Christina School District Assignment Board

Grade Level: 12th

Week 2: of April 13, 2020

		Day 1	Day 2	Day 3	Day 4
ELA		*Satire is a genre of literature that uses wit for the purpose of social criticism. Satire ridicules problems in society, government, businesses, and individuals in order to bring attention to certain vices, and abuses, as well as to lead to improvements.* ------------------------- *Read the article 'How Bad for The Environment Can Throwing Away One Plastic Bottle Be?' 30 Million People Wonder. "As you read underline/mark words and phrases that support the definition of satire and identify the method of satire the author uses (sarcasm, irony, humor, exaggeration, ridicule or*	*Answer the questions.*	*Create a list of 5-8 shows. Are any of them considered to be satirical? Watch an episode of one of the shows, in a brief written response identify and summarize the show/episode, explain why it is considered a satire, what is being critiqued, what are the satirical devices used, what is the call to action of society identified in the show. If you do not have a satirical show on your list watch an episode of the Simpsons and complete the same activity.*	*Think of an object, household product, or rule or expectation in your home. Create a short satirical commentary or commercial. What are you critiquing or making fun of ? What do you want us or your family to do differently?*

Christina School District Assignment Board

			word play).			
Math	**IM4**		*Geometric & Other Sequences* Review Concept Summary: Geometric Sequences (attached), and complete Worksheet 1 #1-3. (attached)	Complete Worksheet #2 #1-5 (attached). Reference Concept Summary if needed.	Complete Worksheet #2 #6-11 (attached). Reference Concept Summary if needed.	Complete Worksheet #3 #1-2(attached). Reference Concept Summary if needed.
	PreCalc		*Unit Circle and Reference Angles* Review 4.1 PP notes and examples to complete Angular & Linear Speed Trigonometry WS #1 & 2. (attached)	Use 4.1 PP notes and examples to complete Angular & Linear Speed Trigonometry WS #3 & 4.. (attached)	Use 4.1 PP notes and examples to complete Angular & Linear Speed Trigonometry WS #5, 6 & 7.. (attached)	Use 4.1 PP notes and examples to complete Angular & Linear Speed Trigonometry WS #8 & 9.. (attached)
	Calc		*Modeling & Optimization*			
Science			**Kinematics: Scalars and Vectors:** Read article. Highlight, underline, and/or annotate for understanding. Do your best to answer included question(s). Write down your best answer(s).	**Distance and Displacement:** Read article. Highlight, underline, and/or annotate for understanding. Do your best to answer included question(s). Write down your best answer(s).	**Speed and Velocity (part 1):** Read 1st part of article [1 page]. Highlight, underline, and/or annotate for understanding. Do your best to answer included question(s). Write down your best answer(s).	**Speed and Velocity (part 2):** Read 2nd part of article [2 pages]. Highlight, underline, and/or annotate for understanding. Do your best to answer included question(s). Write down your best answer(s).

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Social Studies		Complete Activity 1 from the document titled, “Maine Explosion”	Complete Activity 2 from the document titled, “Maine Explosion”	Complete Activity 3, the Guiding Questions and Graphic Organizer for Document A from the document titled, “Maine Explosion”	Complete Activity 3, the Guiding Questions and Graphic Organizer for Document B and the 2 questions on the bottom of the graphic organizer from the document titled, “Maine Explosion” NOTE: Activity 4 will be on next week’s CSD Assignment Board

'How Bad For The Environment Can Throwing Away One Plastic Bottle Be?' 30 Million People Wonder”

A local resident discards a plastic bottle—just as he has done his whole life—with no perceivable effect on the environment.

WASHINGTON—Wishing to dispose of the empty plastic container, and failing to spot a recycling bin nearby, an estimated 30 million Americans asked themselves Monday how bad throwing away a single bottle of water could really be.

"It's fine, it's fine," thought Maine native Sheila Hodge, echoing the exact sentiments of Chicago-area resident Phillip Ragowski, recent Florida transplant Margaret Lowery, and Kansas City business owner Brian McMillan, as they tossed the polyethylene terephthalate object into an awaiting trash can. "It's just one bottle. And I'm usually pretty good about this sort of thing."

"Not a big deal," continued roughly one-tenth of the nation's population.

According to the inner monologue of millions upon millions of citizens, while not necessarily ideal, throwing away one empty bottle probably wouldn't make that much of a difference, and could even be forgiven, considering how long they had been carrying it around with them, the time that could be saved by just tossing it out right here, and the fact that they had bicycled to work once last July.

In addition, pretty much the entire states of Missouri and New Mexico calmly reassured themselves Monday that they definitely knew better than to do something like this, but admitted that hey, nobody is perfect, and at least they weren't still using those horrible aerosol cans, or just throwing garbage directly on the ground.

All agreed that disposing of what would eventually amount to 50 tons of thermoplastic polymer resin wasn't the end of the world.

"It's not like I don't care, because I do, and most of the time I don't even *buy* bottled water," thought Missouri school teacher Heather Delamere, the 450,000th caring and progressive individual to have done so that morning, and the 850,000th to have purchased the environmentally damaging vessel due to being thirsty, in a huge rush, and away from home. "It's really not worth beating myself up over."

"What's one little bottle in the grand scheme of things, you know?" added each and every single one of them.

Monday's plastic-bottle-related dilemma wasn't the only environmental quandary facing millions of citizens across the country. An estimated 20 million men and women wondered how wasteful leaving a single lightbulb on all night really was, while more than 40 million Americans asked themselves if anyone would actually notice if they just turned up the heat a few degrees instead of walking all the way downstairs and getting another blanket.

Likewise, had they not been so tired, and busy, and stressed, citizens making up the equivalent of three major metropolitan areas told reporters that they probably wouldn't have driven their minivans down to the corner store.

"Relax," thousands upon thousands of Americans quietly whispered to themselves as they tossed two articles of clothing into an empty washing machine and turned it on. "What are you so worried about?"

Instructions: After reading the article answer the questions using evidence from the text.

1. What makes this article satirical? Use evidence from the text to support your response.

   ____

   ____

   ____

2. What aspect of society is being criticized in the article how do you know?

   ____

   ____

   ____

3. What satirical devices or methods does the author employ to show his disdain? Use evidence from the text to support your response.

   ____

   ____

   ____

4. What do you think the author’s message or call to action is for society?

   ____

   ____

   ____

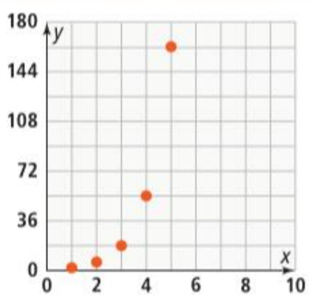
IM4 – Week of April 13th

Geometric & Other Sequences

CONCEPT SUMMARY

	Explicit formula	Recursive formula
ALGEBRA	$a_n = a_1(r)^{n-1}$ nth term, first term, common ratio **Initial condition:** a_1 is the first term	$a_n = r(a_{n-1})$ nth term, common ratio, previous term
NUMBERS	$a_n = 2(3)^{n-1}$ $a_1 = 2$	$a_n = 3(a_{n-1})$

GRAPH

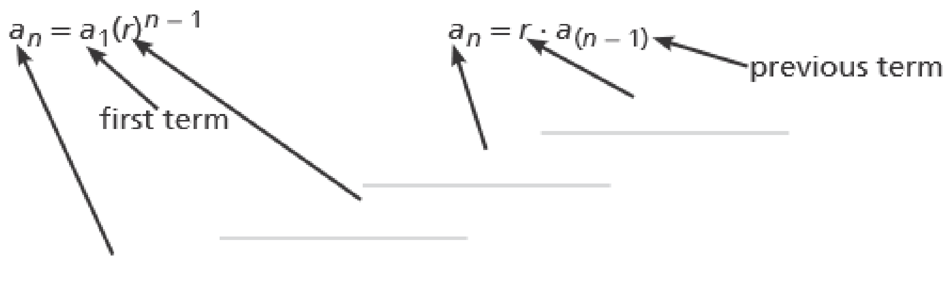


Geometric Sequences Worksheet 1

1. Use words to label the parts of the formulas for the geometric sequences shown. Some have been done for you.

Explicit formula **Recursive formula**

Initial condition: $a_1 =$ ____________



2. Gina incorrectly wrote the explicit formula for the geometric sequence 27, 36, 48, 64, $85\frac{1}{3}$, … Find and correct her error.

The first term is 27. The common ratio is $\frac{3}{4}$.

$a_n = a_1(r)^{n-1}$ $a_n = 27\left(\frac{3}{4}\right)^{n-1}$

The explicit formula is $a_n = 27\left(\frac{3}{4}\right)^{n-1}$.

3. Write the explicit formula for the geometric sequence 1.12, 2.8, 7, 17.5, 43.75, … Then find the value of the 7th term.

$\frac{2.8}{1.12} = \frac{7}{2.8} = \frac{\_\_\_}{7} = \frac{\_\_\_}{17.5} = -$ Find the common ratio.

The first term is ____________. Identify the first term.

$a_n =$ ______$\left(-\right)^{n-1}$ Substitute the values for a_1 and r.

$a_7 =$ ______$\left(-\right)^{7-1}$ Find the 7th term.

$a_7 =$ ____________ Simplify.

The 7th term in this geometric sequence is ____________.

Geometric Sequences Worksheet 2

Is the sequence a geometric sequence? If it is, give the common ratio.

1. 1, 49, 98, 147, ...

2. 4, 12, 36, 108, ...

3. 16, 12, 9, $\frac{27}{4}$, ...

Write a recursive formula and an explicit formula for each geometric sequence.

4. 9, 18, 36, 72, ...

Recursive:

Explicit:

5. 540, 180, 60, 20, ...

Recursive:

Explicit:

Write a recursive formula for each explicit formula.

6. $a_n = -4 \cdot 3^{n-1}$

7. $a_n = 5 \cdot \left(\frac{2}{3}\right)^{n-1}$

Write an explicit formula for each recursive formula.

8. $a_1 = 50$
$a_n = 0.5a_{n-1}$

9. $a_1 = 2$
$a_n = 6a_{n-1}$

10. How are geometric sequences and exponential functions alike? How are they different?

11. The number of subscribers for an online periodical doubles each month. The first month of publication, there were only 100 subscribers. How many subscribers will there be in one year?

1. Find the common difference in each sequence. Then use the differences of the six sequences to create a geometric sequence.

a. $\frac{1}{9}, \frac{4}{9}, \frac{7}{9}, \frac{10}{9}, \frac{13}{9}, \ldots$

b. $-84, -3, 78, 159, \ldots$

c. $17, 18, 19, 20, 21, \ldots$

d. $-52, -25, 2, 29, 56, \ldots$

e. $-23, -20, -17, -14, -11, \ldots$

f. $-2, 7, 16, 25, 34, \ldots$

The geometric sequence is ______________________

What is the explicit formula for the geometric sequence?

2. Find the common ratio in each sequence. Then use the six ratios to create an arithmetic sequence.

a. $8, -28, 98, -343, 1{,}200.5, \ldots$

b. $\frac{2}{3}, \frac{5}{3}, \frac{25}{6}, \frac{125}{12}, \frac{625}{24}, \ldots$

c. $4, -6, 9, -\frac{27}{2}, \frac{81}{4}, \ldots$

d. $\frac{4}{81}, \frac{2}{9}, 1, \frac{9}{2}, \frac{81}{4}, \ldots$

e. $40, 20, 10, 5, \frac{5}{2}, \ldots$

f. $4, 26, 169, 1{,}098.5, \ldots$

The arithmetic sequence is ________________________

What is the explicit formula for the arithmetic sequence?

4.1 Angles

As derived from the Greek language, the word **trigonometry** means “measurement of triangles.” Initially, trigonometry dealt with relationships among the sides and angles of triangles and was used in the development of astronomy, navigation, and surveying.

With the development of calculus and the physical sciences in the 17th century, a different perspective arose—one that viewed the classic trigonometric relationships as *functions* with the set of real numbers as their domains.

4.1 Angles

Consequently, the applications of trigonometry expanded to include a vast number of physical phenomena involving rotations and vibrations, including the following.

- sound waves
- light rays
- planetary orbits
- vibrating strings
- pendulums
- orbits of atomic particles

4.1 Angles

The approach in this text incorporates *both* perspectives, starting with angles and their measure.

An **angle** is determined by rotating a ray (half-line) about its endpoint. The starting position of the ray is the **initial side** of the angle, and the position after rotation is the **terminal side,** as shown in Figure 4.1.

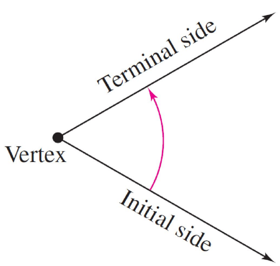


Figure 4.1

4.1 Angles

The endpoint of the ray is the **vertex** of the angle. This perception of an angle fits a coordinate system in which the origin is the vertex and the initial side coincides with the positive *x*-axis. Such an angle is in **standard position,** as shown in Figure 4.2.

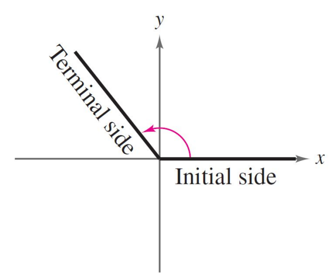


Figure 4.2

4.1 Angles

Positive angles are generated by counterclockwise rotation, and **negative angles** by clockwise rotation, as shown in Figure 4.3.

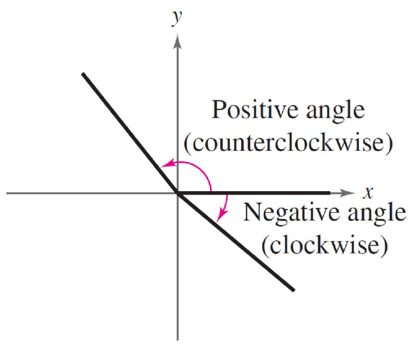


Figure 4.3

4.1 Angles

Angles are labeled with Greek letters such as α (alpha), β (beta), and (theta), as well as uppercase letters such as *A*,*B*, and *C*. In Figure 4.4, note that angles α and β have the same initial and terminal sides. Such angles are **coterminal.**

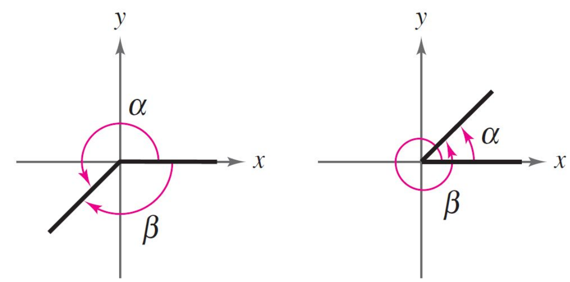
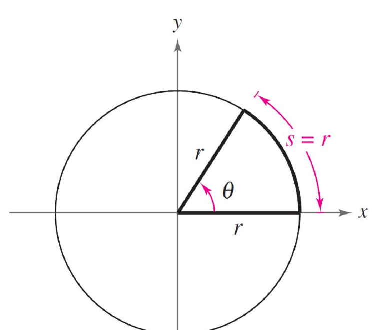


Figure 4.4

4.1 Radian Measure

The **measure of an angle** is determined by the amount of rotation from the initial side to the terminal side. One way to measure angles is in *radians*.

This type of measure is especially useful in calculus. To define a radian, you can use a **central angle** of a circle, one whose vertex is the center of the circle, as shown in Figure 4.5.



Arc length = radius when $\theta = 1$ *radian.*

Figure 4.5

4.1 Radian Measure

Definition of Radian

One **radian** (rad) is the measure of a central angle θ that intercepts an arc s equal in length to the radius r of the circle. (See Figure 4.5.) Algebraically this means that

$$\theta = \frac{s}{r}$$

where θ is measured in radians.

Because the circumference of a circle is $2\pi r$ units, it follows that a central angle of one full revolution (counterclockwise) corresponds to an arc length of

$$s = 2\pi r.$$

4.1 Radian Measure

Moreover, because

$$2\pi \approx 6.28$$

there are just over six radius lengths in a full circle, as shown in Figure 4.6. Because the units of measure for and are the same, the ratio

$$\frac{s}{r}$$

has no units—it is simply a real number.

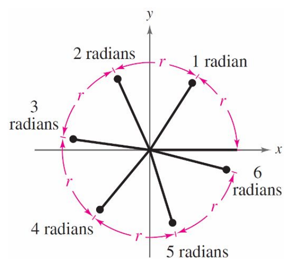


Figure 4.6

4.1 Radian Measure

The four quadrants in a coordinate system are numbered I, II, III, and IV. Figure 4.8 shows which angles between 0 and 2π lie in each of the four quadrants. Note that angles between 0 and $\pi/2$ and are **acute** and that angles between $\pi/2$ and π are **obtuse.**

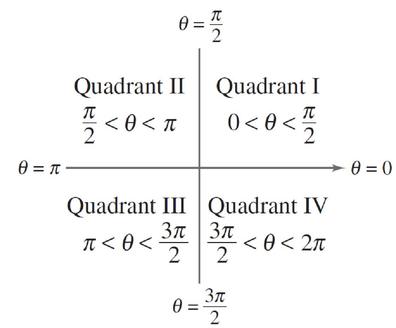


Figure 4.8

4.1 Radian Measure

Two angles are coterminal when they have the same initial and terminal sides. For instance, the angles 0 and 2π are coterminal, as are the angles $\pi/6$ and $13\pi/6$.

A given angle θ has infinitely many coterminal angles. For instance $\theta = \pi/6$, is coterminal with

$\frac{\pi}{6} + 2n\pi$e is *n* an integer.

4.1 Example 1 – *Sketching and Finding Conterminal Angles*

a. For the positive angle $\theta = \frac{13\pi}{6}$btract 2π to obtain a coterminal angle.

$$\frac{13\pi}{6} - 2\pi = \frac{\pi}{6}$$

See Figure 4.9

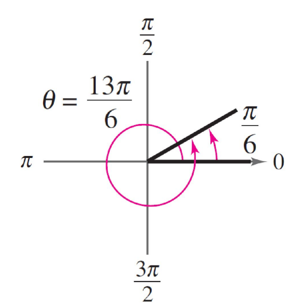


Figure 4.9

4.1 Example 1 – *Sketching and Finding Conterminal Angles*

b. For the positive angle $\theta = \frac{3\pi}{4}$, subtract 2*π* to obtain a coterminal angle.

$$\frac{3\pi}{4} - 2\pi = -\frac{5\pi}{4}$$

See Figure 4.10

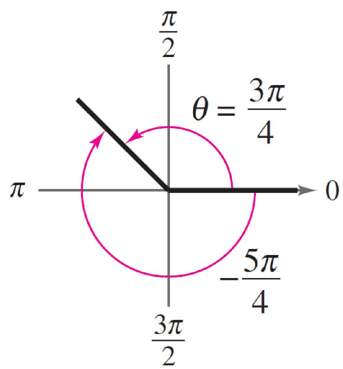


Figure 4.10

4.1 Example 1 – *Sketching and Finding Conterminal Angles*

c. For the negative angle $\theta = -\frac{2\pi}{3}$ld 2*π* to obtain a coterminal angle.

$$-\frac{2\pi}{3} + 2\pi = \frac{4\pi}{3}$$

See Figure 4.11

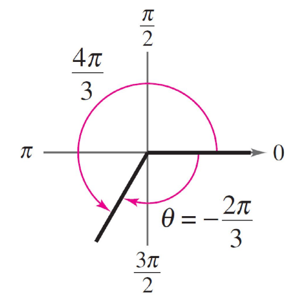


Figure 4.11

4.1 Degree Measure

A second way to measure angles is in terms of **degrees,** denoted by the symbol **°**. A measure of one degree (1°) is equivalent to a rotation of $\frac{1}{360}$ of a complete revolution about the vertex. To measure angles, it is convenient to mark degrees on the circumference of a circle, as shown in Figure 4.12.

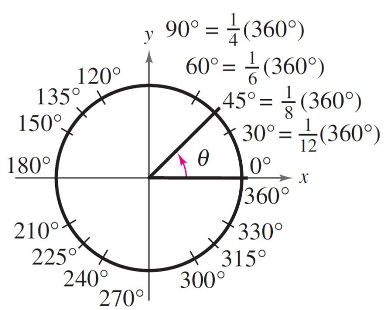


Figure 4.12

4.1 Degree Measure

So, a full revolution (counterclockwise) corresponds to 360° a half revolution to 180°, a quarter revolution to 90° and so on.

Because 2*π* radians corresponds to one complete revolution, degrees and radians are related by the equations

$$360° = 2\pi \text{ rad} \qquad \text{and} \qquad 180° = \pi \text{ rad}.$$

4.1 Degree Measure

From the second equation, you obtain

$$1° = \frac{\pi}{180}\text{ rad} \quad \text{and} \quad 1 \text{ rad} = \frac{180°}{\pi}$$

which lead to the following conversion rules.

Conversions Between Degrees and Radians

1. To convert degrees to radians, multiply degrees by $\frac{\pi \text{ rad}}{180°}$.
2. To convert radians to degrees, multiply radians by $\frac{180°}{\pi \text{ rad}}$.

To apply these two conversion rules, use the basic relationship π rad $= 180°$. (See Figure 4.13.)

4.1 Degree Measure

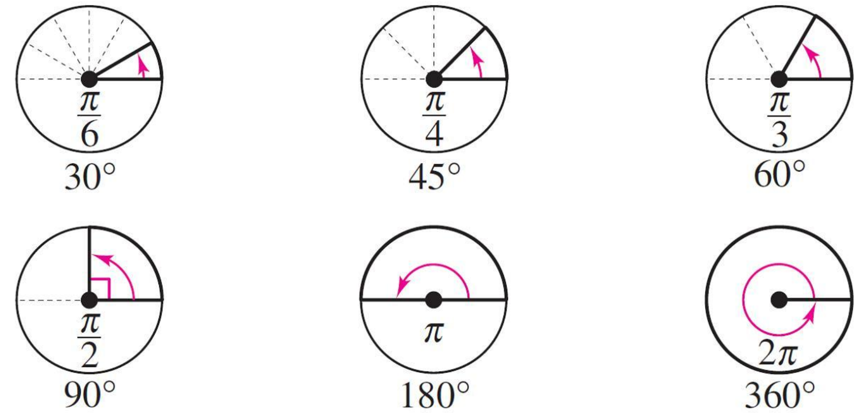


Figure 4.13

4.1 Example 2 – *Converting From Degrees to Radians*

a. $135° = (135\ \text{deg})\left(\frac{\pi \text{ rad}}{180\ \text{deg}}\right) = \frac{3\pi}{4}$ radians — Multiply by $\frac{\pi}{180}$.

b. $540° = (540\ \text{deg})\left(\frac{\pi \text{ rad}}{180\ \text{deg}}\right) = 3\pi$ radians — Multiply by $\frac{\pi}{180}$.

c. $-270° = (-270\ \text{deg})\left(\frac{\pi \text{ rad}}{180\ \text{deg}}\right) = -\frac{3\pi}{2}$ radians — Multiply by $\frac{\pi}{180}$.

4.1 Degree Measure

Two positive angles α and β are **complementary** (complements of each other) when their sum is 90° (or $\pi/2$)

Two positive angles are **supplementary** (supplements of each other) when their sum is 180° (or π). (See Figure 4.14.)

Complementary angles *Supplementary angles*

Figure 4.14

4.1 Example 4 – *Complementary and Supplementary Angles*

If possible, find the complement and supplement of each angle.

a. 72° **b.** 148° **c.** $\frac{2\pi}{5}$ **d.** $\frac{4\pi}{5}$

Solution:

a. The complement is

90° – 72° = 18°.

The supplement is

180° – 72° = 108°.

4.1 Example 4 – *Solution*

cont'd

b. Because 148° is greater than 90° it has no complement. (Remember that complements are *positive* angles.)

The supplement is

180° – 148° = 32°.

c. The complement is

$$\frac{\pi}{2} - \frac{2\pi}{5} = \frac{5\pi}{10} - \frac{4\pi}{10} = \frac{\pi}{10}.$$

The supplement is

$$\pi - \frac{2\pi}{5} = \frac{5\pi}{5} - \frac{2\pi}{5} = \frac{3\pi}{5}.$$

4.1 Example 4 – *Solution*

cont'd

d. Because $4\pi/5$ is greater than $\pi/2$ it has no complement. The supplement is

$$\pi - \frac{4\pi}{5} = \frac{5\pi}{5} - \frac{4\pi}{5} = \frac{\pi}{5}.$$

4.1 Linear and Angular Speed

The *radian measure* formula

$$\theta = \frac{s}{r}$$

can be used to measure arc length along a circle.

Arc Length

For a circle of radius r, a central angle θ intercepts an arc of length s given by

$s = r\theta$ Length of circular arc

where θ is measured in radians. Note that if $r = 1$, then $s = \theta$, and the radian measure of θ equals the arc length.

4.1 Example 5 – *Finding Arc Length*

A circle has a radius of 4 inches. Find the length of the arc intercepted by a central angle of 240° as shown in Figure 4.15.

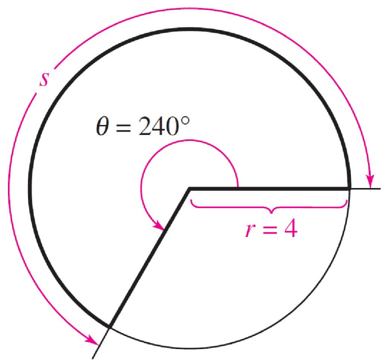


Figure 4.15

4.1 Example 5 – *Solution*

To use the formula

$$s = r\theta$$

first convert 240° to radian measure.

$$240^\circ = (240 \text{ deg})\left(\frac{\pi \text{ rad}}{180 \text{ deg}}\right) = \frac{4\pi}{3} \text{ radians}$$

Then, using a radius of $r = 4$ inches, you can find the arc length to be

$$s = r\theta = 4\left(\frac{4\pi}{3}\right) = \frac{16\pi}{3} \approx 16.76 \text{ inches.}$$

Note that the units for $r\theta$ are determined by the units for r because θ is given in radian measure and therefore has no units.

4.1 Linear and Angular Speed

Linear and Angular Speed

Consider a particle moving at a constant speed along a circular arc of radius r. If s is the length of the arc traveled in time t, then the **linear speed** of the particle is

$$\text{Linear speed} = \frac{\text{arc length}}{\text{time}} = \frac{s}{t}.$$

Moreover, if θ is the angle (in radian measure) corresponding to the arc length s, then the **angular speed** of the particle is

$$\text{Angular speed} = \frac{\text{central angle}}{\text{time}} = \frac{\theta}{t}.$$

Linear speed measures how fast the particle moves, and angular speed measures how fast the angle changes.

4.1 Example 6 – *Finding Linear Speed*

The second hand of a clock is 10.2 centimeters long, as shown in Figure 4.16. Find the linear speed of the tip of this second hand.

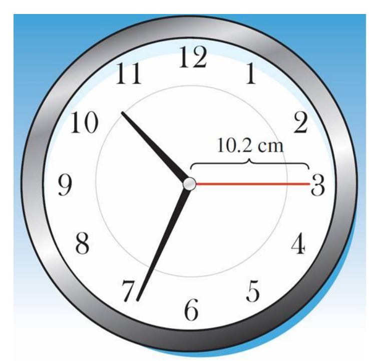


Figure 4.16

4.1 Example 6 – *Solution*

In one revolution, the arc length traveled is

$s = 2\pi r$

$= 2\pi(10.2)$ Substitute for r.

$= 20.4\pi$ centimeters.

The time required for the second hand to travel this distance is

t = 1 minute = 60 seconds.

4.1 Example 6 – *Solution* cont'd

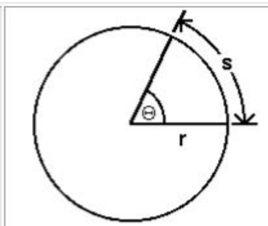
So, the linear speed of the tip of the second hand is

$$\text{Linear speed} = \frac{s}{t}$$

$$= \frac{20.4\pi \text{ centimeters}}{60 \text{ seconds}}$$

$$\approx 1.07 \text{ centimeters per second.}$$

Angular and Linear Speed Trigonometry

Definitions of Symbols		Relationships
C = circumference r = radius d = diameter (d = 2r) s = arc length Θ = central angle *in radians* π = approximately 3.14 **Formulas** C = 2πr = πd and Θ = s/r		1 revolution = 1 turn around circle **(definition)** 1 revolution = 2π radians (***angular*** measurement) 1 revolution = 2πr (***linear*** measurement, i.e. **distance**)
NOTES:	when s = r, Θ = 1 radian	when s = C, Θ = 2π radians

EXAMPLES:

1. A phonograph record has a radius of 3 inches and revolves at 45 RPM. Find the linear speed of the outside edge of the record.

Solution: using the fact that 1 revolution = 2πr:

$$\left(\frac{45 \text{ revolutions}}{1\ \textit{minute}}\right) = \left(\frac{45 \text{ revolutions}}{1\ \textit{minute}}\right)\cdot\left(\frac{2\pi(3)\ \textit{inches}}{1 \text{ revolution}}\right) = \left(848.2\ \frac{\text{inches}}{\text{minute}}\right)$$

Angular and Linear Speed Trigonometry

2. A car is traveling 60 mph. The diameter of the wheels is 3 ft.
   a) Find the number of revolutions per minute the wheels are rotating.

Strategy: We need to convert $\frac{\text{mile}}{\text{hour}} \rightarrow \frac{\text{feet}}{\text{hour}} \rightarrow \frac{\text{feet}}{\text{minute}} \rightarrow \frac{\text{revolutions}}{\text{minute}}$
so, we need three conversion ratios

$$\left(60\ \frac{\text{miles}}{\text{hour}}\right) = \left(60\ \frac{\text{miles}}{\text{hour}}\right)\cdot\left(\frac{5280 \text{ feet}}{1 \text{ mile}}\right) \quad \text{(since 1 mile = 5280 feet)}$$

$$\left(60\ \frac{\text{miles}}{\text{hour}}\right)\cdot\left(\frac{5280 \text{ feet}}{1 \text{ mile}}\right)\cdot\left(\frac{1 \text{ hour}}{60\ \textit{minutes}}\right) \quad \text{(since 1 hour = 60 minutes)}$$

$$\left(60\ \frac{\text{miles}}{\text{hour}}\right)\cdot\left(\frac{5280 \text{ feet}}{1 \text{ mile}}\right)\cdot\left(\frac{1 \text{ hour}}{60\ \textit{minutes}}\right)\cdot\left(\frac{1\ \textit{revolution}}{2\pi(1.5) \text{ feet}}\right) = \left(560.2\ \frac{\text{revolutions}}{\text{minute}}\right)$$

4. b) What's the angular speed of the wheels in radians per minute?

$$\left(560.2\ \frac{\text{revolutions}}{\textit{minute}}\right)\cdot\left(\frac{2\pi\ \textit{radians}}{1 \text{ revolution}}\right) = \left(3519.8\ \frac{\text{radians}}{\text{minute}}\right) \quad \text{(since 1 rev. = } 2\pi \text{ radians)}$$

Angular and Linear Speed Worksheet

Directions for 1 and 2: Use the definition of radian to solve #1 and definition of linear speed to solve #2.

$$\theta = \frac{s}{r} \qquad speed = \frac{distance}{time}$$

1. A highway curve, in the shape of an arc of a circle is .25 miles. The direction of the highway changes 45 degrees from one end of the curve to the other. Find the radius of the circle in feet that the curve follows.

2. The radius of the Earth is 4000 miles. What is the linear velocity of a point near the equator? (Hint, the earth revolves every 24 hours)

Angular and Linear Speed Worksheet

Directions for 3 -- 8: Use the use unit analysis to answer the following questions.

3. To the nearest revolution, how many times will a bicycle wheel measuring 26 inches in diameter turn if it is ridden for one mile?

4. If the wheel of the bicycle in the previous problem turns at a constant rate of 2.5 rev/sec, what is its linear speed in ft/s? How about in mph?

Angular and Linear Speed Worksheet

5. If a wheel with a 16 inch diameter is turning at 12 rev/sec, what is the linear speed of a point on its rim in ft/min?

6. The crankshaft pulley of a car has a radius of 10.5 cm and turns at 6π rad/sec. What is the linear speed of the pulley?

7. Find to the nearest cm/sec the linear speed of a point on the rim of a wheel of radius 24 cm turning at an angular speed of $\frac{17\pi}{12}$ rad/sec.

Angular and Linear Speed Worksheet

8. The linear speed of a point 15.3 cm from the center of a phonograph record is 17π cm/sec. What is the angular speed of the record in rad/sec?

9. Find the coordinates of the final position of a point P moving counterclockwise in uniform circular motion at $\omega = \frac{\pi}{3}$ rad/sec if P starts at the point (5 , 0) and moves for 14 seconds.

Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations. Kinematics is a branch of mechanics. The goal of any study of kinematics is to develop sophisticated mental models that serve to describe (and ultimately, explain) the motion of real-world objects.

In these lessons, we will investigate the words used to describe the motion of objects. That is, we will focus on the *language* of kinematics. The hope is to gain a comfortable foundation with the language that is used throughout the study of mechanics. We will study such terms as scalars, vectors, distance, displacement, speed, velocity and acceleration. These words are used with regularity to describe the motion of objects. Your goal should be to become very familiar with their meaning.

Scalars and Vectors

Physics is a mathematical science. The underlying concepts and principles have a mathematical basis. Throughout the course of our study of physics, we will encounter a variety of concepts that have a mathematical basis associated with them. While our emphasis will often be upon the conceptual nature of physics, we will give considerable and persistent attention to its mathematical aspect.

The motion of objects can be described by words. Even a person without a background in physics has a collection of words that can be used to describe moving objects. Words and phrases such as *going fast*, *stopped*, *slowing down*, *speeding up*, and *turning* provide a sufficient vocabulary for describing the motion of objects. In physics, we use these words and many more. We will be expanding upon this vocabulary list with words such as *distance*, *displacement*, *speed*, *velocity*, and *acceleration*. As we will soon see, these words are associated with mathematical quantities that have strict definitions. The mathematical quantities that are used to describe the motion of objects can be divided into two categories. The quantity is either a vector or a scalar. These two categories can be distinguished from one another by their distinct definitions:

- **Scalars** are quantities that are fully described by a magnitude (or numerical value) alone.
- **Vectors** are quantities that are fully described by both a magnitude and a direction.

Check Your Understanding

1. To test your understanding of this distinction, consider the following quantities listed below. Categorize each quantity as being either a vector or a scalar. Click the button to see the answer.

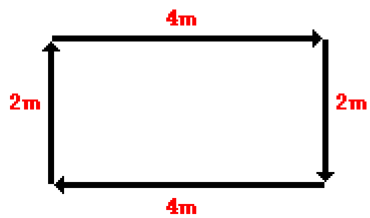
Quantity	Category
a. 5 m	
b. 30 m/sec, East	
c. 5 mi., North	
d. 20 degrees Celsius	
e. 256 bytes	
f. 4000 Calories	

Distance and Displacement

Distance and displacement are two quantities that may seem to mean the same thing yet have distinctly different definitions and meanings.

- **Distance** is a scalar quantity that refers to "how much ground an object has covered" during its motion.
- **Displacement** is a vector quantity that refers to "how far out of place an object is"; it is the object's overall change in position.

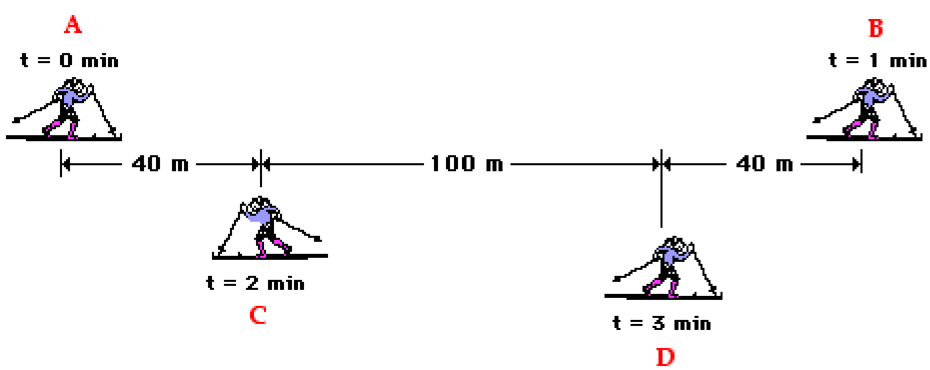
To test your understanding of this distinction, consider the motion depicted in the diagram below. A physics teacher walks 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North.



Even though the physics teacher has walked a total distance of 12 meters, her displacement is 0 meters. During the course of her motion, she has "covered 12 meters of ground" (distance = 12 m). Yet when she is finished walking, she is not "out of place" - i.e., there is no displacement for her motion (displacement = 0 m). Displacement, being a vector quantity, must give attention to direction. The 4 meters east *cancels* the 4 meters west; and the 2 meters south *cancels* the 2 meters north. Vector quantities such as displacement are *direction aware*. Scalar quantities such as distance are ignorant of direction. In determining the overall distance traveled by the physics teachers, the various directions of motion can be ignored.

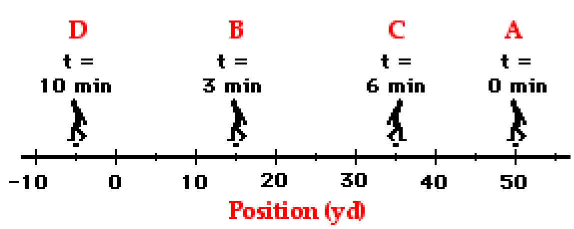
Now consider another example. The diagram below shows the position of a cross-country skier at various times. At each of the indicated times, the skier turns around and reverses the direction of travel. In other words, the skier moves from A to B to C to D.

Quick Quiz Use the diagram to determine the resulting displacement and the distance traveled by the skier during these three minutes.



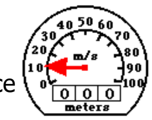
As a final example, consider a football coach pacing back and forth along the sidelines. The diagram below shows several of coach's positions at various times. At each marked position, the coach makes a "U-turn" and moves in the opposite direction. In other words, the coach moves from position A to B to C to D.

Quick Quiz What is the coach's resulting displacement and distance of travel?



To understand the distinction between distance and displacement, you must know the definitions. You must also know that a vector quantity such as displacement is *direction-aware* and a scalar quantity such as distance is *ignorant of direction*. When an object changes its direction of motion, displacement takes this direction change into account; heading the opposite direction effectively begins to *cancel* whatever displacement there once was.

Speed and Velocity (Day 3):



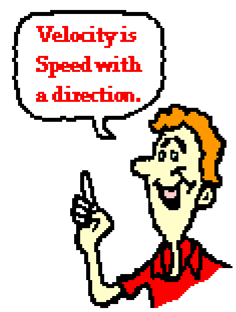
Just as distance and displacement have distinctly different meanings (despite their similarities), so do speed and velocity. **Speed** is a scalar quantity that refers to "how fast an object is moving." Speed can be thought of as the rate at which an object covers distance. A fast-moving object has a high speed and covers a relatively large distance in a short amount of time. Contrast this to a slow-moving object that has a low speed; it covers a relatively small amount of distance in the same amount of time. An object with no movement at all has a zero speed.

Velocity as a Vector Quantity

Velocity is a vector quantity that refers to "the rate at which an object changes its position." Imagine a person moving rapidly - one step forward and one step back - always returning to the original starting position. While this might result in a frenzy of activity, it would result in a zero velocity. Because the person always returns to the original position, the motion would never result in a change in position. Since velocity is defined as the rate at which the position changes, this motion results in zero velocity. If a person in motion wishes to maximize their velocity, then that person must make every effort to maximize the amount that they are displaced from their original position. Every step must go into moving that person further from where he or she started. For certain, the person should never change directions and begin to return to the starting position.

Velocity is a vector quantity. As such, velocity is *direction aware*. When evaluating the velocity of an object, one must keep track of direction. It would not be enough to say that an object has a velocity of 55 mi/hr. One must include direction information in order to fully describe the velocity of the object. For instance, you must describe an object's velocity as being 55 mi/hr, **east**. This is one of the essential differences between speed and velocity. Speed is a scalar quantity and does not *keep track of direction*; velocity is a vector quantity and is *direction aware*.

Determining the Direction of the Velocity Vector



The task of describing the direction of the velocity vector is easy. The direction of the velocity vector is simply the same as the direction that an object is moving. It would not matter whether the object is speeding up or slowing down. If an object is moving rightwards, then its velocity is described as being rightwards. If an object is moving downwards, then its velocity is described as being downwards. So an airplane moving towards the west with a speed of 300 mi/hr has a velocity of 300 mi/hr, west. Note that speed has no direction (it is a scalar) and the velocity at any instant is simply the speed value with a direction.

Calculating Average Speed and Average Velocity

As an object moves, it often undergoes changes in speed. For example, during an average trip to school, there are many changes in speed. Rather than the speed-o-meter maintaining a steady reading, the needle constantly moves up and down to reflect the stopping and starting and the accelerating and decelerating. One instant, the car may be moving at 50 mi/hr and another instant, it might be stopped (i.e., 0 mi/hr). Yet during the trip to school the person might average 32 mi/hr. The average speed during an entire motion can be thought of as the average of all speedometer readings. If the speedometer readings could be collected at 1-second intervals (or 0.1-second intervals or ...) and then averaged together, the average speed could be determined. Now that would be a lot of work. And fortunately, there is a shortcut. Read on.

The average speed during the course of a motion is often computed using the following formula:

$$\text{Average Speed} = \frac{\text{Distance Traveled}}{\text{Time of Travel}}$$

In contrast, the average velocity is often computed using this formula

$$\text{Average Velocity} = \frac{\Delta\,\text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

Let's begin implementing our understanding of these formulas with the following problem:

Q: While on vacation, Lisa Carr traveled a total distance of 440 miles. Her trip took 8 hours. What was her average speed?

To compute her average speed, we simply divide the distance of travel by the time of travel.

$$v = \frac{d}{t} = \frac{440\text{ mi}}{8\text{ hr}} = 55\text{ mi/hr}$$

That was easy! Lisa Carr averaged a speed of 55 miles per hour. She may not have been traveling at a constant speed of 55 mi/hr. She undoubtedly, was stopped at some instant in time (perhaps for a bathroom break or for lunch) and she probably was going 65 mi/hr at other instants in time. Yet, she averaged a speed of 55 miles per hour. The above formula represents a shortcut method of determining the average speed of an object.

Speed and Velocity (Day 4):

Average Speed versus Instantaneous Speed

Since a moving object often changes its speed during its motion, it is common to distinguish between the average speed and the instantaneous speed. The distinction is as follows.

- **Instantaneous Speed** - the speed at any given instant in time.
- **Average Speed** - the average of all instantaneous speeds; found simply by a distance/time ratio.

You might think of the instantaneous speed as the speed that the speedometer reads at any given instant in time and the average speed as the average of all the speedometer readings during the course of the trip. Since the task of averaging speedometer readings would be quite complicated (and maybe even dangerous), the average speed is more commonly calculated as the distance/time ratio.

Moving objects don't always travel with erratic and changing speeds. Occasionally, an object will move at a steady rate with a constant speed. That is, the object will cover the same distance every regular interval of time. For instance, a cross-country runner might be running with a constant speed of 6 m/s in a straight line for several minutes. If her speed is constant, then the distance traveled every second is the same. The runner would cover a distance of 6 meters every second. If we could measure her position (distance from an arbitrary starting point) each second, then we would note that the position would be changing by 6 meters each second. This would be in stark contrast to an object that is changing its speed. An object with a changing speed would be moving a different distance each second. The data tables below depict objects with constant and changing speed.

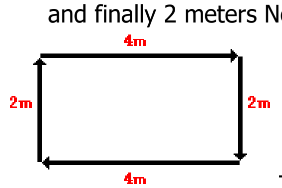
An object moving with a constant speed of 6 m/s

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24

An object moving with a changing speed

Time (s)	Position (m)
0	0
1	1
2	4
3	9
4	16

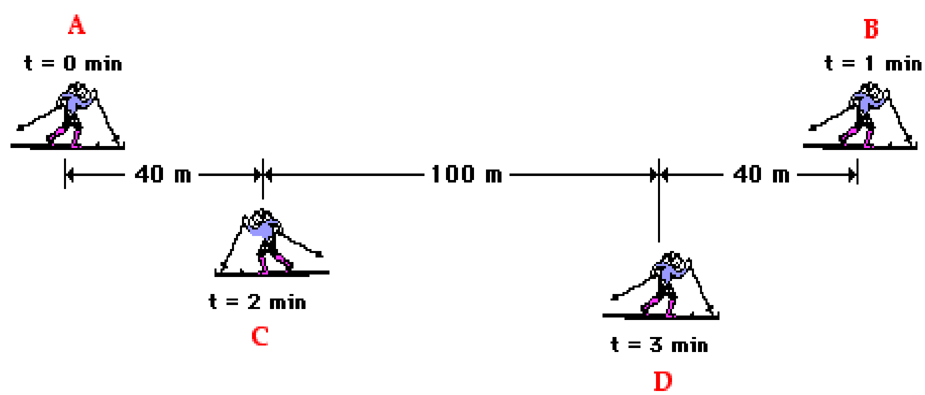
Now let's consider the motion of that physics teacher again. The physics teacher walks 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North. The entire motion lasted for 24 seconds. Determine the average speed and the average velocity.



The physics teacher walked a distance of 12 meters in 24 seconds; thus, her average speed was 0.50 m/s. However, since her displacement is 0 meters, her average velocity is 0 m/s. Remember that the displacement refers to the change in position and the velocity is based upon this position change. In this case of the teacher's motion, there is a position change of 0 meters and thus an average velocity of 0 m/s.

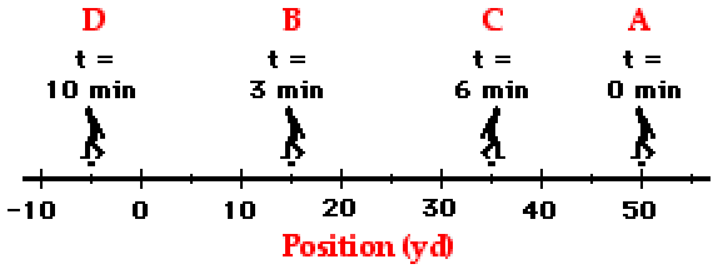
Here is another example similar to what was seen before in the discussion of distance and displacement. The diagram below shows the position of a cross-country skier at various times. At each of the indicated times, the skier turns around and reverses the direction of travel. In other words, the skier moves from A to B to C to D.

Quick Quiz Use the diagram to determine the average speed and the average velocity of the skier during these three minutes.



As a last example, consider a football coach pacing back and forth along the sidelines. The diagram below shows several of coach's positions at various times. At each marked position, the coach makes a "U-turn" and moves in the opposite direction. In other words, the coach moves from position A to B to C to D.

Quick Quiz What is the coach's average speed and average velocity?



In conclusion, speed and velocity are kinematic quantities that have distinctly different definitions. Speed, being a scalar quantity, is the rate at which an object covers distance. The average speed is the distance (a scalar quantity) per time ratio. Speed is *ignorant of direction*. On the other hand, velocity is a vector quantity; it is *direction-aware*. Velocity is the rate at which the position changes. The average velocity is the displacement or position change (a vector quantity) per time ratio.

Maine Explosion

Benchmark Standard:	History 2b: Students will examine and analyze primary and secondary sources in order to differentiate between historical facts and historical interpretations.
Grade:	11/12
Vocabulary / Key Concepts:	Fact Interpretation Point of view

~This is a SHEG lesson modified by CSD for Home~

CENTRAL HISTORICAL QUESTION: What sank the *Maine*?

ACTIVITY 1: Read the headlines and answer the questions.
Headlines from two different newspapers say the following:

- "Search for Missing Bride Continues"
- "Bride Missing! Groom's Family Blame History of Mental Illness"

Answer the following questions in response to the newspapers' headlines:

1. How do these headlines differ?
2. Consider the wording in the headlines and how a reader might respond to each article.
3. What does each headline imply?
4. If these were articles, which would you have wanted to read first?
5. Which do you think would have been the most reliable story? Why?
6. Why might different newspapers choose to present the same event so differently?

In this assignment, you are going to compare two newspaper accounts of an event that happened in 1898.

Destruction of the U.S. battleship *Maine* in Havana Harbor February 15, 1898

NOTES on the *Maine*:

- *Cuba was colonized by Spain.*
- *Cuban rebels had been fighting for independence.*
- *Spain was thought to be brutal in repressing the rebellion.*
- *U.S. had business interests in Cuba.*
- *President McKinley had sent the* Maine *to Cuba (Why? To protect American interests? To prepare for war? To intimidate Spain? This is debated by historians).*
- Maine *exploded on February 15, 1898.*

ACTIVITY 2: Read the Song and answer the questions.

"Awake United States"

This song was rushed into print between the sinking of the Maine *on February 15, 1898, and the declaration of war on April 25, 1898.*

Eagle soar on high, and sound the battle cry!
And how proudly sailed the warship *Maine*,
a Nation's pride, without a stain!
A wreck she lies, her sailors slain.
By two-faced butchers, paid by Spain!
Eagle soar on high,
And sound the battle cry
Wave the starry flag!
In mud it shall not drag!

Answer the following questions in response to the song "Awake United States"

1. According to this song, who sunk the Maine?
2. Does this prove the Spanish blew it up? Explain.

ACTIVITY 3: Read Document A and Document B and complete the Guiding Questions for Document A and for Document B; complete the Graphic Organizer and the questions below the graphic organizer for both documents A and B.

Document A: *New York Journal* (Modified)

The following is an excerpt from New York Journal and Advertiser, published February 17, 1898. Purchased by William Randolph Hearst in 1895, the Journal published investigative and human interest stories that used a highly emotional writing style and included banner headlines and graphic images.

DESTRUCTION OF THE WAR SHIP MAINE WAS THE WORK OF AN ENEMY
Assistant Secretary Roosevelt Convinced the Explosion of the War Ship Was Not an Accident.
The Journal Offers $50,000 Reward for the Conviction of the Criminals Who Sent 258 American Sailors to Their Death.
Naval Officers All Agree That the Ship Was Destroyed on Purpose.
NAVAL OFFICERS THINK THE MAINE WAS DESTROYED BY A SPANISH MINE.

George Bryson, the Journal's special reporter at Havana, writes that it is the secret opinion of many people in Havana that the war ship Maine was destroyed by a mine and 258 men were killed on purpose by the Spanish. This is the opinion of several American naval authorities. The Spaniards, it is believed, arranged to have the Maine drop anchor over a harbor mine. Wires connected the mine to the magazine of the ship. If this is true, the brutal nature of the Spaniards will be shown by the fact that they waited to explode the mine until all the men had gone to sleep. Spanish officials are protesting too much that they did not do it. Our government has ordered an investigation. This newspaper has sent divers to Havana to report on the condition of the wreck. This newspaper is also offering a $50,000 reward for exclusive evidence that will convict whoever is responsible. Assistant Secretary of the Navy Theodore Roosevelt says he is convinced that the destruction of the Maine in Havana Harbor was not an accident. The suspicion that the Maine was purposely blown up grows stronger every hour. Not a single fact to the contrary has been produced.

Source: New York Journal and Advertiser, February 17, 1898.

Document B: *New York Times* (Modified)

Excerpt from the New York Times, February 17, 1898. Established in 1851, the New York Times provided investigative coverage of local New York issues and events, as well as national and international news

MAINE'S HULL WILL DECIDE

Divers Will Inspect the Ship's Hull to Find Out Whether the Explosion Was from the Outside or Inside.

Magazines of War Ships Sometimes Blow Up Because of Too Much Heat Inside –

Hard to Blow Up the Magazine from the Outside.

It has been a busy day for the Navy Department. The war ship Maine was destroyed in Havana Harbor last night. Officials in Washington and Havana have been sending cables all night long. Secretary Long was asked whether he thought this was the work of the enemy. He replied: "I do not. I am influenced by the fact that Captain Sigsbee has not yet reported to the Navy Department. It seems he is waiting to write a full report. So long as he has not made a decision, I certainly cannot. I should think from the signs however, that there was an accident – that the magazine exploded. How that came about I do not know. For the present, at least, no other war ship will be sent to Havana." Captain Schuley, who knows a great deal about war ships, did not entertain the idea that the Maine had been destroyed on purpose. He said that fires would sometimes start in the coal bunkers, and he told of such a fire on board another war ship that started very close to the magazine. The fire became so hot that the heat blistered the steel wall between the fire and the ammunition before the bunkers and magazine were flooded with water to stop the fire. He did not believe that the Spanish or Cubans in Havana had either the information or the equipment necessary to blow up the magazine, while the Maine was under guard.

Source: *New York Times*, February 17, 1898.

Guiding Questions:

Document A – New York Journal

Sourcing:

1. How long after the explosion of the Maine was this article written?
2. What does the headline of the article suggest about the newspaper's point of view?

Close Reading:

3. Upon what type of evidence does the New York Journal base its claims?

Document B – New York Times

Sourcing:

1. How does the date of this article compare with the date on the New York Journal and Advertiser article?

Close Reading:

2. According to these headlines, what happened to the Maine?
3. What kinds of evidence does the New York Times include to support its account of the incident?

Graphic Organizer for Document A and Document B

Document	Publication Date	According to this article, what happened to the Maine?	What information is included to support this version of the story?	Write a quotation that contrasts with something written in the other article.
A ***Journal***				
B ***Times***				

1. Compare the evidence used by both newspapers to support their claims about what happened to the Maine. Which newspaper uses stronger evidence? Explain.
2. Based on the work you have done so far; do you really know what happened to the Maine?

ACTIVITY 4:

DIRECTIONS: Read Documents 1 and 2 and answer the questions (1-4) that follow the two documents.

Document 1:

In 1898, the battleship USS *Maine* was sent to Havana, Cuba, to protect U.S. interests during a Cuban revolt against Spain. On February 14, the vessel exploded and sank. Many Americans blamed Spain, and the incident helped trigger the Spanish-American War. The excerpt below is from an official report of a U.S. Naval Court of Inquiry into the sinking of the Maine. The report was released on March 21, 1898.

"… [T]he vertical keel [of the ship] is broken in two and the flat keel is bent at an angle similar to the angle formed by the outside bottom plating. This break is now about six feet below the surface of the water, and about thirty feet above its normal position.

. . . . In the opinion of the court, the MAINE was destroyed by the explosion of a submarine mine, which caused the partial explosion of two or more of her [ammunition storage rooms] . . . . The court has been unable to obtain evidence fixing the responsibility for the destruction of the MAINE upon any person or persons."

Document 2:

This excerpt appeared as a front-page story on March 6, 1898 in *The San Francisco Call.*

"The Call correspondent has the best of grounds for saying that Consul General Lee . . . has been quietly conducting an investigation of his own, independently of the Naval Court; that he has employed detectives who have obtained front Havana sailors evidence strongly pointing to a plot to destroy the Maine, and that he filed a report with the State Department expressing the opinion that although the Spanish Government was not in any way responsible for the Maine's destruction, it appears the work was done by Spaniards who were sympathizers of [Spain's governor in Cuba] Weyler."

1. In the weeks after the loss of the Maine, confusion about what caused the explosion added to American tensions with Spain over Cuba. How does Document A provide evidence of this confusion?
2. How does Document B also provide evidence of the confusion about what caused the explosion of the Maine?

CENTRAL HISTORICAL QUESTION:

3. Who sunk the Maine? Explain and support your conclusion with evidence.

OVERARCHING QUESTION:

4. How does this assignment / lesson help you identify the need to be able to differentiate between historical facts and historical interpretations? Explain.