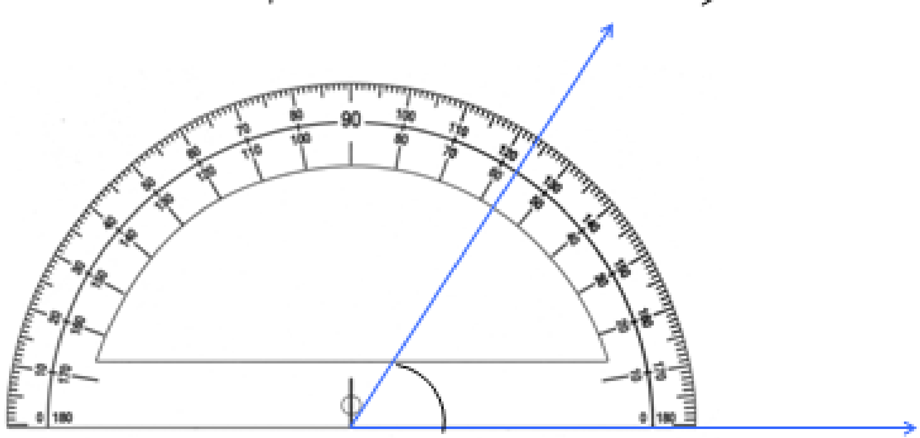
Discuss the activity with the class. Ask questions like: *What did you notice about the first figure (triangle) everyone drew? What happened to everyone's drawing as the shapes became more specific? Why did this happen? How did you decide to draw the figures the way you did?*

Some angles are more difficult to classify than others. In this case, you can use a tool called a <u>protractor</u> to find the angle's exact measurement and then be able to classify it. The following examples are included on the student handout titled "Practice Problems".

Example 1. Use a protractor to measure and classify the following angle:

Step 1. Align the center of the protractor over the vertex of the angle and make sure the bottom line of the angle matches up with the 0° mark.





Step 2. Find the number where the second line of the angle meets the protractor. This is the measurement of the angle. The above angle is 57°.

Step 3. Now we can classify the angle.

Is it less than, greater than, or equal to 90°?

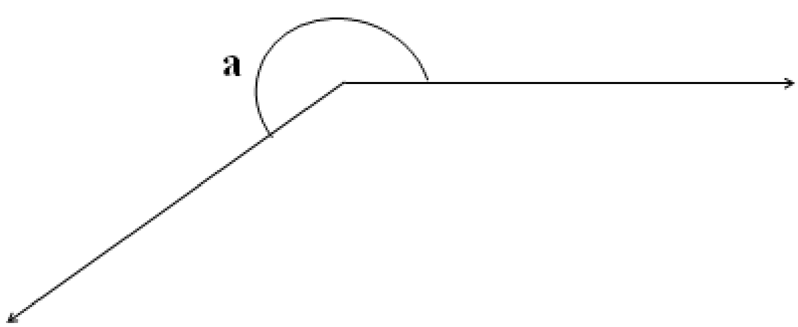
$57^\circ < 90^\circ$

The above angle is an acute angle!

Tips for Using a Protractor

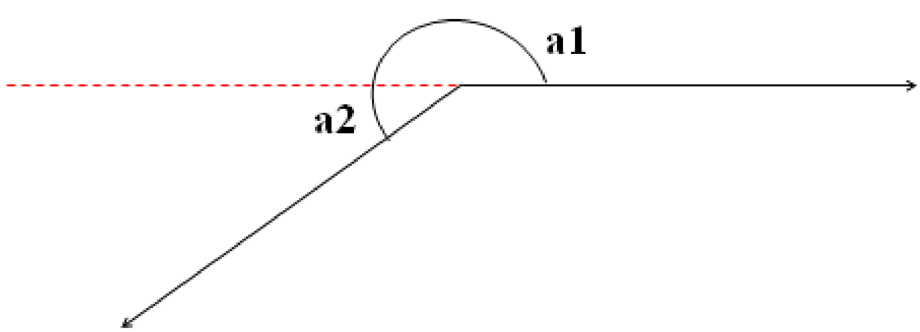
- Some protractors have scales in degrees and radians, just like a ruler has inches and centimeters. Make sure you are reading the measurement in degrees.
- Some protractors have a degree scale reading left to right and another reading right to left. If an angle looks acute, but the measurement says it is obtuse, you reading from the wrong side!
- If the sides of the angle you want to measure are too short to get a measurement, use a straight edge to extend the line. This way you will get a more accurate reading.

Example 2. What is the measurement of this reflex angle (*a*)? We know the measurement is going to be greater than 180°, however, your protractor cannot measure past 180°! There are two ways to go about finding the measurement of this angle.



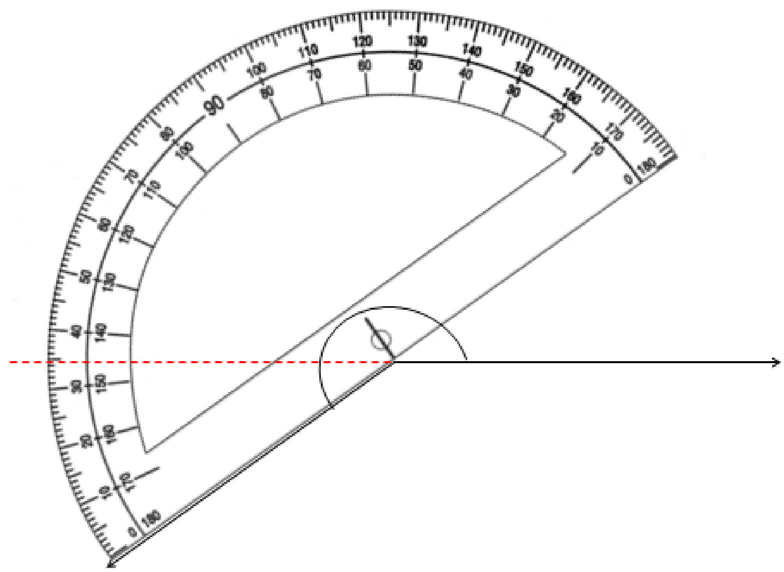
Method 1.

Step 1. Divide the angle into two angles, **a1** and **a2**, by using a straight edge to extend one of the lines (as seen by the dotted line).



Step 2. Measure angles ***a1*** and ***a2***.

Angle ***a1*** is a straight angle which we know is equal to 180˚.
Angle ***a2*** is equal to 35˚.



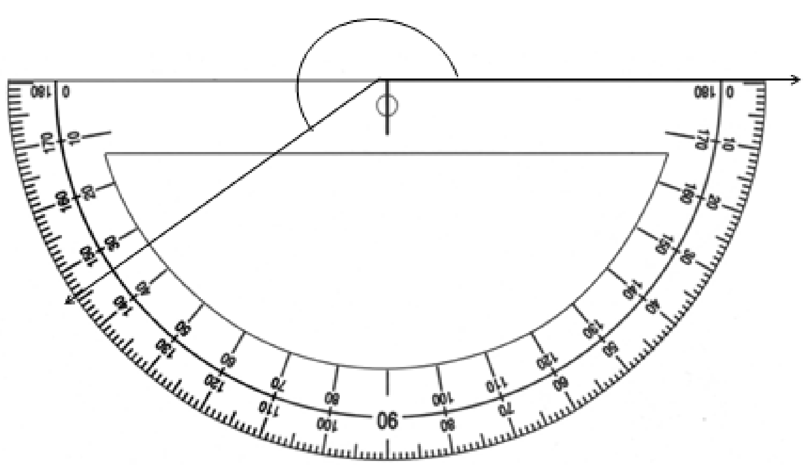
Step 3. Add ***a1*** and ***a2*** to find the total measurement of the original angle.

180˚ + 35˚ = 215˚

Angle (a) is 215˚!

<u>Method 2.</u>

Step 1. Measure the angle opposite of angle (***a***) with your protractor.
The opposite angle is 145˚.



Step 2. We know a full rotation measures 360˚, so subtract 145˚ from 360˚ to get the measurement of angle (a).

$360^{\circ} - 145^{\circ} = 215^{\circ}$

Angle (a) is 215°!

Complementary and Supplementary Angles

When two angles add up to 90°, they are called complementary angles. If you were to put them together they would make up a right angle. When two angles add up to 180°, they are called supplementary angles. If you were to put them together they would make up a straight angle. The following examples are included on the student handout titled "Practice Problems".

Example 3. If an angle is 40°, what is its complementary angle?

$90^{\circ} - 40^{\circ} = 50^{\circ}$

The complementary angle is 50°.

Example 4. If an angle is 98°, what is its supplementary angle?

$180^{\circ} – 98^{\circ} = 82^{\circ}$

The supplementary angle is 82°.

In Class Activity – Shark Angling

(10 – 20 minutes; optional)

As a class, choose a shark from the Global Shark Tracker™ website. Next, zoom in enough so you will be able to measure the angles of the shark's path. Pick five and list their measurements on the board for the class to see. Students will use the measurements to solve for each angle's complementary and supplementary angle. Go over answers as a class.

Pose the following questions: *When might you need to solve for complementary angles in everyday life? What about supplementary angles? Can you think of an instance when a shark researcher would need to?* *There are no wrong answers!

<u>Part 3. The Pythagorean Theorem</u> (45 – 60 minutes)

Right triangles are a special type of triangle where two sides come together to form a 90° angle. The side opposite the right angle is called the <u>hypotenuse</u> and the two sides creating the right angle are called <u>legs</u>.

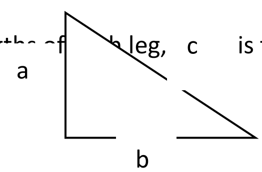
The <u>Pythagorean Theorem</u> is a concept named after the Greek mathematician Pythagoras. While he is well known for the discovery and proof of the Pythagorean Theorem, evidence shows that Babylonians and the Ancient Egyptians had knowledge of the concept centuries prior to the Greeks.

The Pythagorean Theorem is used when dealing with right triangles **only**. If you know the length of both legs, you can solve for the length of the hypotenuse. You could even solve for the angles if you know the measurements of all three sides.

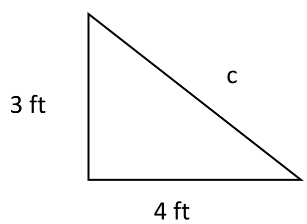
The Pythagorean Theorem states:

$$\mathbf{a^2 + b^2 = c^2}$$

Where **a** and **b** are the length of each leg, c is the length of the hypotenuse.



Example 5. Use the Pythagorean Theorem to find the hypotenuse of this triangle.



Step 1. Identify the information.

Equation: $a^2 + b^2 = c^2$

$a = 3$ ft

$b = 4$ ft

$c =$ unknown

Step 2. Plug in the information.

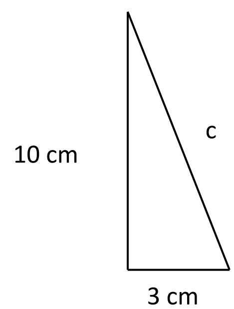
$3^2 + 4^2 = c^2$

Step 3. Solve the equation.

$9 + 16 = c^2$
$25 = c^2$
$\sqrt{25} = c$
$5 \text{ ft} = c$

The hypotenuse is 5 ft long.

Example 6. Calculate the hypotenuse.



Step 1. Identify the information.

Equation: $a^2 + b^2 = c^2$
a = 10 cm
b = 3 cm
c = unkown

Step 2. Plug in the information.

$10^2 + 3^2 = c^2$

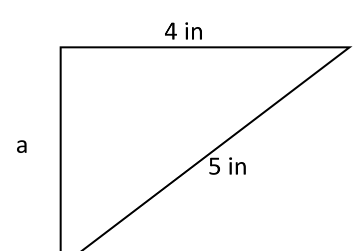
Step 3. Solve the equation.

$100 + 9 = c^2$
$109 = c^2$
$\sqrt{(109)} = c$
$5 = 10.44$

The hypotenuse is 10.44 cm long.

You can also use the Pythagorean Theorem to solve for the length of the legs if you have the measurement of the hypotenuse.

Example 7. What is the length of leg "a"?



Step 1. Identify the information.

Equation: $a^2 + b^2 = c^2$

a = what we are solving for

$b = 4$ in

$c = 5$ in

Step 2. Plug in the information.

$a^2 + 4^2 = 5^2$

Step 3. Solve the equation.

$a^2 + 16 = 25$

$a^2 = 9$

$a^2 = \sqrt{(9)}$

$a = 3$ inches

Leg "a" is 3 inches long.

You can also use the Pythagorean Theorem to determine if a triangle is a right triangle – as long as you have the measurements of all three sides.

Example 8. Is a triangle with the following measurements a right triangle?

$a = 9$ cm

$b = 40$ cm

$c = 41$ cm

Step 1. Plug the information into the equation.

$9^2 + 40^2 = 41^2$

Step 2. Solve the equation.

$9^2 + 40^2 = 41^2$

$81 + 1600 = 1681$

$1681 = 1681$

Step 3. Are the numbers equal?

Yes! $1681 = 1681$

This is a right triangle since the Pythagorean Theorem works with the measurements we are given.

Example 9. Is a triangle with the following measurements a right triangle?

a = 18 in
b = 23 in
c = 34 in

Step 1. Plug the information into the equation.

$18^2 + 23^2 = 34^2$

Step 2. Solve the equation.

$18^2 + 23^2 = 34^2$
$324 + 529 = 1156$
$853 \neq 1156$ in

Step 3. Are the numbers equal?

No. 853 does not equal 1156.

This is not a right triangle since the Pythagorean Theorem does not work with the measurements given.

In Class Activity – Practice Using the Pythagorean Theorem

(5 – 15 minutes; optional)

Determine if the triangles with the following sides are right triangles:

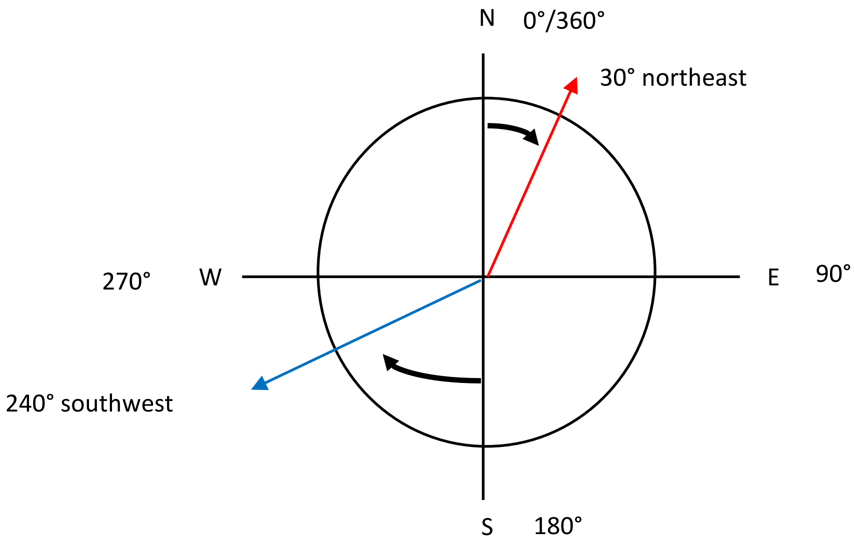
1. a = 61 b = 99 c = 20 Answer: *No*
2. a = 7 b = 54 c = 55 Answer: *No*
3. a = 8 b = 15 c = 17 Answer: *Yes*
4. a = 24 b = 10 c = 26 Answer: *Yes*
5. a = 11 b = 26 c = 88 Answer: *No*

For a fun added twist, divide the class into teams. Write each problem one at a time on the board or projector (or call the numbers out). Allow each team to solve the problem using the Pythagorean Theorem and then determine if they have a right triangle or not. Each team should receive a point for

Part 4. Angles and Ship Navigation (5 – 15 minutes)

The OCEARCH crew uses angles every day when on expedition. Angles are an important part of open water navigation, ship operation, and even play a part in tracking the sharks.

The M/V OCEARCH has an 8 inch liquid-filled magnetic compass located in its pilothouse. A compass is an instrument used to determine direction by means of a magnetic needle that always points to Earth's magnetic north pole. Directions on a compass are read in degrees, since basically you are just determining the angle the needle is making relative to Earth's magnetic north pole.

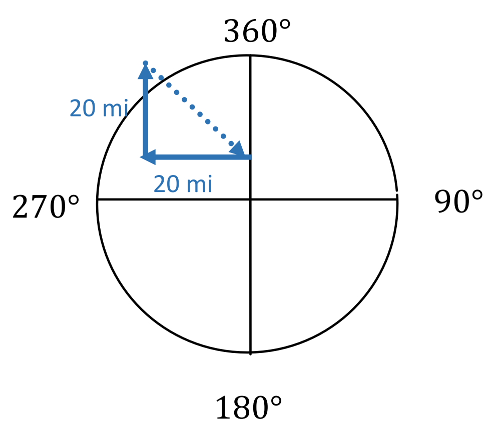


In Class Activity – Ship Navigation

(10 – 15 minutes; optional)

Imagine that the OCEARCH Crew is on an expedition off the coast of South America. One afternoon they lose all satellite communication and are left without internet or radios (including GPS!). The only tools the crew has to navigate with are paper maps and their magnetic compass. Luckily, expedition leader Chris Fischer remembers that the ship traveled 20 miles directly west, then turned 90° north and traveled for another 20 miles.

Pretend you are an OCEARCH crewmember and explain how you would use your knowledge of geometry to navigate the ship back to its starting location. *Hint: Draw a picture!



Since this is a right triangle, Chris knows if they travel southeast at a 45° angle, they will return to their starting point!

The OCEARCH crew also uses angles to analyze shark migration patterns. For example, researchers want to know how many sharks have been within a certain degree (45° northeast to be exact) of coastline relative to Jacksonville, Florida. The figure below shows that four sharks have pinged in within 45° northeast of Jacksonville, Florida.

In Class Activity – Fritz the Tiger Shark

(10 – 20 minutes; optional)

Materials: Students will need a protractor and a pencil.

This is a migratory pattern from Fritz, a tiger shark being tracked by OCEARCH researchers. As you can see, Fritz's migratory pattern produced a triangle! Students should further investigate this strange pattern using the handout provided on the following page.

<u>Answers to Worksheet</u>

b= approximately 45˚

c= approximately 46˚

1. a= approximately 89˚

2. Yes! 89 + 45 + 46 = 180˚
3. 46˚
4. 89˚

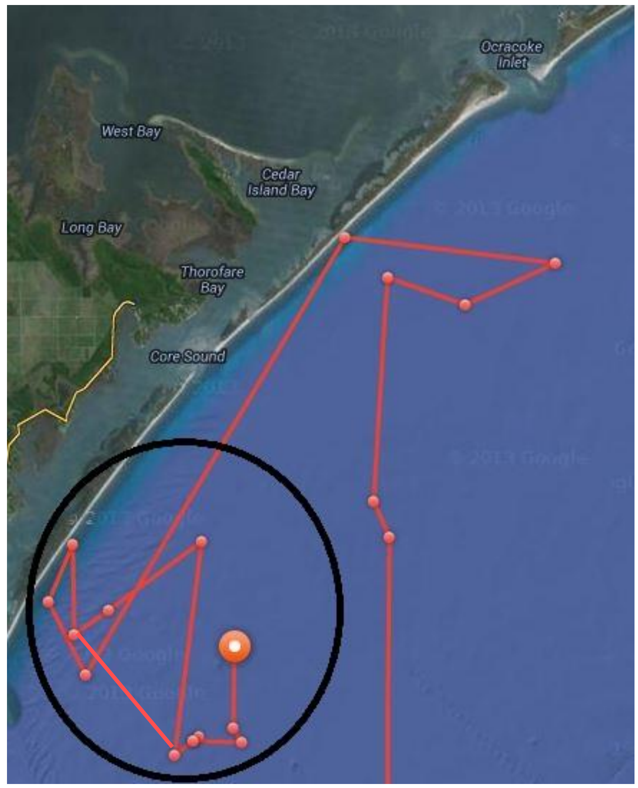
Fritz the Tiger Shark

Name: ______________________________________

Date: ____

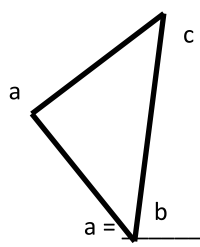
Instructions

This is a migratory pattern from Fritz, a tiger shark being tracked by OCEARCH researchers. As you can see, Fritz's migratory pattern produced a triangle! Answer the questions below referring to Fritz's migratory pattern.



1. Just by looking at the map, what type of triangle do you think Fritz made?

2. Find each angle using a protractor.



a = ________

b = ________

c = ________

3. Do the angles add up to 180˚?

Geometry – Practice Problems

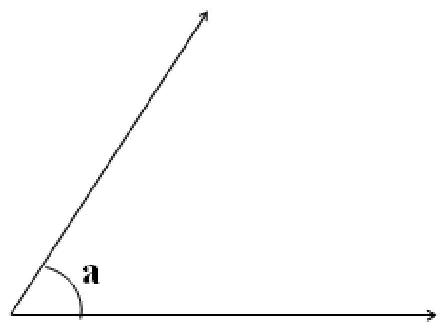
Name: ____

Date: ____

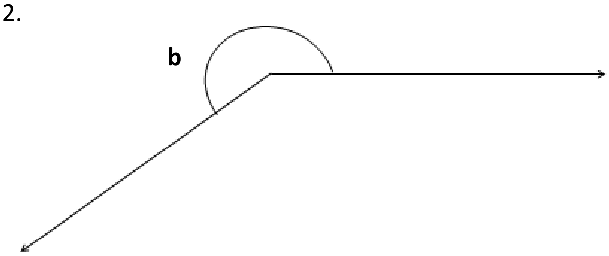
Instructions

Use a protractor to measure the following angles:

1.



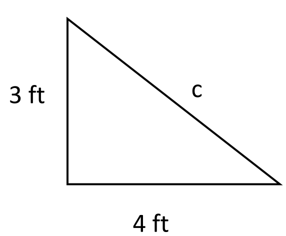
2.



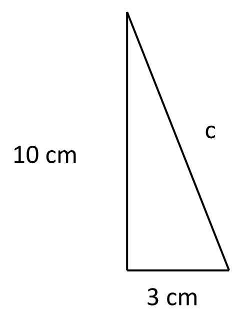
3. If an angle is 40°, what is its complementary angle?

4. If an angle is 98°, what is its supplementary angle?

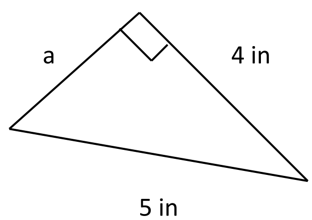
5. Use the Pythagorean Theorem to find the hypotenuse of this triangle.



3. Use the Pythagorean Theorem to find the hypotenuse of this triangle.



4. What is the length of leg “a”?



5. Is a triangle with the following measurements a right triangle?

a = 18 in
b = 23 in
c = 34 in

6. Is a triangle with the following measurements a right triangle?

a = 9 cm
b = 40 cm
c = 41 cm

Activity 1. Shark Measurements

(20 – 30 minutes)

Introduction

This activity is intended to provide students with the opportunity to use angles in real situations. Taxonomists use morphometrics (type of study used to analyze the size and shape of physical features) to classify species.

Materials

- Worksheet
- Writing utensil
- Protractor
- Calculator (optional)

Instructions

Have the students use the following image of a great white shark to (a) measure, (b) classify, and solve for the complementary (c) and supplementary (d) angles of each angle. If an angle does not have a complementary or supplementary angle, the students can write "none".

Answers

1. a: *140˚* b: *obtuse* c: *none* d: *40˚*
2. a: *115˚* b: *obtuse* c: *none* d: *65˚*
3. a: *117˚* b: *obtuse* c: *none* d: *63˚*
4. a: *120˚* b: *obtuse* c: *none* d: *60˚*
5. a: *76˚* b: *acute* c: *14˚* d: *104˚*
6. a: *131˚* b: *obtuse* c: *none* d: *49˚*
7. a: *25˚* b: *acute* c: *65˚* d: *155˚*
8. a: *90˚* b: *right* c: *none* d: *90˚*
9. a: *62˚* b: *acute* c: *28˚* d: *118˚*

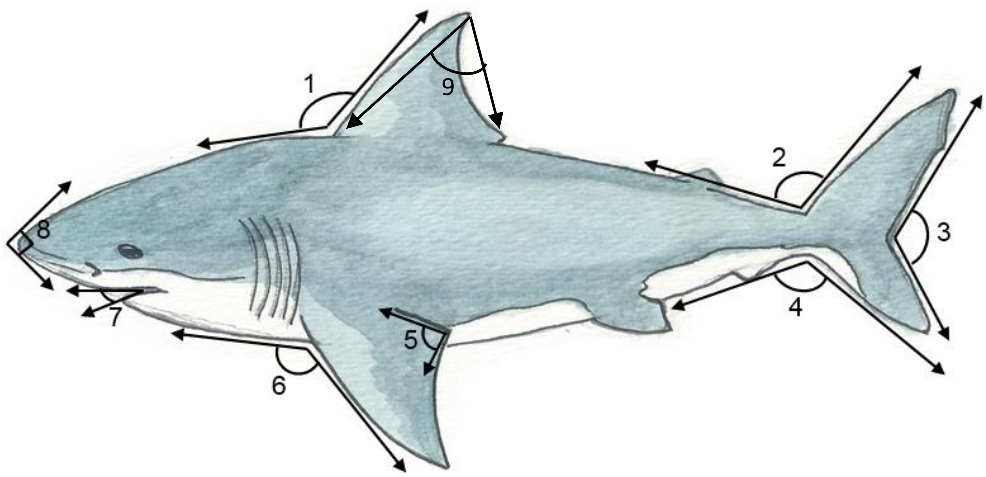
Activity 1. Shark Measurements

Name: ______________________________

Date: ________________________________

Instructions

Use the following image to (a) measure, (b) classify, and solve for the (c) complementary and (d) supplementary of each angle. If an angle does not have a complementary or supplementary angle, write "none".



1. a: ____________________

b: ____________________

c: ____________________

d: ____________________

2. a: ____________________

b: ____________________

c: ____________________

d: ____________________

3. a: ____________________

b: ____________________

c: ____________________

d: ____________________

4. a: ____________________

b: ____________________

c: ____________________

d: ____________________

5. a: ____________________

b: ____________________

c: ____________________

d: ____________________

6. a: ____________________

b: ____________________

c: ____________________

d: ____________________

7. a: ____________________

b: ____________________

c: ____________________

d: ____________________

8. a: ____________________

b: ____________________

c: ____________________

d: _____________________

9. a:

____

b: _____________________

c: _____________________

d: _____________________

Geometry

Activity 2. Shark Stories

(45 – 60 minutes or take home assignment)

Introduction

This activity will allow students to use their knowledge of angles in a creative way while coming up with scientific reasons to describe shark migration patterns.

Materials

- Computer with internet access
- Lined paper
- Writing utensil
- Protractor
- Access to printer (optional)

Instructions

Give students time to get familiar with the OCEARCH website and Global Shark Tracker™ (www.ocearch.com).

Students will choose one shark from the Global Shark Tracker™ and zoom in on its last 10 pings. The student will then have to measure each angle the shark turned and describe the journey in a short story.

Example: *"After travelling north for 10 miles, Lydia sensed a school of tuna in the far distance. She immediately turned 28° left and quickly continued northwest until she met up with the fish."*

Notes:

- Students must include the angle measurement of the shark's turn in their story as well as a screenshot (or neatly drawn map) with the angles labeled. This will make things easier to grade.
- There are no wrong answers when describing reasons for the shark's movements. If students have trouble coming up with their own scientific reasons, provide the following examples:
    - Following the migration paths of their prey
    - Travelling to breeding or nursery sites
    - Inclement weather
    - Ship traffic