

**6th Grade
Lesson Plan
Packet**

4/13/2020-4/17/2020

Remote Learning Packet

NB: Please keep all work produced this week. Details regarding how to turn in this work will be forthcoming.

April 13 - April 17, 2020

Course: 6 World Cultures

Teacher(s): Mrs. Malpiedi patricia.malpiedi@greatheartsirving.org

Mr. Loomis joseph.loomis@greatheartsirving.org

Weekly Plan:

Monday, April 13

- Finish “Identifying Countries Practice” worksheet and check your answers (25 minutes)

Tuesday, April 14

- Read Thucydides excerpt (15 min)
- Answer questions (15 min)

Wednesday, April 15

- Write 3-paragraph essay about the Thucydides reading (30 min)

Thursday, April 16

- Reread Wednesday’s essay and use proofreading checklist (10 min)
- Review Timeline from last week using your flashcards (15 min)

Friday, April 17

- Complete the “Black Plague” worksheet (30 min)

Statement of Academic Honesty

I affirm that the work completed from the packet is mine and that I completed it independently.

I affirm that, to the best of my knowledge, my child completed this work independently

Student Signature

Parent Signature

Monday, April 13

We hope you had a beautiful weekend. Today you will practice identifying countries on a map and make sure you are also practicing the correct spelling of their names. You will need your textbook and a colored pen for corrections.

1. Complete the **Identifying Countries Practice Worksheet** found at the end of this packet.
2. Enjoy your afternoon. (Get some fresh air if you can!)

Tuesday, April 14

We will shift gears for the next couple of days with a reading and writing assignment. Today you will test your reading and comprehension skills. You will need a new piece of notebook paper.

1. On your paper, write your heading and add the following title:

Thucydides Reading Questions

2. Read the passage below. If you find it challenging -- good! Look for main ideas rather than getting caught up on unfamiliar people.

Some context: This passage comes from Book 1 Chapter 20 of *History of the Peloponnesian War* by Thucydides. In Book 1, the author provides a brief history of Greece, describes that his method of writing history sticks to facts rather than exaggerations, and claims that the Peloponnesian War resulted from the Lacedaemonians' fear of Athens' growing supremacy. [Note: the Spartans were a part of the Lacedaemonian region/group.] Thucydides was an Athenian general and historian who lived around 460 BC to 404 BC. This history was originally written in Greek; the excerpt below is from an English translation by Richard Crawley.

From Book 1 Chapter 20 of *History of the Peloponnesian War*

The way that most men deal with traditions, even traditions of their own country, is to receive them all alike as they are delivered, without applying any critical test whatever. The general Athenian public fancy that Hipparchus was tyrant when he fell by the hands of Harmodius and Aristogiton, not knowing that Hippias, the eldest of the sons of Pisistratus, was really supreme, and that Hipparchus and Thessalus were his brothers; and that Harmodius and Aristogiton suspecting, on the very day, nay at the very moment fixed on for the deed, that information had been conveyed to Hippias by their accomplices, concluded that he had been warned, and did not attack him, yet, not liking to be apprehended and risk their lives for nothing, fell upon Hipparchus near the temple of the daughters of Leos, and slew him as he was arranging the Panathenaic procession.

Glossary

Accomplice - someone who helps with the crime

Apprehended - caught, arrested

Conveyed - given

Critical - using analysis and good judgment

Fancy - like to think

Fell upon - Attacked

Fixed on - planned

Nay - even more so

Panathenaic procession - a parade through the city which took place on the last day of the Panathenaic festival, a religious festival which honored Athena

Slew - killed

Tyrant - a cruel and oppressive ruler

(turn to next page for questions)

3. Answer the following questions. Write your answers on your page, using complete sentences where appropriate.
- Think back to our unit on Ancient Greece. The Peloponnesian War (431 BC – 404 BC) was between which two powerful Greek city-states? Why were they fighting? Who won?
 - Draw a family tree that includes Pisistratus, Hippias, Hipparchus, Thessalus.
 - True or False? Most Athenians think that Hipparchus was a cruel and oppressive ruler.
 - True or False? Hippias is Hipparchus' brother.
 - True or False? Harmodius and Aristogiton kill Hipparchus right before the procession -- instead of the original time they had planned -- because they believed that Hipparchus' brother had been warned and they did not want to get caught in the act.
 - Look at the sentence in bold. Please rewrite both of them in your own words. (Hint: What does the author mean by "most men"? "Receive them all alike? "Critical test?")

Wednesday, April 15

You will spend today's History time writing a thoughtful essay. You will need your notes from yesterday and a new piece of paper. You should use pencil, not pen.

- Reread and think about this sentence from the reading: "***The way that most men deal with traditions, even traditions of their own country, is to receive them all alike as they are delivered, without applying any critical test whatever.***" You rephrased it in your own words in yesterday's assignment. Here are other ways the sentence has been interpreted:
 - "Most people, in fact, will not take the trouble in finding out the truth, but are much more inclined to accept the first story they hear."
 - "Most people hear stories, even stories from their own country, and believe the first thing they hear rather than thinking about whether or not it is true."
- On your new piece of notebook paper, write your heading and the following title:

Thucydides Essay
- Write a 3 paragraph essay using the outline below. It is helpful to create an outline first. Each paragraph should contain at least four sentences.
 - ❖ PARAGRAPH 1: Paraphrase what Thucydides says in yesterday's reading.
You might start with a topic sentence like this: "In the passage from Book 1 Chapter 20 of *History of the Peloponnesian War*, Thucydides describes..."
 - ❖ PARAGRAPH 2: Describe what the quote means.
You might start like this: "Thucydides writes that 'The way that most men deal with traditions, even traditions of their own country, is to receive them all alike as they are delivered, without applying any critical test whatever.' This means that..."
 - ❖ PARAGRAPH 3: Relate the quote to today's times, stating whether or not you think people still accept stories in the way Thucydides describes. Give examples from your own experience.
You might start like this: "Thucydides' statement about how most people don't think critically is still true/no longer true. When people read the news today, for example..."
(To write this paragraph, consider: Did you immediately believe the most recent news headline or article that you read? Many people do. Why do you think that is the case? Do you think this is good -- why or why not? If not, what should people do instead?)

Thursday, April 16

Today you will proofread your essay and then review the dates we learned and studied last week. You will need yesterday's essay, a colored pen for corrections, and the Timeline flashcards from last week.

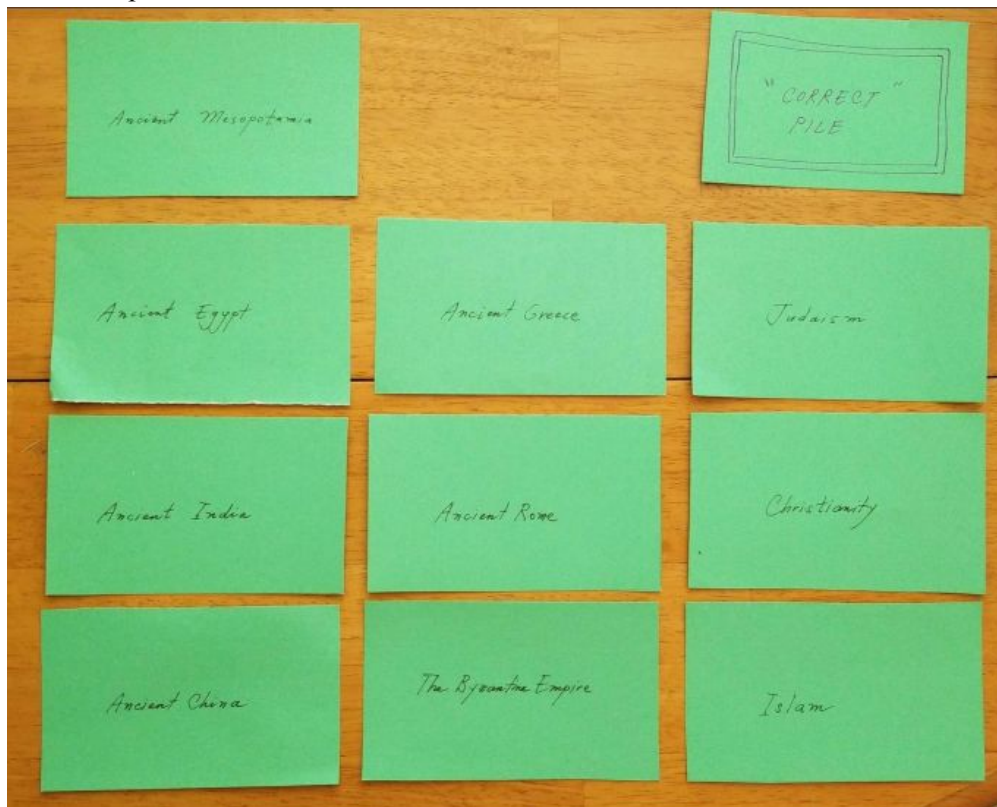
1. Reread your essay twice, doing so **aloud** at least once. (When you read your writing aloud, it can help you hear when your sentences are too long, poorly-phrased, etc.) Use the checklist below to make corrections.

Proofreading Checklist

- Do I have a strong topic sentence for each paragraph?
- Do I have a strong concluding sentence for each paragraph?
- Do my sentences sound smooth and natural as I read them out loud?
- Have I corrected any spelling errors? If I am not sure about my spelling, have I checked with a dictionary?
- Have I corrected any grammar or punctuation errors?

2. Afterwards, take out your **World Cultures Timeline Flashcards**. Lay all ten of them out on your desk so that you can only see names, not dates.

For example:



3. Look at one flashcard at a time and identify the dates for the time period/religion. Check your answer by flipping the card over. **If you got the answer correct, put the card in a pile. If you got the answer incorrect, do not put it in the pile. Keep it on the table and move on to the next card.** Continue playing until all of the cards are in a pile--meaning, you eventually got all of the dates correct!

Friday, April 17

Happy Friday! Today you will return to our unit on the Middle Ages.

1. Complete the Black Plague worksheet found at the end of this packet.
2. Bind all your materials from this week neatly together with a clip or other tool. Store them with this week's Remote Packet.
3. Have a wonderful weekend.

Monday, April 13, 2020

Identifying Countries Practice Worksheet

Bell Work (5 min): Are you able to answer these questions from our units on Christianity and Islam?

1. What holiday did many Christians celebrate yesterday and what does it commemorate?

2. Fill in the blanks: Starting April 23rd of this year, Muslims will observe a month of _____ * called _____.
**one of the five pillars of Islam*

Part A: (10 min) Take out your textbook and turn to the map on page 1. There are four regions listed on the chart below. Looking at one region on the map at a time, name as many countries as you can from the region, and list them in the chart below. (Remember, these are the countries we studied in the Week 1 Remote Packet.) **Spend no fewer than 10 minutes on this part of the worksheet. Time yourself.**

East and Southeast Asia	North Africa	The Middle East	Western Europe

When you are done, turn to the next page to complete Part B and Part C.

Part B: (5 min) Check your answers using the key below. Using your colored pen, fill in any countries you missed in the chart from Part A and correct your spelling. You can view individual maps of the regions on pages 48 (East and Southeast Asia), 549 (Middle East and North Africa), and 640 (Western Europe.)

East and Southeast Asia	North Africa	Middle East	Western Europe*
Cambodia <i>Cambodia, Cambodia</i>	Algeria	Bahrain	<i>*just the countries on p. 640 that are in color</i>
China	Egypt	Iran	Austria
East Timor	Libya	Iraq	Belgium
Indonesia	Morocco	Israel	Denmark
Japan	Tunisia	Jordan	Finland
Laos		Kuwait	France
Malaysia		Lebanon	Germany
Myanmar		Oman	Great Britain
North Korea		Qatar	Greece
Papua New Guinea		Saudi Arabia	Iceland
Philippines		Syria	Ireland
Singapore		Turkey	Italy
South Korea		United Arab Emirates	Luxembourg
Taiwan		Yemen	Netherlands
Thailand			Norway
Vietnam			Portugal
			Spain
			Sweden
			Switzerland

Part C: (5 min) Practice your spelling: rewrite each of the countries two times directly underneath its name. Cambodia is done for you as an example.


Friday, April 17, 2020

Black Plague Worksheet

Part A: Read the textbook excerpt below and then answer the questions.

THE BLACK DEATH


The Black Death



The Black Death is sometimes said to have been the worst disaster in history. It killed about 25 million people in Europe alone (about a quarter of the total population), and nobody knows how many millions more in Asia.

The Black Death was a form of bubonic plague. It got its name from spots of blood that formed under the skin and turned black. The first symptoms were the swelling of glands in the groin and armpit. Victims usually died within a few hours. The plague was first carried by rat fleas which could also live on humans. Bubonic plague is not carried by human contact, but the Black Death later changed to pneumonic plague, which spreads from person to person.

The disease seems to have been carried from central Asia to the Crimea by a Tartar (Mongol) raiding party, and from there to the Mediterranean by ship, arriving at Genoa, in Italy, in 1347. It



▲ The Black Death came from Asia to Europe in 1347 and reached its peak in 1349. Only a few areas were unaffected because people managed to isolate themselves and stop the disease from spreading.

▼ A typical European town street in the Middle Ages had filthy open sewers, rats and refuse everywhere. Human waste was hurled from the windows with the cry "Gardes-lool!" to warn passersby. It was no wonder the plague spread, but many people thought it was the judgment of God on a wicked world.



▲ The feelings of fear and helplessness were reflected in the art and literature of the time. Pictures showed the Black Death as a skeleton riding on horseback.

spread west and north, reaching Paris and London in 1348, and Scandinavia and northern Russia in 1349. It devastated regions: houses stood empty and towns were abandoned. Fields became littered with unburied corpses.

The effects of the Black Death were widespread. Before it, Europe had had a surplus of labor and wages were low. Afterward there was a severe shortage of workers. As a result wages soared and attempts to hold wages down led to revolts (see pages 298-299). The already weak feudal system collapsed.

▼ People burned the clothes of the dead to try to stop the infection spreading. The plague killed rich and poor alike and sometimes whole towns were wiped out.



1. In what year did the Plague arrive in Europe? _____
2. In what year did the Plague reach Durham, Scandinavia and Northern Russia? _____
3. What was the cause of the Plague and how did it get to Europe? (2 sentences) _____

4. What were two effects (positive or negative) of the Plague? (2 sentences)

Part B: Look carefully at the two paintings below. Answer the questions with as much detail as you can. Write in complete sentences.



1. Name one negative or ugly thing the artist depicts in Painting 1.

2. Name one positive or beautiful thing the artist depicts in Painting 1.



3. Name one negative or ugly thing the artist depicts in Painting 2.

4. Name one positive or beautiful thing the artist depicts in Painting 2.

Remote Learning Packet

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April 13 - 17, 2020

Course: 6 Latin

Teacher(s): Miss Salinas annie.salinas@greatheartsirving.org

Ms. Baptiste deborah.baptiste@greatheartsirving.org

Weekly Plan:

Monday, April 13

- Complete the Stage 10 vocabulary list
- Conjugation review sheet - AS

Tuesday, April 14

- Make Stage 10 vocab flashcards

Wednesday, April 15

- Verbs in context - DB
- Model sentences worksheet - DB

Thursday, April 16

- Practice Stage 10 vocabulary flashcards
- Stage 10 grammar sheet - verbs continued: person and number - AS

Friday, April 17

- Practice Stage 10 vocabulary flashcards
- Agreement of subject and verb sheet

Statement of Academic Honesty

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Monday, April 13

1. Referring to p. 146, fill in the missing vocabulary information on the “Stage 10: Vocabulary List” worksheet. You may either complete the information on the sheet itself or write it out on a separate piece of notebook paper. If using notebook paper, please be sure to put a full heading including the title “Stage 10 Vocabulary List.”
2. Complete the conjugation review sheet.

Tuesday, April 14

Make flashcards for the Stage 10 vocabulary words. Include the following information on your cards:

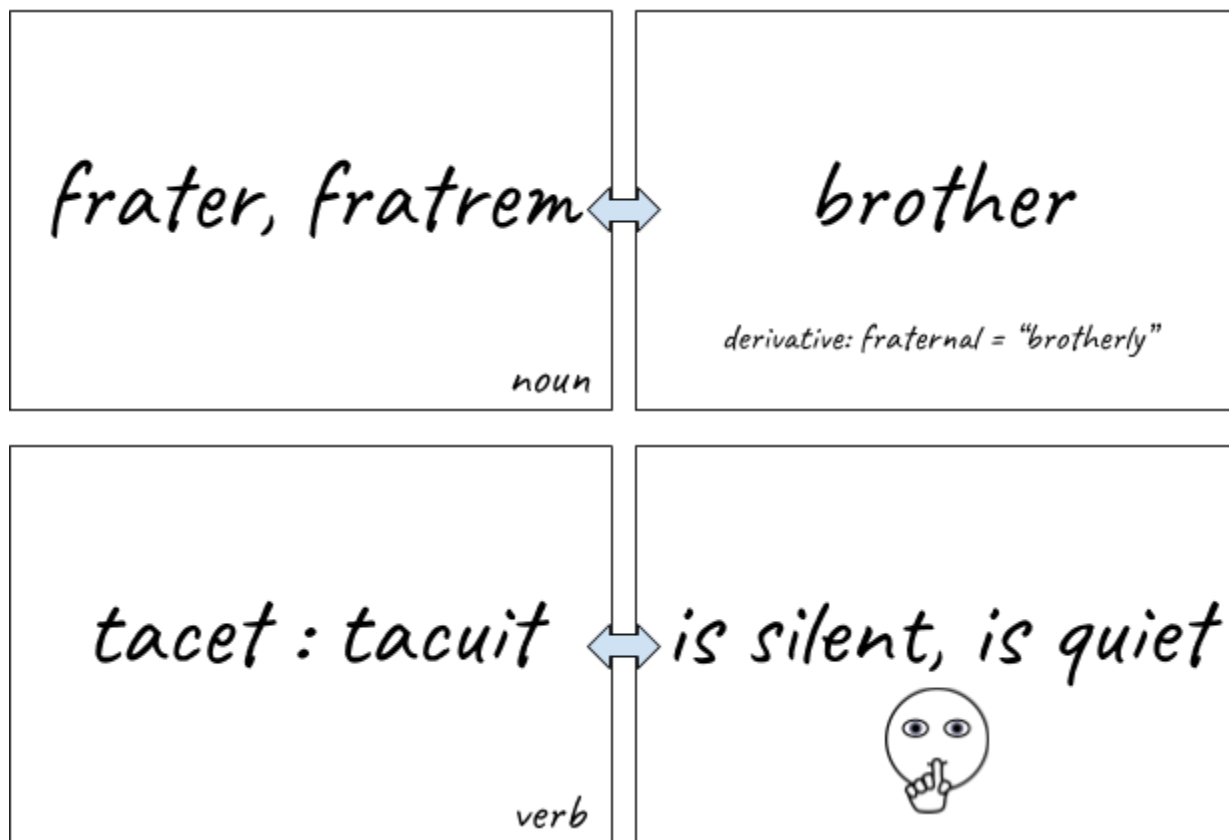
Nouns: nominative, accusative, part of speech, meaning

Verbs: present, perfect, part of speech, meaning

Adjectives: masculine and feminine, part of speech, meaning

Adverbs: Latin, part of speech, meaning

As you create your flashcards, I also encourage you to add onto them with a drawing or a derivative that will help you visualize and remember what the Latin word means. Here are examples of how your vocab flashcards could look:



Wednesday, April 15

1. Complete the worksheet “Verbs in Context”. This is to help you prepare for your next task!
2. Open your red book to page 132. Using the model sentences and illustrations on pg. 132-135 of your book, answer the questions on the worksheet “Stage 10 Model Sentences”.

Thursday, April 16

1. Practice your Stage 10 vocab for five minutes! Go through your flashcards and see if you can guess any on the first try. As you go through them, say the words to yourself in both English and Latin. If you think of any more derivatives, write them down.
2. Complete the first Stage 10 grammar sheet, “Verbs: Person and Number”. (There are two pages to it: make sure you do both of them!)

Friday, April 17

1. Spend five minutes practicing your Stage 10 vocab! Go through your flashcards and see how many you can remember. Sort them by words you know and words you need to practice, then practice those words several more times. Make sure you say them aloud as you go!
2. Complete the final worksheet for this week, “Agreement of Subject and Verb”.
3. Celebrate! You made it through week three of remote learning! *Euge!*

Monday

Stage 10 Vocabulary

Fill in the blanks, using page 146 of your textbook.

Nouns and Pronouns

<i>Nominative</i>	<i>Accusative</i>	<i>Declension</i>	<i>Meaning</i>
	librum	2 nd	book
imperium	imperium	2 nd	
frater	fratrem		brother
	pacem	3 rd	
uxor	uxorem	3 rd	wife
	portum	*4 th	
nōs	nōs	n/a (pronoun)	we/us
vōs	vōs	n/a (pronoun)	you (pl.)

* To be learned next year

Adjectives

<i>Word</i>	<i>Meaning</i>
callidus, callida	
contentus, contenta	
sōlus, sōla	
suus, sua	

Verbs

<i>3rd sing. Present</i>	<i>3rd sing. Perfect</i>	<i>Conjugation</i>	<i>Meaning</i>
exclāmat	exclāmāvit	1 st	
	habitāvit	1 st	lives
nūntiat	nūntiāvit	1 st	
	servāvit	1 st	saves, looks after
tacet		2 nd	is silent, is quiet
accipit		3 rd -iō	
invenit	invēnit	4 th	
abit		irregular	

Adverbs

<i>Word</i>	<i>Part of Speech</i>	<i>Meaning</i>
	adv.	than
semper	adv.	
	adv.	violently, loudly

Monday

Verbs – Conjugation Review Sheet

A **verb** is a word that:

- 1) describes an _____,
- 2) shows a state of _____,
- 3) _____ two words together, or
- 4) _____ another verb.

In English, we use a separate name or pronoun to tell us who is doing the action of a verb. In Latin, we change the personal _____ to tell us who is doing the action of a verb.

Person and Number

Verbs in Latin have a **person** just like English verbs do.

Person refers to the _____ of the subject.

For a **1st person** verb, the _____ is the subject.

For a **2nd person** verb, the _____ is the subject.

For a **3rd person** verb, someone or something _____ than the speaker or the listener is the subject.

Number refers to **how many** subjects; _____ (one) or _____ (more than one).

The **personal endings** of a Latin verb indicate who the subject is (_____) and how many subjects there are (_____).

Fill in the following chart for **verbs**.

	<i>Personal Ending</i>	<i>Who is doing the action?</i>
<i>1st Person</i>	-o / -m	<i>I</i>
<i>2nd Person</i>		
<i>3rd Person</i>		

<i>Personal Ending</i>	<i>Who is doing the action?</i>

What do the following pronouns mean in English?

ego:

nos:

tu:

vos:

Wednesday

Verbs in Context

First, fill out your verb endings chart to remind you who does the action of each verb. Next, supply the missing information about verbs found in those sentences. (These words are based on the verbs in the model sentences on pages 132-135.) The first one is done for you.

	<i>Personal Ending</i>	<i>Who is doing the action?</i>
<i>1st Person</i>	-o / -m	<i>I</i>
<i>2nd Person</i>		
<i>3rd Person</i>		

<i>Personal Ending</i>	<i>Who is doing the action?</i>

1. dicit -- (he) says

dicimus -- *we say*

2. sumus -- _____

sum -- *I am*

3. habēo-- I have

habēmus -- _____

4. facimus -- we make

facitis -- _____

5. pingis -- you (sing.) paint

pingimus -- _____

6. estis -- y'all are

sumus -- _____

7. spectat -- (she) watches, looks at

spectatis -- _____

8. pugās-- you (sing.) fight

pugnatis--- _____

9. docēmus -- we teach

docētis -- _____

10. sum -- I am

es -- _____

Wednesday

Model Sentences Worksheet

Open your red book to pages 132-135. Look at the pictures, and read the sentences that go along with them as best you can. When you are finished reading, complete this worksheet to translate each sentence.

1. Rōmānus dīcit, “nōs Rōmānī sumus architectī. nōs viās et pontēs aedificāmus.”

The Roman says, “We _____ are _____. _____ build _____ and bridges.”

2. “nōs Rōmānī sumus agricolae. nōs fundōs optimōs habēmus.”

“_____ Romans _____ . We _____ the _____ farms.”

3. Graecus dīcit, “nōs Graecī sumus sculptōrēs. nōs statuās pulchrās facimus.”

The Greek _____, “_____ are _____. _____ make beautiful _____.”

4. “nōs Graecī sumus pictōrēs. nōs pictūrās pingimus.”

“_____ Greeks _____ . We _____ pictures.”

5. Rōmānus dīcit, “vos Graecī estis ignāvī. vōs āctōrēs semper spectātis.”

“The Roman _____, “Y’all _____ are _____. _____ always _____.”

6. Graecus dīcit, “vōs Rōmānī estis barbarī. vōs semper pugnātis.”

_____ says, “_____ are barbarians. You _____ fight.”

7. Rōmānus dīcit, “nōs sumus callidī. nōs rēs ūtilēs facimus.”

The Roman says, “_____ are _____. We _____ useful things.”

8. Graecus dīcit, “nōs sumus callidiōrēs quam vōs. nōs Graecī Rōmānōs docēmus.”

The Greek says, “_____ more clever than _____. _____ Greeks _____ the Romans.”

Thursday

Stage 10: Verbs Continued

Person and Number

In Stage 4, you learned that verbs have **person**, which indicates the identity of the subject.

1st person means that the _____ is the subject (i.e. *I, we*),

2nd person means that the _____ is the subject (i.e. *you, y'all*), and

3rd person means that **someone or something** _____ is the subject (i.e. *he, she, it, the girl, the slave, the merchant, etc.*).

In Stage 5, you learned that verbs also have **number** which indicates **how many** subjects:

_____ (one) or _____ (more than one).

In this Stage, you have met sentences whose subjects are “we” and “you (pl.) / y’all”:

e.g. **nōs laborāmus.** *We work/are working.*

vōs laborātis. *Y'all work/are working.*

nōs currimus. *We run/are running.*

vōs curritis. *Y'all run/are running.*

Look at the sentences above, then answer the following two questions:

When the subject of a verb is 1st person plural (i.e. *we*), the verb ends in _____.

When the subject of a verb is 2nd person plural (i.e. *y'all*) the verb ends in _____.

Now observe the following examples:

nōs Rōmānī sumus fortissimī. **barbarōs ferōcissimōs superāmus.**

We Romans are very brave. *We overpower very fierce barbarians.*

vōs Graecī estis ignavī. **actorēs semper spectātis.**

You Greeks are lazy. *You always watch actors.*

Note that the pronouns **nōs** and **vōs** are not necessary, since the endings **–mus** and **–tis** make it clear that “we” and “you” are being spoken about. The Romans generally used **nōs** and **vōs** only for emphasis.

Circle the correct answers:

1. If the main verb of a sentence ends in **–mus**, who is doing the action?

nos / we

ego / I

tu / you

2. If the main verb of a sentence ends in **–tis**, who is doing the action?

tu / you

vos / y'all

is, ea, id / he, she, it

The chart below gives the complete endings for 1st, 2nd, and 3rd person verbs in the singular and plural:

	<i>Personal Ending</i>	<i>Who is doing the action?</i>
<i>1st Person</i>	-o / -m	I
<i>2nd Person</i>	-s	you
<i>3rd Person</i>	-t	he, she, it

<i>Personal Ending</i>	<i>Who is doing the action?</i>
-mus	we
-tis	y'all
-nt	they

Review:

Conjugate and translate the following verbs in the **present** tense:

	<i>1st Conjugation spectat: spectāvit</i>	<i>Translation</i>	<i>3rd Conjugation petit: petīvit</i>	<i>Translation</i>
<i>1st person sing.</i>	specto	I watch		
<i>2nd person sing,</i>			petis	you attack
<i>3rd person sing.</i>				
<i>1st person plural</i>				
<i>2nd person plural</i>	spectatis	y'all watch		
<i>3rd person plural</i>			petunt	they attack

Conjugate and translate the following verbs in the **imperfect** tense:

	<i>2nd Conjugation videt: vīdit</i>	<i>Translation</i>	<i>4th Conjugation audit: audivit</i>	<i>Translation</i>
<i>1st person sing.</i>	videbam	I was seeing		
<i>2nd person sing,</i>			audiebas	you were hearing
<i>3rd person sing.</i>				
<i>1st person plural</i>	videbamus	we were seeing		
<i>2nd person plural</i>			audiebatis	y'all were hearing
<i>3rd person plural</i>				

Friday: Agreement of subject and verb

Hint: find who is doing the action - I, you, he/she/it, we, y'all, or they - then circle the verb with the right ending.

- A Circle the verb which correctly completes each sentence. Then translate each sentence. *The first one is done for you.*
- 1 nōs Rōmānī (sum, estis, sumus) fortissimī.
we Romans are very brave.
 - 2 duo iuvenēs ē porticū (discēdēbat, discēdēbant, discēdēbātis).
 - 3 tū ad palaestram (ībam, ībātis, ībās).
 - 4 vōs Graecī (estis, es, sunt) turbulentī.
 - 5 ego sententiam (habēbāmus, habēbās, habēbam).
 - 6 vōs rhētorem Graecum (expectat, expectābātis, expectāmus).
 - 7 nōs Rōmānī librōs Graecōs (legunt, legitis, legimus).
 - 8 iuvenēs argūmentum (audiēbant, audiēbat, audiēbātis).

Hint: find your verb, underline it, and match the ending to the correct pronoun.

- B Circle the noun or pronoun which correctly completes each sentence. Then translate each sentence. *The first one is done for you.*
- 1 (tū, nōs, ego) tibi statuam dō. I give the statue to you.
 - 2 (nōs, vōs, Rōmānus) praemium accipitis.
 - 3 (tū, Graecus, vōs) contrōversiam nūntiābās.
 - 4 (vōs, Rōmānī, nōs) sunt architectī optimī.
 - 5 (ego, tū, Rōmānus) pācem servās.
 - 6 (ego, nōs, vōs) imperium maximum habēmus.
 - 7 (Graecus, ego, nōs) victōrem nūntiāvit.
 - 8 (ego, nōs, vōs) estis fēlīcēs.
 - 9 (vōs, nōs, tū) sumus contentī.

Remote Learning Packet

NB: Please keep all work produced this week. Details regarding how to turn in this work will be forthcoming.

April 13 - 17, 2020

Course: 6 Literature & Composition

Teacher(s): Ms. Arnold jacqueline.arnold@greatheartsirving.org

Ms. Brandolini catherine.brandolini@greatheartsirving.org

Weekly Plan:

Monday, April 13

- practice poem
- read & annotate TWTW Ch V

Tuesday, April 14

- practice poem
- answer TWTW Ch V reading questions

Wednesday, April 15

- practice poem
- poetry imitation

Thursday, April 16

- practice poem
- read & annotate TWTW Ch VI

Friday, April 17

- practice poem
- answer TWTW Ch VI reading questions

Statement of Academic Honesty

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Student Signature

Parent Signature

Monday, April 13

Recite the poem aloud at least two times. Remember to follow the punctuation of the lines, to pronounce each word clearly, and to avoid a monotone recitation!

Carefully read and annotate TWTW Chapter V. Pay special attention to the idea of hospitality and “home, sweet home”.

Tuesday, April 14

Recite the poem aloud at least two times. Remember to follow the punctuation of the lines, to pronounce each word clearly, and to avoid a monotone recitation!

Answer the questions about TWTW Ch V. Either answer them on looseleaf or print the reading question handout included in the packet. If you are using looseleaf, please title your page “TWTW Ch V Questions”. Remember to write neatly, to include our usual header, and to write in complete sentences.

Wednesday, April 15

Recite the poem aloud at least two times. Remember to follow the punctuation of the lines, to pronounce each word clearly, and to avoid a monotone recitation!

After you recite the poem, begin the **Poetry Imitation Activity**. You will imitate the structure and style of “The Moon was but a Chin of Gold,” and write your own poem on a separate piece of looseleaf. Please follow each of the steps below.

1) Observe the poem. Look back at our annotations to review the form and meaning. Your poem will also include these elements:

- Personification of an object (preferably something from nature)
- Description of the object, moving from the parts of its “face” to its “body”; move from a description of the parts to the whole
- Mixture of blunt descriptions and longer musings about the object’s nature
- Dickenson has a varied rhyme scheme; choose either ABCB or ABBC for your poem

2) Choose your topic. Ideally, go outside and find something in nature. Observe your chosen topic carefully. What properties does it have (refer to the 10 Categories)? What similes can you think of that would help describe your topic? What sort of person/personality could be associated with your topic? Choose a topic that has shown some change or growth in the springtime (buds bursting into leaf or flower; caterpillars eating to prepare for spinning their cocoons; birds hatching from eggs; etc)

3) Using that information you brainstormed in step 2, imitate Dickenson’s poem. Your poem must be at least three stanzas long and follow one of the rhyme schemes indicated above.

Thursday, April 16

Recite the poem aloud at least two times. Remember to follow the punctuation of the lines, to pronounce each word clearly, and to avoid a monotone recitation!

Carefully read and annotate TWTW Chapter VI. Pay special attention to the various animals' approaches to vice and overcoming bad habits.

Friday, April 17

Recite the poem aloud at least two times. Remember to follow the punctuation of the lines, to pronounce each word clearly, and to avoid a monotone recitation!

Answer the questions about TWTW Ch VI. Either answer them on looseleaf or print the reading question handout included in the packet. If you are using looseleaf, please title your page "TWTW Ch VI Questions". Remember to write neatly, to include our usual header, and to write in complete sentences.

The Wind in the Willows Chapter V Reading Questions

1. What is meant by the “small inquiring something which all animals carry inside them” ?

2. What stirred the sense of “wistfulness” in Rat and Mole as they journey through the little village? (p 52) What does wistfulness mean in this context?

3. What is being personified in the following excerpt: “those invisible little hands” (53)?

4. Despite Mole’s desperate plea to follow the scent of home, Ratty refuses to pause their journey. Why is he so insistent?

5. After Mole joyfully reunites with his home, a wave of discontent washes over him. What is the cause of his very sudden shift in mood?

6. Compare/contrast Mole's home (Mole End) with Bilbo's home (Bag End). What elements of each home comfort the two distinct characters?

7. How does Ratty show hospitality in this chapter? Look especially at pages 60 & 63.

8. In this chapter, what do we learn about Rat through his actions (indirect characterization)? List two of Rat's personality traits, and refer to his actions in this chapter to support each trait.

9. What "frame of mind" did Rat attempt to bring about in Mole at the end of this chapter? (Refer to page 64)

The Wind in the Willows Chapter VI Reading Questions

1. When Badger, Rat, and Mole stage an intervention in Toad's life, Badger explains, "independence is all very well, but we animals never allow our friends to make fools of themselves beyond a certain limit..." (67). Are these three animal friends legitimately concerned for Toad, or do their actions display an inappropriate nosiness and desire to control Toad?

2. What two 'methods' do Badger, Rat, and Mole employ in their attempt to bring Toad to reason?

3. As the trio is watching over the locked-up Toad, Badger explains that they "shall have to take it in turns to be with him, till the poison has worked itself out of his system" (70). Should "poison" be interpreted literally or figuratively? What might it refer to?

4. How does Toad trick Rat, thus enabling his own escape?

5. What “all too familiar sound” caused Toad to “start and fall a trembling” and brought about another temptation for Toad?

6. What vice/ flaw/ defect enables Toad to succumb to his “old passion,” and steal the motorcar? (refer to the last paragraph on p. 74)

7. Which three offenses has Toad been declared guilty?

8. What is Toad’s fate at the end of this chapter?

Remote Learning Packet

NB: Please keep all work produced this week. Details regarding how to turn in this work will be forthcoming.

April 13 - 17, 2020

Course: Math Fundamentals

Teacher(s): Ms. Schweizer rose.schweizer@greatheartsirving.org

Weekly Plan:

Monday, April 13

- Read pages 1-3
- Section 11.1, pg. 368, 9-30 mod 3, 40-42 all

Tuesday, April 14

- Read Pages 4-5
- Page 15, exercises 11-22 all

Wednesday, April 15

- Read Pages 6-8
- Page 16, exercises 1-25 odd

Thursday, April 16

- Read Pages 9-12
- Section 11.2, pg. 373, 3-27 mod 3
- pg. 374 Problems 1-3 all

Friday, April 17

- Read Pages 13-14
- Section 11.3, pag. 376, 7-29 odd

Statement of Academic Honesty

I affirm that the work completed from the packet is mine and that I completed it independently.

I affirm that, to the best of my knowledge, my child completed this work independently

Student Signature

Parent Signature

This is the first week we are really jumping into new material, but I'm sure you can all handle it. Last week we reviewed the properties of positive numbers so that this week we can talk about **NEGATIVE NUMBERS!** The types of numbers that we can work with are going to double!

Highlight or underline as you read my notes to help you understand as you go. Remember, you also have the section in the book as well. Email me if you have any questions.

Monday, April 13

What even are negative numbers? Find out by reading pages 1-3 in the packet and then completing the exercises from Section 11.1 in your book. Remember to complete the exercises on a separate piece of paper, copying down the original question and showing all your work. Then use the answer key to correct your work and make any corrections in pen.

Tuesday, April 14

We are not using the book today. Read pages 4-5 in the packet and then complete, on a separate piece of paper, the exercises found on page 15 of the packet. For numbers 11 and 12 it should say "a and b". Since your answers may be slightly different, I am not including an answer key for today.

Wednesday, April 15

Today's lesson is not in the book either. Read pages 6-8 in the packet about categorizing numbers and complete the exercises found on page 16 of the packet. I've included a limited answer key, but remember that your answers should include an explanation.

Thursday, April 16

Adding Integers! Now that we've discussed some of the properties of negative numbers, we are ready to work with them. Read pages 9-12 in the packet and then complete the exercises in Section 11.2. Remember to complete the exercises on a separate piece of paper, copying down the original question and showing all your work. Then use the answer key to correct your work and make any corrections in pen.

Friday, April 17

Subtracting Integers. You're a smart cookie, you know the drill. Read the pages in the packet and then complete the exercises in the book on a separate piece of paper. Correct them afterwards.

Answer Key:

Monday: Section 11.1

- 9. Number line
- 12. Number line
- 15. 3
- 18. 8
- 21. Number line
- 24. Number line
- 27. -3, -2, -1
- 30. -4, -3, -2, -1, 0
- 40. Negative
- 41. Negative
- 42. Negative

Tuesday: Page 15

Answers may vary

Wednesday: Page 16

- 1. Whole, integer, rational, real
- 3. Irrational, real
- 5. Whole, integer, rational, real
- 7. Rational, real
- 9. Rational, real
- 11. Irrational, real
- 13. False
- 15. False
- 17. True
- 19. True
- 21. -- 26. May vary

Thursday: Section 11.2

- 3. -- 6. Number lines
- 9. -3
- 12. 9
- 15. 19
- 18. a. 3 b. 3
- 21. 1
- 24. -10
- 27. True
- Pg. 374
- 1. $-282 + 1200 = 918$ ft
- 2. $12 + (-7) + 15 = 20$
- 3. $25 + 3 + (-8) + (-12) = 8$

Friday: Section 11.3

The answers are in the back of the textbook.

1 History of Negative Numbers

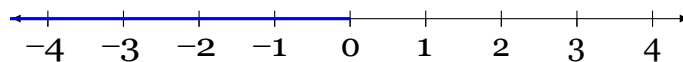
Negative numbers are commonly accepted today and most people work with them without giving a thought to the mathematical foundation of negative numbers, but this was not always the case. In ancient Greece, numbers were thought of geometrically, as distances, so they did not have the concept of a negative number. In fact, the first mention of negative numbers in Greek mathematics appears in the 3rd century, where they are dismissed as absurd. Since their idea of number was based on distance, they had no concept of what a negative number would mean.

The first widely accepted appearance of negative numbers was in the 7th century in India. The Indian mathematician Brahmagupta used negative numbers to represent debts, owing someone money. However, this interpretation was not sufficient for all mathematicians and many mathematicians still did not wholly accept negative number for hundreds of years.

All through the Renaissance mathematicians struggled with the concept of negative numbers and how we can work with them mathematically. They focused especially on how negative numbers effect which square roots can be found and how we find them. It was not until the 19th century that negative numbers were completely accepted by the mathematical community the way that they are today. So don't worry if you struggle with negative numbers, mathematicians struggled with them for over 1000 years!

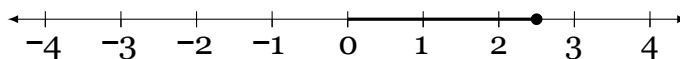
2 What are negative numbers?

As we know them today, **negative numbers** are numbers with a value less than zero, drawn to the *left* of zero on a number line.



Notice on the number line how -1 is the same distance from zero as 1 since they are both 1 away from zero. Likewise, -3 and 3 are both 3 away from zero. Since they are the same distance away from zero but in opposite directions, they are **opposites**.

On the number line below, we can count the distance from zero to find the **opposite** of the point.



Since the point is 2.5 units away from zero, its opposite is 2.5 units away from zero in the opposite direction: -2.5.

Find the opposites of the following integers:

1. 7
2. -11

3 Absolute Value

This distance from zero to a number is called the **absolute value** of the number. Since a number and its opposite are the *same* distance from zero, they will have the *same* absolute value. Absolute value is written by two parallel lines around the number; $|2| = 2$ (we read this as the absolute value of 2 equals 2).

Since the absolute value is a *distance*, it is always positive. (Remember the Greeks only had positive numbers because they were *distances*).

Ex.

$$|7| = 7$$

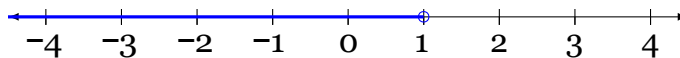
$$|-7| = 7$$

Find the absolute value of the numbers below.

1. $|31|$
2. $|0|$
3. $|-82|$

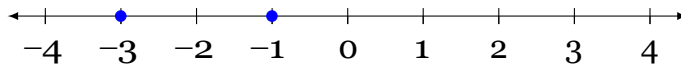
4 Comparing Negative Numbers

Consider the inequality $x < 1$. We know that x can be any number less than one. On a number line, we can graph the inequality as follows:



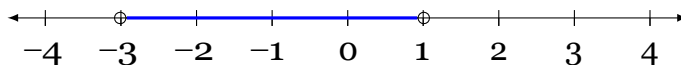
The blue line shows us all the different values for x . Notice how all the numbers *less than*, that is *smaller than*, one are to the *left* of one. This is true for any number. Anything to the **left** of that number is **less than** that number.

This includes the negative numbers. Look at the following number line:



From the number line we can conclude that $-3 < -1$ since -3 is to the left of -1.

We can also use a number line to solve inequalities like $3 < x < 1$. Notice that x is in between -3 and 1. We can see all these values on a number line:



Thus, x can be any number between -3 and 1, or any number on the blue line.

Draw a number line to compare the two numbers. Place a $<$ or $>$ in each blank.

1. 0 5

2. -6 -8

5 Absolute Value Versus Opposites

Review yesterday's lesson to write down the definitions and give an example for the following vocabulary words:

opposites:

absolute value:

Now that you have those definitions in front of you, notice the differences between the **opposite** of a number and its **absolute value**. The opposite of a number may be negative, but the absolute value is *always* positive.

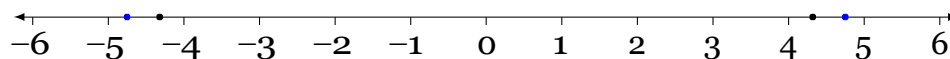
Find the opposite and the absolute value of the following numbers:

1. 88
2. -1243

6 Fractions

Yesterday we introduced the idea of negative numbers by considering the integers, the whole numbers. But what about fractions? Fortunately, fractions work just like whole numbers do: the opposite of $\frac{3}{4}$ is $-\frac{3}{4}$. With this in mind, list 4 values that are greater than -5 and less than -4:

One way to solve this problem is to consider all the numbers between positive 4 and positive 5. This includes numbers like 4.32, 4.5, $\frac{19}{4}$ and many more (infinitely many more). Now consider the opposite of these numbers. See the number line below:



Notice how since 4.32 (the black dot) is closer to zero than $\frac{19}{4}$ (the blue dot) in the positive numbers, the same is true of its opposite. -4.32 is closer to zero than $\frac{19}{4}$. Thus in the negative numbers, the less **absolute value** a number has, the closer a number is to zero and the *larger* it is. Zero is like a mirror reflecting the positive numbers, everything is flipped in the negative numbers.

List numbers in between each pair of numbers:

1. -1, 0
2. -2.5, -1.5

7 Fractions in General

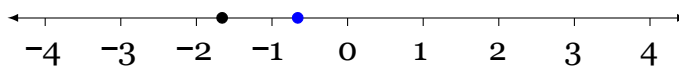
What is the opposite and the absolute value of $\frac{a}{b}$?

Just like with the integers, the opposite is the number that is the same distance away from zero. Thus, the *opposite* of $\frac{a}{b}$ is $-\frac{a}{b}$. The absolute value of the fraction is still its distance away from zero, so $|\frac{a}{b}| = \frac{a}{b}$.

Ex. Find the opposite and the absolute value of $-\frac{13}{25}$.

$$\begin{aligned} \text{opposite} &: \frac{13}{25} \\ -\frac{13}{25} &= \frac{13}{25} \end{aligned}$$

Ex. Compare $-\frac{2}{3}$, $-\frac{5}{3}$



Since $\frac{2}{3}$ is to the *right* of $\frac{5}{3}$ then we can conclude

$$-\frac{2}{3} > -\frac{5}{3}$$

Compare the following fractions by writing an inequality:

1. $-\frac{4}{5}$, $\frac{1}{4}$
2. $-3\frac{5}{7}$, $-3\frac{1}{2}$

8 Number Groups

Let's compare and contrast the following sets of numbers:

A: $\frac{2}{5}$, 9

Clearly, one of these numbers is a whole number and one of them is a fraction. However, recall that 9 can also be written as a fraction as $\frac{9}{1}$. So both numbers are fractions, but only 9 is a **whole number**.

B: -17, 13

In this case one is negative and less than zero. However, both numbers are considered **integers** because they can be written as a fraction over 1.

C: 0.33333333..., 0.3928471789808209100003165...

Both decimals continue on forever and do not terminate, but notice that the first decimal repeats the same digit (3) over and over while the second decimal does not repeat. In fact, 0.33333333... is just another way to write $\frac{1}{3}$, so the first number can also be considered a fraction but the second cannot!

D: π , $\frac{1}{2}$

Here we have an **irrational** number like π which continues forever and does not repeat any digits. In comparison, if we write $\frac{1}{2}$ in decimal form (0.5) it terminates. However, both numbers have established values on the number line.

9 Categorizing

In the previous section we noted that we have different types of numbers with different properties. In order to know what types of properties a certain number has, mathematicians have established the following categories.

whole numbers: This includes the counting numbers and zero (0,1,2,3,4,...)

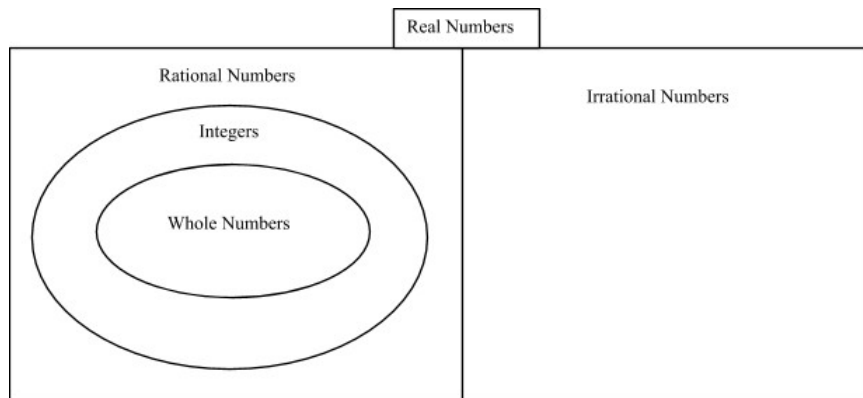
integers: whole numbers and their opposites, numbers who can be written as a fraction over 1 (...,-3,-2,-1,0,1,2,3,...)

rational numbers: numbers that can be written as a ratio of two integers (i. e. fractions), including the integers. This includes terminating decimals like 0.5 and repeating decimals like 0.333333..... since they also can be written as fractions.

irrational numbers: a number that is not rational (it doesn't fit into the other categories). Any decimal that does not terminate or repeat is considered an irrational number. There are many famous irrational numbers like the number π . Another famous irrational number is the $\sqrt{2}$, which was the first irrational number discovered by that famous Greek cult, the Pythagoreans.

real numbers: The real numbers is the largest category, it includes all the different types of numbers on the real number line, both rational and irrational.

An easy way to picture how all these categories are connected is by the following Venn Diagram:



When categorizing a number, make sure to put it in the *smallest* category to which it belongs. While it is true to say that 24 is a rational number, it is more precise to say that it is a whole number. To say it is a whole number gives us more information about the number's properties and how it behaves.

10 For Curious Minds

You will not be tested on this material, but it is interesting to know!

Each category of numbers is called a *ring* among mathematicians and each one has a specific letter.

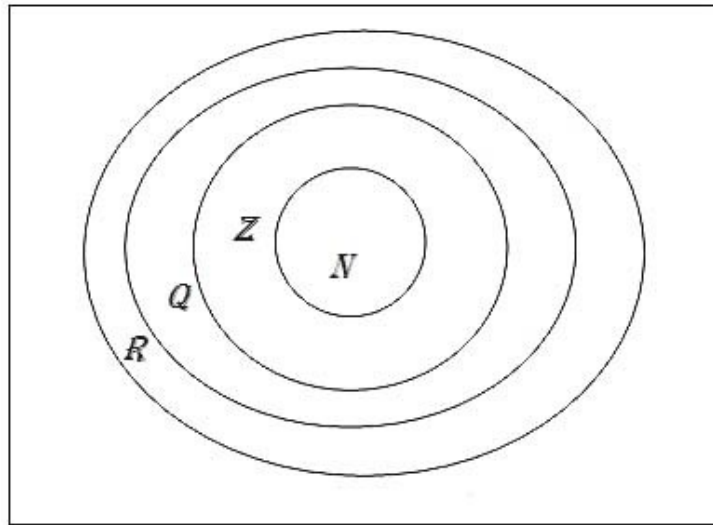
The whole numbers (without zero) are called the *natural* numbers and are denoted by N .

The integers are written as Z , which comes from the German word Zahl, for number. This is a result of significant work from German-speaking mathematicians, like Leonhard Euler.

The rational numbers are written as Q , for quotient. Remember that the fraction bar is another way of writing the division symbol.

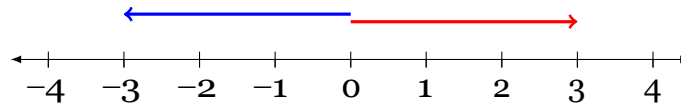
The real numbers are written as the letter R , for real.

Another way to see this relationship is in the following diagram:



11 Arrow diagrams

Look at the following arrow diagram:



The red arrow starts at zero and moves to the right 3 units, which can be written as

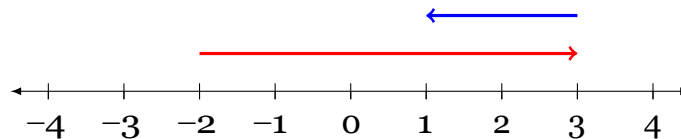
$$0 + 3 = 3$$

The blue arrow, on the other hand, starts at zero and moves to the *left* three units. Recall that addition and subtraction are **inverse** operations, so one way to interpret this arrow is with subtraction:

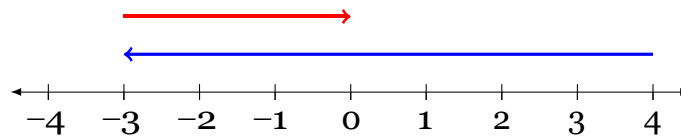
$$0 - 3 = -3$$

Write an equation for each number line using both arrows:

1.



2.



12 Inverses

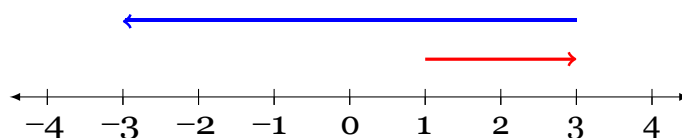
However, we also know that 3 and -3 are **opposites**, so their arrows are opposite directions as well. All negative numbers are to the *left* of zero, so this arrow also represents:

$$0 + (-3) = -3$$

Think back to division of fractions. In order to divide, we use the reciprocal (flip the number) and use the inverse operation, multiplication. In the case of negative numbers, instead of subtracting a positive number, we use its opposite and use the inverse operation. Thus, **adding a negative number is the same as subtracting a positive number**. The operations are flipped.

Now we know that any left facing arrow can either represent subtraction or addition of a negative number. Look at the following example:

Ex.

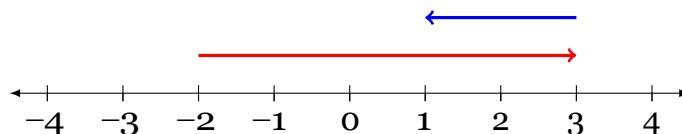


The first arrow starts at 1 and goes to the *right* two units: $1 + 2$. The next arrow goes to the *left* six units. So we are *subtracting* positive six or *adding* negative six. the final equation would look like this:

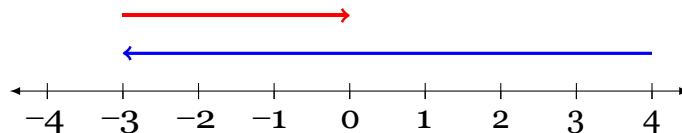
$$1 + 2 + (-6) = -3$$

Now write equations for these number lines using negative numbers:

1.

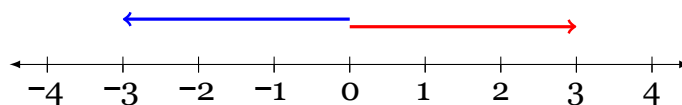


2.

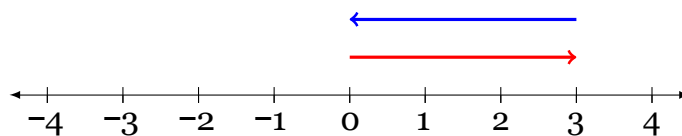


13 Absolute Value as Referee

Let's return to the first number line.



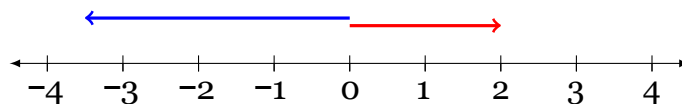
As we talked about, the arrow pointing to the *right* represents positive 3 and the arrow pointing to the *left* represents negative 3. Now, if we change the number line slightly, what equation does it represent now?



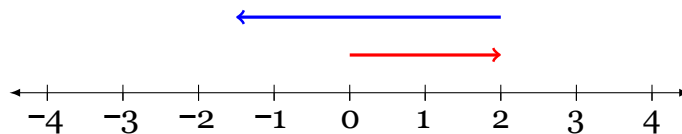
$$3 + (-3) = 0$$

This is because 3 and -3 are opposites: they are the same distance from zero and have the same **absolute value**. (Opposites are also called *additive inverses*, adding 3 and -3 "undoes" each other).

Now think about the the following two numbers:



In this case, it is clear that the blue arrow is much longer and therefore the **absolute value** of the negative number is greater, $|-3.5| > |2|$. Let's see what happens when we add the two numbers together:

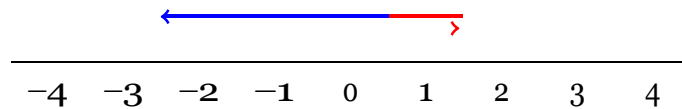


$$2 + (-3.5) = -1.5$$

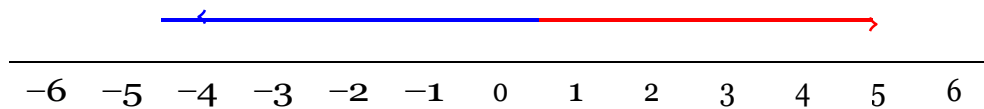
Since the absolute value of the negative number is greater than the absolute value of the positive number, the result is negative.

Look at the following number lines and state whether the result would be positive, negative, or zero.

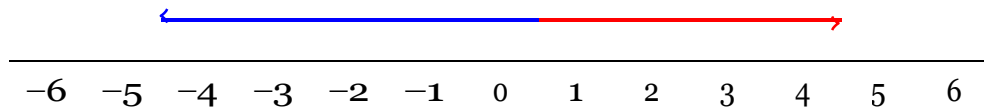
1.



2.



3.



14 Final Notes

Remember that addition is associative and commutative. If you've forgotten those properties, go look them up! They will help simplify solving addition problems with negative numbers.

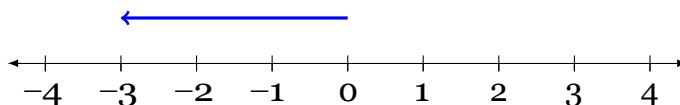
Fill in the blank:

1. The sum of two positive integers is a _____ integer.
2. The sum of two negative integers is a _____ integer.

15 Review

Yesterday we talked about adding negative numbers. Fill in the blank:
Adding a negative number is the same as _____ a positive number.

Recall that this is true because addition and subtraction are **inverse operations** and positive and negative numbers are opposites.



In the number line above, the blue arrow can either be seen as subtraction of a *positive* number **or** addition of a *negative* number.

$$0 - 3 = -3$$

$$0 + (-3) = -3$$

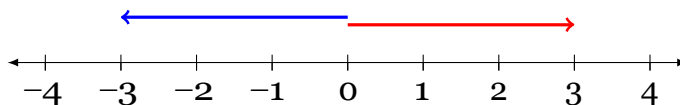
Rewrite the following equations changing the subtraction of a positive number into the addition of a negative number.

1. $8 - 5 = 3$

2. $13 - 16 = -3$

16 Number Lines

Let's look at the number line from yesterday:



We already said the left facing blue arrow can represent two things:

1. The subtraction of a positive number.
2. The addition of a negative number.

Since a positive number is to the *right* of zero, adding a positive number is shown by a *right* facing arrow. Since negative numbers are to the *left* of zero, adding a negative number is shown by a *left* facing arrow.

Now, if *subtracting* a positive number goes the opposite way, to the *left*, then what do you think happens when we subtract a *negative* number? The arrow also goes the opposite direction! Since *adding* a negative number goes to the left, *subtracting* a negative number is shown by a right facing arrow.

That tells us we can also interpret the red arrow two ways as well!

1. The addition of a positive number.
2. The subtraction of a negative number.

17 Subtracting Integers

Today we are focusing on the inverse of addition: **subtraction**. Now, we still have the same two basic facts from yesterday:

1. Addition and subtraction are inverse operations.
2. Positive and negative numbers are opposites.

From these facts we were able to transform the addition of a negative number into subtraction of a positive number.

What if we are *subtracting* a negative number? Just like with addition, we can use the inverse operation: change the subtraction into addition. Since we are using the inverse *operation* we also must use the opposite *number*. Thus, **subtracting a negative number becomes adding a positive number!**

Ex.

$$8 - (-4)$$

$$8 + 4 = 12$$

Notice how we use the inverse operation (addition) and the opposite number (-4). Practice using the inverse operation and the opposite number on the following exercises:

1. $7 - (-9)$
2. $-3 - (-5)$
3. $-2 - 8$

Notice in the last problem how changing the subtraction to addition $(-2) + (-8)$ makes the problem easier. $2+8=10$, so $(-2) + (-8) = (-10)$.

8. The Great Barrier Reef is the world's largest reef system and is located off the coast of Australia. It reaches from the surface of the ocean to a depth of 150 meters. What does -150 represent in this situation? (Why is it negative?) What does $| -150 |$ represent in this situation?
9. Give an example of a and b where a is negative, b is positive, and $|a| < |b|$.
10. Give an example of a and b where a is negative, b is positive, and $|a| > |b|$.
11. Give an example of a and b where both are negative, and $|a| < |b|$.
12. Give an example of a and b where both are positive, and $|a| < |b|$.
13. Give an example of a and b where $a < b$, but $|a| > |b|$.
14. Give an example of a and b where a is a greater distance from zero, but $a < b$. (What other problem is this identical to?)
15. Explain why $| |x| |$ is the same as $|x|$.
16. Simplify the expression $| - | -x | |$.
17. If Sue owes John \$50, interpret the meaning of -\$50 and $| -\$50 |$.
18. Give an example to show that $|a + b|$ is not always the same as $|a| + |b|$.
19. Give an example to show that $|a - b|$ is not always the same as $|a| - |b|$.
20. Explain why $|a \times b| = |a| \times |b|$.
21. If a is 5 units from 2, what are all the possible values of a ?
22. If b is 7 units from -1, what are all the possible values of b ?
23. If $|x|$ represents the distance from x to 0, what do you think $|x - y|$ represents?
24. If Object A is at an elevation of 500 feet and Object B is at an elevation of -700 feet, which object is farther from the surface of the earth? (What does an elevation of -700 feet mean?)
25. CHALLENGE: What is $\sqrt{4^2}$? What is $\sqrt{(-4)^2}$? Simplify the expression $\sqrt{n^2}$.

9. Give a real number that is not irrational.
10. Give an integer that is not a whole number.
11. Give a whole number that is not rational.
12. Give a number that is both rational and irrational.
13. Give a number that is both rational and an integer.
14. Give a number that is both a whole number and an integer.

Exercises

Classify each of the following numbers in as many ways as possible.

- | | | | |
|-------------------|---------------------|-----------------------|----------------------|
| 1. 6 | 2. -8 | 3. $\sqrt{5}$ | 4. $-\frac{6}{7}$ |
| 5. 0 | 6. π | 7. 56.789 | 8. 36.789898989... |
| 9. $6\frac{1}{2}$ | 10. $-\frac{18}{2}$ | 11. 0.34334333433334. | 12. $\frac{125}{10}$ |

Label each of the following statements as True or False. If the statement is false, explain why it is false.

13. All real numbers are irrational numbers.
14. Some rational numbers are irrational numbers.
15. All rational numbers are whole numbers.
16. All whole number are integers.
17. Some integers are negative numbers.
18. Some positive numbers are irrational numbers.
19. All integers are rational numbers.
20. 0 is a rational number.

For each of the following, given an example or explain that it is not possible.

21. Give an irrational number that is not a real number.
22. Give a whole number that is not an irrational number.
23. Give a rational number that is not a whole number.
24. Give a number that is both an integer and irrational.
25. Give a number that is both rational and a whole number.
26. Give a number that is both a negative and an irrational number.

Challenge Questions

Label each of the following statements as True or False. If the statement is false, explain why it is false.

27. A whole number plus a whole number is always a whole number.
28. An integer times an integer is always an integer.
29. An irrational number plus an irrational number is always an irrational number.
30. A rational number plus a rational number is always a rational number.
31. A whole number minus a whole number is always a whole number.

Remote Learning Packet

NB: Please keep all work produced this week. Details regarding how to turn in this work will be forthcoming.

April 13 - 17, 2020

Course: Physical Education

Teacher(s): James.Bascom@GreatHeartsIrving.org
John.Bascom@GreatHeartsIrving.org
Joseph.Turner@GreatHeartsIrving.org

Weekly Plan:

Monday, April 13

Mobility Routine

Tuesday, April 14

Workout

Wednesday, April 15

Mobility Routine

Thursday, April 16

Workout

Friday, April 17

Mobility Routine

Statement of Academic Honesty

I affirm that the work completed from the packet is mine and that I completed it independently.

I affirm that, to the best of my knowledge, my child completed this work independently

Student Signature

Parent Signature

Monday, April 13

General Mobility Routine (15-20 minutes)

All students are expected to complete Part I. 9th Graders are expected to continue the workout and complete Part II (any middle school student that would like an extra challenge is more than welcome).

Note: no equipment is required for this workout and only a minimum of space. If space is a challenge make modifications as necessary.

PART I:

1. Warmup by running for 2 minutes.
2. Then begin in a resting squat for 30s
3. Bear crawl forwards about 5 feet then straight back.
4. Step back into a pushup position
5. Perform 5 pushups
6. Downdog for 30s
7. Updog for 30s
8. Return to a pushup position
9. Perform 5 pushups

10. Stand up & perform 20 jumping jacks, 10 squats, 10 lunges, and 5 burpees
11. Return to a resting squat for 30 seconds
12. While in resting squat, perform 2 shoulder screws forwards, then 2 backwards, both sides
13. Bear Crawl sideways about 5 feet then return straight back
14. Step back into a pushup position
15. Step your right foot up directly outside your right hand
16. Then reach straight up toward the sky with your right hand & hold for 30s
17. Return to pushup position
18. Step your left foot up directly outside your left hand
19. Then reach straight up toward the sky with your left hand & hold for 30s

20. Return to pushup position
21. 5 pushups
22. Step your feet up to your hands and return to a resting squat
23. Remaining in the squat, grab your left ankle with your right hand and reach straight up toward the sky with your left hand & hold for 30s
24. Remaining in the squat, grab your right ankle with your left hand and reach straight up toward the sky with your right hand & hold for 30s

25. Hands down behind you Crab Walk forwards about 5 feet then straight back
26. Stand up & perform 20 jumping jacks, 10 squats, 10 lunges, and 5 burpees
27. Perform 3 slow Jefferson Curls
28. Rolling Bear Crawl x1 revolution one direction
29. Back Bridge for about 10-15 seconds
30. Rolling Bear Crawl x1 revolution in the opposite direction
31. Find a low hanging branch, pullup bar, ledge, rings, etc. to hang from for as long as you can hold

PART II:

1. Get into a plank
2. Alternate touching opposite elbow and knee for a total of 10 touches
3. Gorilla Hop x2 to the right
4. Gorilla Hop x 2 back to the left
5. Stand and perform 10 steam engine squats (fingers locked behind your head, every time you stand up from a squat touch opposite knee/elbow)
6. Hurdler's walk x6 steps forward
7. Hurdler's walk x6 steps backward
8. Frog Hop x2 forwards
9. Frog Hop x2 backwards

10. Get into a long lunge position
11. Keeping front foot flat on the ground, without touching the back knee to the ground, and trying to keep torso straight up and down slowly lower hips toward the ground. Hold for 15 seconds
12. Switch legs and repeat (hold for 15 seconds)
13. 3 slow Jefferson Curls
14. Rolling Bear Crawl x1 revolution one direction
15. Back Bridge for about 10-15 seconds
16. Rolling Bear Crawl x1 revolution in the opposite direction
17. Find a low hanging branch, pullup bar, ledge, rings, etc. to hang from for as long as you can hold

Tuesday, April 14

Warmup:

1. 3 minute warmup jog
2. 10 jumping back, 5 squats, 1 pushup x3

Workout:

The workout today is a High Intensity Interval Training (HIIT) workout. All this means is that during each set you will be doing as many exercises as possible at maximum intensity for a set amount of time then resting for a set amount of time. It will be up to you to choose exactly what your work/rest times are, but these are our recommendations: 6th grade - 30 seconds work / 30 seconds rest; 7th - grade 35 seconds work / 25 seconds rest; 8th grade - 40 seconds work / 20 seconds rest; 9th grade - 45 seconds work / 15 seconds rest. Remember, these are just guidelines. The harder you make this workout for yourself the better for you it will be.

Set 1. Shuttle run - sprint back and forth between two lines approximately 10 meters apart

Set 2. Burpees

Set 3. One legged hops - using the same two lines, 10 meters apart, hop on one leg one direction and the other leg back

Set 3. Alternate 6 squat jumps, 6 jump lunges, 6 jumping jacks

REPEAT THIS SEQUENCE AT MAXIMUM INTENSITY FOR 12 MINUTES

Nota Bene: Depending on what equipment you have available there are a lot of fun options you could throw in: Box jumps, box jump burpees, jump rope, slam ball exercises, hitting a tire with a sledge hammer. Feel free to add any of these or similar high intensity exercises to this workout.

Wednesday, April 15

Repeat *General Mobility Routine (15-20 minutes)*

Thursday, April 16

Warmup:

6 minute jog

Workout:

6th grade: rest 45 seconds in between each round

7th grade: rest 30 seconds in between each round

8th grade: rest 15 seconds in between each round

9th grade: no rest in between each round

Round 1	Round 2	Round 3	Round 4
10 second plank	15 second plank	20 second plank	30 second plank
Bear crawl 5 meters	Bear Crawl 10 meters	Bear Crawl 5 meters	Bear Crawl 10 meters
5 pushups	Max reps pushup set	5 pushups	Max reps pushup set
10 second plank	Bear Crawl 10 meters	20 second plank	Bear Crawl 10 meters
10 jumping jacks	Crab Walk 10 meters	20 jumping jacks	Crab Walk 10 meters
	50 jumping jacks		100 jumping jacks
	Crab walk 10 meters		Crab Walk 10 meters

Friday, April 17

Repeat *General Mobility Routine (15-20 minutes)*

Remote Learning Packet

NB: Please keep all work produced this week. Details regarding how to turn in this work will be forthcoming.

April 13 - 17, 2020

Course: 6 Nature of Science

Teacher(s): Mr. Brandolini david.brandolini@greatheartsirving.org

Mr. Mooney sean.mooney@greatheartsirving.org

Mr. Schuler david.schuler@greatheartsirving.org

Weekly Plan:

Monday, April 13

- Read “Anaximenes” on pp. 91-92 of the *Nature of Science*
- Read Supplementary Material: Anaximenes (see below)
- Complete the day’s reading worksheet questions

Tuesday, April 14

- Read “Pythagoras” on pg. 93 of the *Nature of Science*
- Read Supplementary Material: Pythagoras (see below)
- Complete the day’s reading worksheet questions

Wednesday, April 15

- Read Supplementary Material: Heraclitus (see below) (Read the Supp. Material first)
- Read “Heraclitus” on pp. 94-95 of the *Nature of Science*
- Complete the day’s reading worksheet questions

Thursday, April 16

- Read Supplementary Material: Parmenides (see below) (Read the Supp. Material first)
- Read “Parmenides” on pp. 96-97 of the *Nature of Science*
- Complete the day’s reading worksheet questions

Friday, April 17

- Read Supplementary Material: Empedocles (see below)
- Read “Empedocles” on pg. 99 of the *Nature of Science*
- Complete the day’s reading worksheet questions

Statement of Academic Honesty

I affirm that the work completed from the packet is mine and that I completed it independently.

I affirm that, to the best of my knowledge, my child completed this work independently

Student Signature

Parent Signature

This week we continue our study of the earliest of the natural scientists, the Pre-Socratics. These earliest of scientists show us what it means to ponder carefully the most fundamental questions about the natural world. We hope you enjoy! Remember that you (or your parents) can reach out to us with questions.

NB: Please note carefully which order you should complete the readings. Please do follow the order, but it is a good idea to have them side by side throughout so you can consult back and forth as questions and insights arise.

Monday, April 13

1. NoS pp. 91-92
2. Special Reading: Anaximenes
3. Worksheet

Tuesday, April 14

1. NoS p. 93
2. Special Reading: Pythagoras
3. Worksheet

Wednesday, April 15

1. Special Reading: Heraclitus (Read the Special Reading before the textbook)
2. NoS pp. 94-95
3. Worksheet

Thursday, April 16

1. Special Reading: Parmenides (Read the Special Reading before the textbook)
2. NoS pp. 96-97
3. Worksheet

Friday, April 17

1. NoS p. 99
2. Special Reading: Empedocles
3. Worksheet

Chapter Five: Anaximenes

Thales vs. Anaximander

- Thales: Water, you see, is the perfect choice. It is abundant, it surrounds the land, it is basic, it can be in solid, liquid, or ga—
- Anaximander: Yes, yes, but how do you explain the existence of *fire*? Water and fire are opposites, and opposites are continually at war with each other. If it was all water and no fire in the beginning, fire could never have come to be.
- Thales: But that's true of *any* substance you choose, not just water. What else could it be?
- Anaximander: The *indefinite*.
- Thales: The what?
- Anaximander: Material without any real, definite form to it, and so without any opposites.
- Thales: Can you *show* me this "indefinite"?
- Anaximander: Well, not exactly... It has turned into all of the substances we see.
- Thales: How are you so sure it existed then?
- Anaximander: I mean...what else could it be?
- Thales: Hmm...

Did you catch the problem that Thales is pointing out? The *indefinite* may solve the opposites problem, but it creates a new problem—that no one has any experience of the indefinite. While that does not mean it cannot exist, it makes us less certain.

Along Comes Anaximenes

There was a young man who lived at the same time as Thales and Anaximander, and in the same city too. His name was Anaximenes (an-ax-SIM-uh-nees). Anaximenes is thought to be 24 years younger than Anaximander, and—you guessed it—a student of his. He must have heard many arguments like the one above,¹ and he must have wondered about these questions a lot.



Have you ever had to make a choice between two options that *both* seem very good to you? If you have, you may have some idea of the dilemma that Anaximenes was in. Both arguments were really good—how could he choose? Well, Anaximenes did what many people do

¹ Ok, not *exactly* like the one above.

when faced with a decision like this—he tried to choose both. And the way he did so was one of the greatest strokes of scientific genius the world had ever seen.

Anaximenes' Solution

In order to choose what was great about both systems, Anaximenes proposed an entirely new idea. He said that the ultimate material principle of the universe was...

Air!

Why was this a stroke of genius? Why, because it captured the best things about both theories! Read on, and you shall see.



Back to the Basics

Anaximenes, like Thales, chose a substance that we all know and experience daily. It is one of those basic, fundamental substances that we find everywhere in our world. And it turns out, most of the good arguments for water also apply to air. Look:

Water	Air
Water is everywhere and in abundance.	Air is everywhere and in abundance.
Water surrounds the land on every side.	Air surrounds and covers the entire earth, like a blanket. Have you ever been anywhere where there wasn't any air?
Water is basic. That is, it seems that you cannot mix ingredients together to make water.	Air, in a similar way, is also basic. Air is just <i>there</i> . It does not seem to be <i>made of</i> other things.
Water is fluid and changeable. It takes on any shape, depending on the container it is in.	Air is also fluid and changeable. If you have ever seen someone make balloon animals, you are well aware of air's fluidity.
Water is essential for life.	Air is similarly essential for all living things. Both plant and animal life ² depends on a steady supply of air.

As you can see, many of the arguments in favor of water can be applied equally well to air. At this point, air and water may seem to be about equal. But just wait to see how air handles Anaximander's objection.

² Yes, even fish! Their gills allow them to breathe in the air that is mixed into the water.

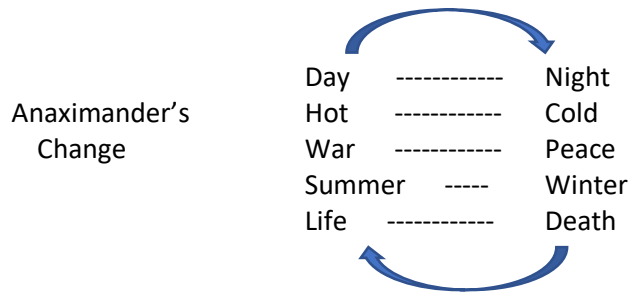
Answering Anaximander

Not only does air have the strengths of water, it also has some of the strengths of the indefinite—indeed, many of air’s characteristics make it seem very much like the indefinite. Air has no visible size or shape, hardly any visible qualities at all. In general, it seems a little more neutral than water or fire, and does not seem to be intensely opposed to anything in the way that water and fire are. Really, if you were going to find a real-world material substitute for Anaximander’s *indefinite*, you could not do better than air.

But these similarities, on their own, are not enough to answer Anaximander’s challenge. To answer Anaximander’s challenge, Anaximenes had to do some thinking about *change*.

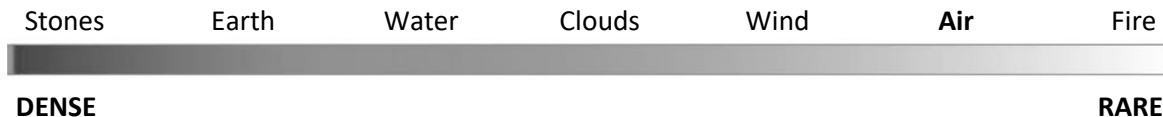
A Brand-New Pair of Opposites

Anaximander, as you will recall, saw all change as a kind of back-and-forth war between opposite forces. And there were tons of these forces everywhere in the world.



Anaximenes agreed, in part. He said yes, there were opposites—but not so many. In fact, he said, there were only *two opposites*: **density** and **rarity**.³

When something is changing, it is becoming either more or less dense. And what exactly is the “it” that is getting more or less dense? You got it—air! Anaximenes understood every material in the world as a denser or rarer form of air. He laid them out in this order:



Air could become water by becoming denser—a process called **condensation**. Water could become earth or stones by further condensation. Air could become fire by becoming rarer—a process called **rarefaction**. All the change that you see in the world, said Anaximenes, can be explained by changes in density.

Do you see how this solves Anaximander’s challenge? Air is not the *opposite* of anything—it is just in a different place on a continuous spectrum between two opposites, rarity and density. Under this system, fire and water are also not opposites—they are just different densities of air.

³ *Density*, as you’ll recall from Chapter 1, is about how tightly packed together the matter is (lead is denser than feathers); *rarity* is about how spread out the matter is (feathers are rarer than lead).

Evidence for Air: Changes in Material

There is plenty of evidence to support Anaximenes' theory of change.

One of the most common and well-known examples is with the evaporation and condensation of water. We all know—and people at the time knew it too—that water is getting less dense when it evaporates or turns into steam. So water becomes “air”⁴ through rarefaction. And then it becomes a cloud and, eventually, rain, through the process of condensation. Thus, condensation and rarefaction do a perfectly good job of explaining how water can become air, and air can become water.



It is easy to observe the rarefaction and condensation of water.

Other examples are easy enough to think of. Say you have a little pile of dirt in your hands and you throw it into the air and becomes a cloud of dust. This would be a process of rarefaction (the dust is becoming *less dense* by spreading out) and the resulting cloud would be something closer to air. But that same pile of dirt, as you can imagine, could be packed together so tightly into such a dense form that it becomes a rock.⁵

More Evidence for Air: Other Apparent Opposites

Condensation and rarefaction, the only true opposites, can also explain why there appear to be other opposites. Hard and soft, for example, seem to be opposites, but really, when a thing becomes harder, it is really just becoming denser, and when a thing becomes soft it is really just becoming rarer.

Condensation and rarefaction, however, could also explain opposites that were not so obvious. Demonstrating this was one of Anaximenes' great achievements. He managed to show that, although they may seem unrelated, condensation and rarefaction actually explain changes between *hot and cold*.

To show this, Anaximenes' appealed to an experience that everyone can have. Put your hand next to your mouth and exhale with your mouth wide open. Do you feel that it is warm? Now, purse your lips so that there is only a small opening, and blow through it. Do you feel that it is cold? Anaximenes explained that when your mouth is wide open, the air coming out is *rarer*; when you make the opening smaller, you *condense* the air—and that makes the air colder! This, said Anaximenes, proves that even pairs of opposites that you would not expect, like hot and cold, ultimately depend on density and rarity.

The Soul of the Cosmos

Thus, by explaining change in a different and very convincing way, Anaximenes has avoided the problem that Anaximander pointed out with Thales' water, and at the same time was able to choose a substance that is part of the world we experience. Well done, Anaximenes!

At this point, however, one might ask: when Anaximenes solved the problem of change, why didn't he simply go back to Thales' answer of water? Couldn't we just as easily say that everything is simply the condensation and rarefaction of *water*?

Anaximenes' reason may surprise you. He preferred air because our souls, he said, are made of air. This was a commonly held belief at the time, and not without good reason. After all, one of the first ways to

⁴ Steam or water vapor can be thought of as water in air form.

⁵ There is actually an entire class of rocks that are formed this way. They are called *sedimentary* rocks.

check if a person or an animal is alive is to check for *breathing*. While air is flowing in and out of us, we are alive; when air stops moving through us, we die. Furthermore, just as the soul is the unseen mover of the body, so air is an unseen mover of the world around us. Have you ever seen the branches and leaves of a tree stirred to life, or *animated*, by the wind? For these reasons, many of the ancients said that the soul is breath or air.⁶



Have We Done It?

Anaximenes seems to have done it—what better choice is there than air? How could anyone object to this? As you’ll see, actually, many natural scientists following Anaximenes have disagreed with him and proposed new theories. His insights, nevertheless, had a lasting effect and shaped the way others after him—even those who disagreed with him—thought about change and the material causes of the natural world.

⁶ The Latin word for soul, “*anima*” (from which we get words like animated and animal) itself comes from an earlier root meaning “breath.”

Name: _____
Section & Course: _____
Teacher: _____
Date: _____

The Pre-Socratic Philosophers: Anaximenes
Nature of Science textbook: pp. 91-92
Supplementary Readings: pp. 1-5

1. Anaximenes was a student of _____.
2. Anaximenes said the ultimate material principles of the universe was _____.
3. Anaximenes' idea solved some of the concerns of the ideas of both _____ and _____.
4. Anaximenes did not think there were as many opposites as Anaximander. He said there were only _____ opposites:
 - a. _____
And
 - b. _____
5. What does rarity mean? (see the side bar on p. 91) (Use a complete sentence, please.)

6. Put the following in order from dense to rare.

Water	Stones	Earth	Fire	Air	Clouds	Wind
-------	--------	-------	------	-----	--------	------

Most Dense:
Most Rare:

(Worksheet continues onto the next page)

7. How does Anaximenes' insight solve Anaximander's challenge?
 - a. By showing that fire can come out of its opposite, water
 - b. By showing that the *indefinite* does not exist
 - c. By showing that change is really just a series of opposite forces switching places
 - d. By showing that air is not the opposite of anything and that water and fire are not opposites after all
 - e. By showing that the indefinite is a visible substance (air) we all experience everyday

8. What was Anaximenes' trying to prove by having you experience the difference between blowing hot air when your mouth is open wide and cool air when it is closed?
 - a. Condensation and rarefaction cause changes between hot and cold
 - b. Air is on a spectrum between less dense and more dense
 - c. Water and fire are not opposites after all
 - d. The indefinite is made of matter
 - e. Hot air is less dense than cold air

9. One of the main reasons Anaximenes chose air over water has to do with the fact that the ancients commonly held that a person's soul was made of _____.

Chapter Six: Pythagoras

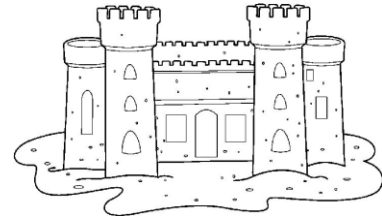
The “Milesians”

The thinkers that we have seen—Thales, Anaximander, and Anaximenes—were searching for an ultimate material principle—something out of which everything in the world is made—while at the same time trying to explain the change that they saw around them. These three thinkers were all from the same city of Miletus, in an Eastern region of the Greek world, called Ionia. These thinkers, since they all lived in *Miletus*, have come to be known as the “*Milesians*.” Meanwhile there were thinkers in the western parts of the Greek world that were also beginning to think scientifically about the natural world. They, as you will see, had a somewhat different approach.

Harmony

When these western thinkers looked at the changing world around them, they wondered less about the *material* that made everything up, and wondered more about what *held it all together*.

If you were one of these western thinkers, you might look at a sandcastle, for example, and wonder less about what is made of, and wonder more about why all the sand is staying together to form *one, unified* sandcastle.

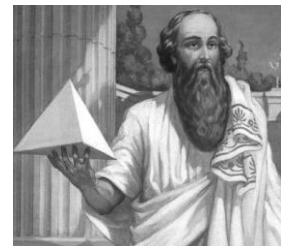


You might similarly look at a chicken, and think less about its material and more about why the materials are staying together to form *one, unified* chicken.

You might similarly look at *every individual thing* in the entire universe, and indeed the entire universe as a whole, and wonder why the materials are coming together to form *unified* wholes.

Pythagoras

The first to think these kinds of thoughts was a man named Pythagoras (pih-THAG-or-us). The life of Pythagoras is shrouded in mystery. We know very little about him. Even people who lived at the same time and in the same city hardly knew anything about him! He was intentionally secretive and silent. He shared his secrets only with his group of followers, a secret society or brotherhood of sorts, and they all believed the same things, followed the same rules, and observed the same rituals—and all were secretive and silent. If you were not part of this secret brotherhood, his thoughts and actions remained mostly a mystery to you.



There are, however, *some* things that we have managed to learn from some of his followers. Some are rather strange—for example, he is said to have commanded his followers never to eat beans. Other ideas of his were more important. Most important of all, it seems was his understanding of *mathematics*.

Mathematics

“Math? But what does math have to do with natural science?” you might ask. Quite a lot, in fact. Pythagoras might answer, it has *everything* to do with natural science. Indeed, Pythagoras said he knew what held everything in the world together: it was *number*.

Unity

Remember that Pythagoras is looking for the principle of harmony and *unity*: what holds things together and makes them *one*. The word unity itself comes from the Latin word meaning “*one*.” And the thought of *one* is a mathematical thought—one is the basis for every number that there is.

The Tetractys

If you were a “Pythagorean,” (that is, if you belonged to Pythagoras’ secret society), one of your most beloved symbols was the *tetractys*. Followers of Pythagoras loved it so much that some historians say they actually *worshipped* it.

The Tetractys is the first four numbers, added together.

Take the first number, *one*.



Then add the next number, *two*.



And the next, *three*.



And, lastly, *four*.



And what do you get? Ten, a perfect number! You also get a perfect equilateral triangle,⁷ which is one of the most perfect and beautiful shapes. (Do you see that you can count *four* on each side?)

The number ten, such a perfect number, formed in such a perfect and harmonious way by the first four numbers! If such order, and harmony, and perfection, and unity could be found in number, perhaps number was the principle of such order and harmony in the whole cosmos.

The Pythagorean Theorem

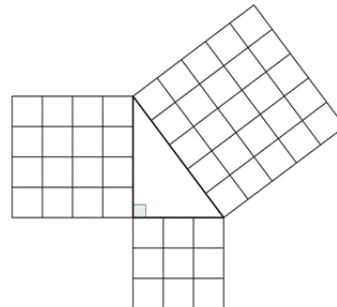
Have you ever heard of the “Pythagorean Theorem”? Perhaps you have had to memorize it in a math class at some point in your education. It is usually written: $a^2 + b^2 = c^2$. You have now met the person it is named after!

The Pythagorean Theorem is a truth about right triangles (triangles with one right angle) and the squares built on the sides.

If you take any right triangle, like this one,

and build perfect squares on its sides,

the sum of the areas of the squares on the legs will *always* equal the area of the third square on the hypotenuse.



If you don’t believe me, just count!⁸

⁷ A triangle with all three sides equal to each other.

⁸ If you want to be *really* certain that this is true of *every* right triangle, just wait: you will learn the proof of it in 9th grade when you study Euclid’s *Elements*.

If numbers and shapes could come together in such perfect harmony in this way, this is another good reason to believe that they were responsible for all the harmony and order in the universe.

Musical Ratios

Evidence that number was responsible for order and harmony in the material world is found again, in a special way, in *music*.

Say you have an instrument with strings, like a guitar. Pythagoras noticed that different lengths of strings, produced different pitches.

For example, a string of 10 inches 10 _____

makes a different pitch than a string of 5 inches. 5 _____

When these two strings are played together, they sound very good, or *harmonious*, together.

But only *some* lengths sounded harmonious; other combinations sounded jarring or harsh (dissonant). The important realization that Pythagoras had was that:

*the **number of inches of the strings** was responsible for the **harmony** in the sound.*

He played the following strings together, and found *they all produced the same harmony (or chord)*:

A 10-inch and 5-inch string, 10 _____
5 _____

8-inch and a 4-inch string, 8 _____
4 _____

6-inch and a 3-inch string, 6 _____
3 _____

2-inch and a 1-inch string. 2 _____
1 _____

Do you see what is going on here? The ratios are all equal! As long as the string-lengths had the same *ratio*, they made the same harmony! You can tell, from your study of fractions, that all of these ratios of the strings shown above are equal:

$\frac{10}{5} = \frac{8}{4} = \frac{6}{3} = \frac{4}{2} = \frac{2}{1}$
--

It was by experimenting with these ratios that Pythagoras figured out the harmonies in the first musical scale (still called the Pythagorean scale to this day).

Indeed, it seemed that *number* was responsible for musical harmony. And music is such a perfect illustration of the harmony and discord found in the world: so many different sounds and pitches, all brought together to form a beautiful, harmonious, and ordered unity in the music. Just listen to a good piece of classical music and you will know exactly what I mean.

The fact that *number* was in some way responsible for harmony in music is a good indication that number is harmonizing not only music, but the entire universe.

Pythagorean Thoughts Today

As strange as the initial claim may have sounded—that everything is *number*—it turns out that we ourselves, to some degree, are still Pythagoreans.⁹

How do you explain that, if you drop a rock from a very tall cliff, you can describe the distance it falls (d) in a given time (t) with the equation $d = \frac{1}{2}gt^2$? When you study Physics in high school, you will see how mathematical equations like this can describe all sorts of motions and other natural phenomena. Other natural sciences too, use equations all of the time. Chemistry, as you will see, makes use of equations, and even Biology has some ways of using it.

Lastly, consider one of the most famous scientific discoveries of all time, made in more recent times by a natural scientist named Albert Einstein. His contribution to our understanding of the universe is an *equation*:

$$E = mc^2$$

Indeed, natural scientists today, in many ways, are still following Pythagoras' line of thinking. Truly, the more examples that you think of, the more reasonable it starts to seem that *number* is somehow an underlying principle controlling and harmonizing everything in the universe. Of course, we don't want to take it *too far*—we wouldn't want to *worship* number¹⁰—but it does seem that Pythagoras was really on to something when he said that number was the principle of harmony and order in the universe.

⁹ Except that we can eat as many beans as we'd like to.

¹⁰ Some scientists today, unfortunately, make the mistake of saying that you cannot truly know something unless you can describe it with numbers and equations. While not exactly number worship, it seems to be getting too close. Although number is so important for our knowledge of many things, there is much that we can know scientifically that cannot be described with number and equations.

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The Pre-Socratic Philosophers: Pythagoras
Nature of Science textbook: p. 93
Supplementary Readings: pp. 8-11

10. The Pythagoreans were the first to advance the study of _____.
11. The One is composed of both the _____ and the _____.
12. Complete this line from p. 93: “And indeed all things that are known have _____.”
13. Thales, Anaximander, and Anaximenes were known as the _____, and they were from the Eastern part of the Greek world.
14. Pythagoras, however, was part of a group of thinkers from the _____ region of the Greek world.
15. What united the Eastern and Western thinkers was that *change* was a key point of reflection. A key difference, though, was that the Milesians were more concerned with the *material* making up the universe and the Western thinkers were more concerned with what _____ it [the universe] _____.
16. Pythagoras said that what held everything in the world together was _____.
17. Draw the Tetractys and answer the following questions:
 - a. What is $1+2+3+4$ equal to? _____
 - b. How many dots are there in the tetractys? _____
 - c. What shape does the tetractys form? A perfect _____



18. Pythagoras' reflection on musical ratios led him to realize that there was a crucial connection between:

- a. Matter and Harmonious Sound
- b. Musical Harmony and Light
- c. Number and Musical Harmony
- d. Math and Natural Science

19. What evidence is there that modern people like us are very much influenced by Pythagoras?

- a. Most people believe number is the fundamental structure of the universe.
- b. Natural scientists continue to explain fundamental things about the universe in terms of numbers and equations.
- c. Many current thinkers use ratios to explain harmony.
- d. We are not allowed to eat beans.

Chapter 7: Heraclitus

Hidden Wisdom

*"We step into and we do not step into the same rivers.
We are and we are not."*

"A dry soul is wisest and best."

*"All things are an equal exchange for Fire
and Fire for all things."*



These cryptic little passages are some of the few surviving writings of our next thinker, a man named Heraclitus (HAIR-uh-CLITE-us). If his words sound confusing to you, you are not alone! They are difficult to understand, because Heraclitus actually wrote with the *intention* of making his words hard to understand—that way, only the truly wise, who persevered in trying to figure out what he meant, could actually attain his wisdom.¹¹

Unity of Opposites

"The path up and down is one and the same."

Do you remember Anaximander's ideas about change—pairs of opposites, always at war with each other? Well, Heraclitus noticed these opposites too, and called the war between them "*strife*." But then he said something radically new and different. What we normally think of as two opposites, he said, are actually one and the same reality.

"What on earth does this mean?" you might ask. "*Opposites are the same? But 'opposite' and 'same' are opposites!*"

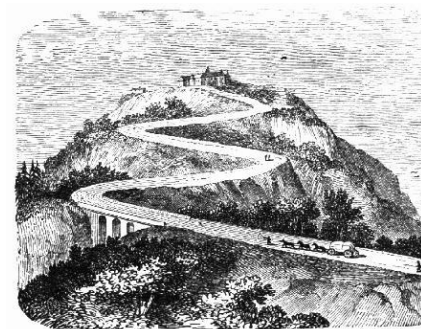
"That's right," responds Heraclitus with a little smile, "*they are opposites. And they are the same.*"

Examples of the Unity of Opposites

How confusing! Luckily, Heraclitus gave many examples, like the one quoted above: "*The path up and down is one and the same.*" People say that up and down are two different things, but they are failing to see the underlying reality: the path that leads *up* a hill is the *same exact path* that leads *down*. Up and down are really just two aspects of the same reality.

Similarly, people think that "pure" and "polluted" are opposites, but look:

*"Sea is the most pure and the most polluted water;
for fishes it is drinkable and salutary [healthy],
but for men it is undrinkable and deleterious [harmful]."*



Seawater is thus both opposites—pure and polluted—at the same time. What makes seawater pure and healthy for fish is the *same thing* that makes it polluted and unhealthy for us (the saltiness of it). What seems to be two opposites is actually just two aspects of the same thing—salty water.

¹¹ Heraclitus was generally disliked by people at the time, who thought he was arrogant and snobby for doing this.

“One man’s trash is another man’s treasure”¹² is a similar saying that is commonly used today. Trash and treasure, though opposites, are united in the same one object.

Logos: The Unity and Harmony in All Things

Wisdom, says Heraclitus, lies in seeing the underlying unity in things, especially the unity of opposites. To see the unity in all things, is to know what he calls the “*Logos*”¹³, which is the principle of harmony and unity in the cosmos. Does this sound familiar? Pythagoras was in search of the same thing, and he said that it was *number*. Heraclitus here declares that the unifying principle is not number, but *Logos*.

To get a sense of what *Logos* is, take a look at these examples:

When you see that the path up is the path down, you are seeing the *Logos* that unites them.

When you see that pure and polluted are the same, you are seeing the *Logos* that unites them.

Indeed, when you see that disease and health, weariness and rest, feast and famine, war and peace, waking and sleeping, yes even life and death—when you see that these are the same, then you have seen the *Logos* that unites them.

Balance and Strife

Are there really no opposites then? Was Anaximander wrong? Well, not exactly. Heraclitus, as you might expect by now, would reply: “There *are* opposites, and there *are not* opposites.”

This again, can be confusing. Luckily, again, Heraclitus gave us an image to illustrate how opposites are related. The image is that of a bow:

Look at the opposite ends of the bow. Do you see how they are both pulling on the string, in *opposite* directions? If you are in archery club, or have ever used a bow, you have first-hand experience of the fact that these opposite ends are actually pulling very hard on the string.¹⁴

The constant pulling of the opposite ends of the bow is what Heraclitus would have described as constant *strife* (or war) between the two opposites.

Notice also, however, that neither side is winning—in the constant strife between opposites, the opposites are always perfectly *balanced*.

Lastly, we should notice—are there really two opposites here? Well, yes in some sense there are: the two opposite ends of the bow. But those opposites ends are ends of *one and the same* bow, so in another sense these opposites are actually one and the same.



¹² This is not one of Heraclitus’, but he said many things like it, such as: “Donkeys prefer rubbish to gold, [and men gold to rubbish].”

¹³ Do you recognize this word? We saw earlier this year that it meant “study of.” It actually has *many* meanings in Greek, and Heraclitus is using it to mean something a little different, as you will see.

¹⁴ Earlier this year, Mr. Turner let me shoot an arrow with his bow, and I got to have this experience firsthand.

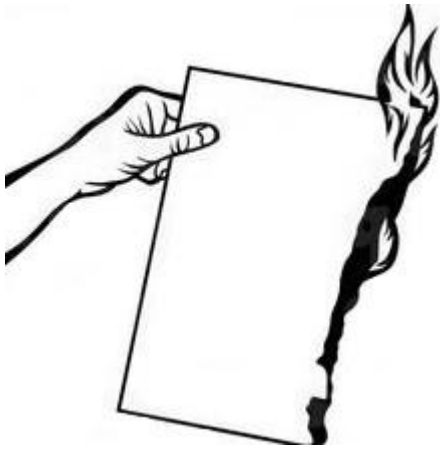
The Natural World

Heraclitus saw all of these principles in the natural world. The cosmos was unified and harmonious—there was some *logos* that was holding it all together. But there was also much *strife*, much war between opposites, that resulted in all of the change that we see. This strife, he said, always balanced out in the end.

Unity, harmony, *Logos*, strife, balance, change—to see how Heraclitus saw all of these things working together in the natural world, let's take a look at his favorite image: fire.

Fire

Let us imagine a fire, slowly burning a piece of paper, like the one pictured below.



Watch, in your imagination, as the fire consumes the paper.

Bit by bit, the paper turns to ashes and smoke.

We are already familiar with this as a good image of **change**: paper changes into smoke and ash. It's also a good illustration of the **strife** or war that Heraclitus says is involved in all change.

In some sense the fire is raging—we see the strife. But look how slowly and evenly and steadily it is burning—is there not also here a sense of **balance**?

And finally, what is at the heart of all of it, **bringing together** and **uniting** strife and balance, causing and directing the change from paper to smoke? That's right—*Fire*.

The Three World Masses, Governed by Fire

Fire, as we just saw, unites all of Heraclitus' ideas about the world into one. This had a profound effect on how Heraclitus saw the natural world.

Previous thinkers had said that all was water, or all was air; Heraclitus responds that no, everything is *fire*. But he goes even further than those thinkers went with their materials—it was not only the material out of which everything was made, it was also the *cause* of all changes and the *director* of those changes. Fire, in a very real way, was *in charge of the cosmos*.

The cosmos, he said, consists of three main substances: earth, water, and fire. These substances could all change back and forth between one another. Earth could change to water, water could change to fire, and so on. But, in all of this, fire is in charge, directing every change. All things can turn into fire, and fire can turn into all things.

*"All things are an equal exchange for Fire and Fire for all things,
as goods are for gold and gold for goods."*

He also says:

*“This cosmos...always was, is, and shall be: an everlasting fire,
kindling in measures and going out in measures.”*

This is his explanation of the world that we see around us. The whole universe is an everlasting fire, though it is never all on fire at once: part of it is kindled, and another part goes out. Part of it (e.g. the sun) is on fire right now, while part of it (e.g. a mountain) is not currently aflame.

Do you see his central ideas coming through again here? There is change and strife, as parts of the world go up in flame. But there is also balance, for not all is burning at once. And underlying all of the things that we experience—earth, water, fire, and all the changes that we see—there is a single thing unifying them all, the *Logos* of the natural world: *fire!*

The Soul is Fire

Not only is the entire visible, material world made of fire and changed by fire, but even our very souls are fire.

The idea that the soul is fire actually has a long tradition and was indeed a common idea at the time. And it makes sense if you think about it. When you feel something very strongly, your heart is *burning*. When you feel full of life and energy, you feel like you’re *on fire*. And conversely, when a person dies—and the soul has left the body—the body loses its heat and becomes cold.

So, Heraclitus says, the soul is fire. And look at how well this idea corresponds to the rest of his theory:

What unites all the material parts of the universe? → Fire!

What unites all the material parts of the human body? → Soul!

What directs and governs all action and change in the universe? → Fire!

What directs and governs all the actions and changes of a human being? → Soul!

Heraclitus said that every human soul is actually a little piece of the great cosmic fire, and would rejoin that great cosmic fire after death.

He also explained why wisdom is good for the soul, in this way. The soul, he said, is fire. And fire is the *Logos*. Therefore, when the soul (which is fire) comes in contact with the *Logos* (which is also fire), it is enflamed and burns brighter than ever. And this—when the soul unites with the *Logos*—is what we call wisdom.

Conclusion

Are you starting to get a sense for how Heraclitus thought about the world? It is hard to understand, to be sure—probably the most difficult theory we have seen yet. Indeed, Heraclitus *wanted* it that way. But hopefully you are at least by now getting some sense for the underlying unity—the *Logos*—that Heraclitus saw in all things.

Name: _____
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Wednesday: “Chapter 7: Heraclitus” on Special Reading pp. 13-17

1. The word Heraclitus uses to describe the change and opposition between elements is...

- a. Hatred
- b. Squabble
- c. Strife
- d. Animosity

2. Heraclitus argued that what we normally think of as opposites are actually _____ and the _____.

3. *Logos* (which usually means reason, account, study, and is where we get the word “logic”) is also being used here to mean the principle of _____ and _____ in the _____.

4. To explain how opposites can actually be in *balance* with one another, Heraclitus uses an image of...

- a. Two donkeys tied to opposite ends of a cart
- b. A see-saw
- c. Pushing a stone up a hill
- d. The tension of a bow-string

5. What element does Heraclitus argue is the governing principle of the natural world? What is one reason for his choice?

6. According to page 16, how does fire burning up a piece of paper show both **strife** and **balance** at the same time?

Next page→

Wednesday continued: “Heraclitus” on NoS pp. 94-95:

6. Read fragment 63 carefully. What do you suppose Heraclitus means when he says, “We step into and we do not step into the same rivers”? In other words, if the water in a river one day is technically different water than the water flowing in the same spot the next day, is it the same river?

7. Choose one Fragment from either page and find a connection between that passage and any of our earlier readings.

Chapter Eight: Parmenides

Different Views of Change

Change, as you may have noticed, has been a very important part of every natural scientist's theory so far. Indeed, noticing change—for example, the change of grass to cow—was part of what got us started on this inquiry in the first place. Since then, several of the thinkers we've met have come up with an explanation for how or why change happens. See if you can remember who said what:

- a) All change is the result of condensation and rarefaction.
- b) All change is the result of balanced “strife” between opposites, overseen and moderated by fire.
- c) All change is the result of warring opposites, who pay “penalty and retribution” to one another for their “injustice.”

Answers are at the bottom of the page.¹⁵

Today we will meet someone new, who looked at change and said something astonishingly different.

Parmenides

This thinker's name was Parmenides (par-MEN-ih-dees). Parmenides was born in the western Greek city of Elea, around 515 B.C. Plato tells the story of how one time, when Parmenides visited Athens, Socrates¹⁶, who was still very young, went to hear him speak.

Parmenides had a style somewhat like that of Pythagoras and Heraclitus—shrouded in mystery. Rather than writing out his thoughts in a clear scientific explanation, Parmenides wrote them in the form of a poem, to give them the sound of wisdom coming from the gods.



The Poem

The poem begins with Parmenides in chariot, speeding down the “road of the god,” being pulled along by “wise horses” and led by “maidens.” The horses draw the chariot upward, into the sky, until they reach the Gates of Day and Night, which are alternately closed and locked by Justice. Parmenides worries that he will not make it through, but the maidens persuade Justice to open the gates for him, and he passes through them, out of the world.

Once past the Gates of Day and Night, he meets a goddess, who welcomes him and congratulates him on making it so far. Then the goddess says:

*“There is need for you to learn all things—
both the unshaken heart of persuasive Truth
and the opinions of mortals, in which there is no true reliance.”*

And that is when she reveals the incredible and shocking Truth...

¹⁵ a) Anaximenes, b) Heraclitus, c) Anaximander

¹⁶ Socrates was the teacher of Plato, and Plato the teacher of Aristotle.

Two Possible Paths

Everything either is, or is not.

This is the truth that the goddess reveals to Parmenides. Either something *is*, or it *is not*: that is, it *exists*, or it *does not exist*. Actually, it seems fairly straightforward—do you agree with it?

Either this coffee exists, or it does not exist.

Either dumbo octopuses exist, or they do not exist.

There does not seem to be any third option, does there? There's no "kind of exists," because even that would be a type of existence.

Sounds reasonable to me!

The First Way is the True Way

Then the goddess continues. Although there are two paths—*is* and *is not*—only one is the true way:

It *is*.

Hmm, now this seems a little strange. I thought there were two options. Why can I only choose one of them? Why can't I say that something *is not*, or *does not exist*?

The goddess explains: *It is actually impossible to say that something does not exist*. If you try, you are uttering either 1) falsehood or 2) nonsense.

- 1) If you say, for example, that water does not exist, you are speaking falsehood. And falsehood is obviously not the true path.
- 2) But let's say you claim "Mr. Jingle does not exist." If he *does* exist, you are speaking falsehood, as we saw above. If he *does not* exist, then what are you actually talking about? Your subject, "Mr. Jingle," would be as nonsensical and meaningless as any other non-existing thing, like "glubbawump." Do you see? Saying "Glubbawump does not exist" is not really true or false—it simply doesn't mean anything, because "glubbawump" is meaningless.¹⁷

The Shocking Conclusion

Are you following so far? The goddess said there are two ways—*is* or *is not*. And then she pointed out that, of these, there is only one true way—*is*—because any time you say "is not" you are either speaking falsehood or nonsense.

Since there is only one way—that it *is*, or *exists*—it means that everything that you can think of *actually exists* and is in fact, already in existence. And from this bewildering statement, an even more bewildering conclusion follows:

There is no such thing as change.

That's right—all change is just an illusion. Our five senses do not present the world to us the way it really is. It only *appears* that things are changing and moving, coming-to-be, growing, and passing away.

¹⁷ This is a very tricky philosophical argument, and I encourage you to give it some thought. Is it really *meaningless* nonsense to talk about leprechauns, for example, if they do not exist? Or am I still able to mean *something*?

In reality, however, we know that they are not. *Every kind of change and motion you can think of is absolutely impossible.*

Does the sun rise and set? No.

Does summer eventually turn to winter? No.

Do new plants and animals come into being, grow, and then pass away? No.

Can I go get a drink of water? No.

How is this possible? Though it seems impossible, says Parmenides, that is just because our senses are deceiving us. We can know by using our *reason*—the logical thinking that we just did—that no kind of change or motion is possible.

In case you're not convinced, let's repeat the argument:

Everything either *is*, or *is not*. But saying "is not" is nonsense or falsehood. The only true way, therefore, is to say "is." And that means that everything you can think of actually *already exists*.

"But why does this mean there is no change?" you ask. Great question! Let's try it out. Let's see if you can claim that something changed, that something new has come into existence.

You: "I'm so excited, I went into my backyard yesterday and there is a new chicken!"

The goddess: "A new chicken? What do you mean?"

You: "Well, this chicken used to *not* exist, and now it *does* exist."

The goddess: "Say that first part again?"

You: "The chicken did not exist..."

The goddess: "I thought I already told you that was impossible."

You: "But..."

Another common way of expressing this idea is: ***being cannot come from non-being***. That is, something cannot come from nothing. A being, like a baby chicken, cannot suddenly come to be, because then you would have to say it came from non-being (that is, non-existence), which has been shown to be impossible.

The same argument applies for *every change*, even small ones—like changes in color. If an apple *is* red right now, it must have always been red; otherwise, you would have to say "The apple's redness did not exist," and Parmenides has shown that that is not possible.

Yes, indeed, this is a truly shocking idea about the natural world. Nothing changes or moves, and everything in existence always has existed and always will. Can we really accept this? Can we really

believe that everything our senses tell us is a lie? Well, says Parmenides, if you are going to follow reason and logical thinking, you are going to have to abandon your senses.

Parmenides' Contribution to Natural Science

Just in case you are worried right now—"Are my senses really deceiving me? Is everything I've ever thought about the world just one big lie??"—let me put your fears to rest. You *can* trust your senses to tell you truth about the world around you. Remember, as Aristotle showed us in the beginning of this school year, all knowledge begins in the senses.

Yes, Parmenides was wrong about change—change *is* possible—but that does not mean his ideas were worthless. Quite the contrary. When Parmenides started teaching his ideas, he caused quite a stir! People felt very troubled by it, especially because they did not know how to disprove Parmenides. Rather than worrying that change is impossible, however, they simply realized that their understanding of change just must not be good enough. Parmenides' paradox inspired them to seek a deeper understanding of what change really is.¹⁸ The first person to give an excellent response to Parmenides was a natural scientist named Empedocles. It is his answer that we will be reading about in the next chapter.

¹⁸ The problem was not fully settled until Aristotle showed how all change is truly possible in his book entitled *The Physics*. In the meantime, others made very good attempts.

Name: _____
Section & Course: _____
Teacher: _____
Date: _____

The Pre-Socratic Philosophers: Parmenides
Nature of Science textbook: pp. 96-97
Supplementary Readings: pp. 20-23

1. Which of the following has been a very important part of every natural scientist's theory?
 - a. Motion
 - b. Opposites
 - c. Water
 - d. Change
 - e. The Senses

2. Which foundational Greek philosopher heard Parmenides speak?
 - a. Socrates
 - b. Plato
 - c. Aristotle
 - d. Pythagoras
 - e. None of the above

3. One particularly unique aspect of Parmenides' writing is that he wrote his theories in the form of a _____ rather than a direct explanation.

4. What are the two possible paths the goddess reveals to Parmenides?
 - a. Path one: _____
 - b. Path two: _____

5. According to Parmenides, it is impossible to say _____
_____.

6. In the direct reading from Parmenides (p. 96 – parag. 4 at the bottom), the goddess describes “the way” or Being. List 4 attributes (characteristics) of “the way”.
 - a. _____
 - b. _____
 - c. _____
 - d. _____

(Worksheet continues onto the next page)

7. What is the potential problem with saying that thing can come into being, or be generated?

8. According to Parmenides, what always deceive us?

- a. The gods
- b. The Earth
- c. The senses
- d. The elements

9. What shocking claim does Parmenides make?

- a. Air is truly the fundamental material of the universe
- b. Change and motion are impossible and do not exist
- c. Matter does not truly exist
- d. Air, water, and fire are actually the same thing

10. Consider your answer to question 9. Which Greek thinker finally showed that claim to be an error?

_____ showed that claim to be an error in his book entitled _____.

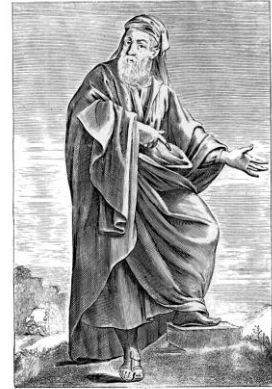
Chapter Nine: Empedocles

Parmenides' Paradox

Recall from the last chapter how Parmenides proved—with a very powerful, logical argument—that change was impossible. This, as we discussed, is a terrifying thought, because it would mean that everything our five senses tell us is a lie. We want to reject the argument immediately, but there's a problem—Parmenides' argument is so good that it seems impossible to disprove.

Empedocles

Among those who were troubled by Parmenides' conclusion, was the gifted philosopher and natural scientist named Empedocles (em-PED-uh-klees). Empedocles is described by ancient authors as an “associate and emulator” of Parmenides—that is, they knew each other, and Empedocles sought to emulate (imitate) Parmenides in his science and philosophy. Empedocles, to be sure, respected Parmenides very much and was devoted to his teaching. He believed Parmenides was right—being cannot come from non-being. And yet, he could not accept what Parmenides claimed was the logical conclusion: that all change was impossible. Empedocles was determined to find a solution—some way to show that Parmenides was *right about being, but wrong about change*.



Empedocles eventually came up with a solution and wrote all of his ideas down in a poem (in imitation of Parmenides¹⁹). Let us examine this theory together and judge whether or not it met Empedocles' ambitious goal of proving that something cannot come from nothing, and yet change is still possible.

The Four Elements

Though he lived in the west, and was influenced by western thinkers like Pythagoras and Empedocles, he had an idea about the natural world that was in some ways more in line with the old Milesian thinkers in the East: Thales, Anaximander, and Anaximenes. You'll remember that each of these Eastern Greek thinkers was in search of the ultimate material principle that everything is made of. Thales said water, Anaximander said the indefinite, and Anaximenes said air.

A name commonly used to describe an ultimate material cause is “*element*.” An element is an ultimate underlying material cause that everything is made of, but itself is not made of anything. When we described water and air as *basic* in this way, we could have also used the word *element*.

Empedocles took this Milesian idea of *elements*, but unlike those thinkers who each said that there was one element, Empedocles said that there were four elements: *fire, air, earth, and water*. These were the materials that everything else was made of, and which themselves were not made of anything. (Thus, contrary to Thales' idea, water could never become earth; or, contrary to Anaximenes' theory, air could never become water no matter how much you condensed it).



Fire



Air



Earth



Water

¹⁹ Everyone—ancient and modern alike—agrees that Empedocles was the superior poet.

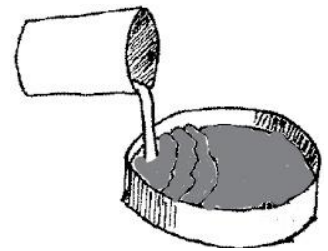
These four elements, he said, were *eternal*. They had always existed and always will exist and can never be changed at all in any way. Does this ring a bell? It sounds very much like Parmenides! It looks like he is following the “one true path” that the goddess points out, that everything *is* or *exists*, and always will. Let us see now what he says about change.

What about Change?

Water, he says, has always been and always will be. No new water is ever created, and no water is ever destroyed. All the existing water will never change even the slightest bit. And the same thing goes for fire, and for air, and for earth.

So far, this is a lot of *not changing*—how then did Empedocles explain all the change that he saw in the world? His solution lay in the idea of *mixtures*.

Let’s think about Water and Earth—neither can be created or destroyed or changed in any way. *But* mix them together and voila! – you’ve “created” mud! And if you were somehow to separate the water and the earth once more, then you would have “destroyed” the mud.



This, Empedocles said, is really what is meant by coming-to-be and passing away. When something “new” is “created,” it is not *really* creation—it is just those same elements that have always been around, coming together in a new mixture.

In this way, Empedocles has both affirmed Parmenides and affirmed our senses. Something cannot come from nothing—this is true. But our senses are not deceiving us. When it *looks* like something new has come into existence, we might call it “creation,” but really it is more like *combination*. Nothing new ever comes into existence—it is just that the elements, which have always been around, are coming into a new combination.

Do you see the brilliance of this solution? And he does not stop there, but goes on to explain the entire system by which our whole world came to be the way that it is. Keep reading!

Love and Strife and the “Creation” of the World

In many of the theories we have encountered so far, change happens between opposites. And this is no different in Empedocles’ theory. In this theory, the opposites are *Love* and *Strife*.

When elements come together in a mixture, they are brought together by Love. When they are separated out, they are being torn apart by Strife.

Love and Strife alternate, or “take turns,” affecting the elements. At times, all things are being brought together by Love, and, at other times, torn apart by Strife. There was a time, says Empedocles, at which *all* the elements—everything that exists—were brought together in perfect harmony and they formed a perfect Sphere. But then it was Strife’s turn, and Strife separated *everything*, leaving four distinct masses—earth, air, water, and fire—each completely separate. Then, it was Love’s turn again, and Love began joining the elements back together again.

And this is where we are right now—in the middle of the process that Love has begun. Some of the elements have joined together through Love, making things like plants and animals. But a lot of the

elements are still separate, which is why we can easily see huge masses of earth, huge oceans of water, a whole sky of air, and all the balls of fire in the heavens (sun, stars, etc.).

The Painter Analogy

Can it really be that everything that we know of is really just a combination of four elements? Really, says Empedocles, it should not be that surprising. Just think of a painter. He begins with a blank canvas a few colors of paint—maybe red, blue, yellow, and white—and from there can paint anything and everything in the universe. So it is with the elements. Depending on how Love (the painter in the analogy) joins the elements together, any number of things can result.



Conclusion

What an incredible theory! Empedocles has succeeded in explaining just about everything²⁰. He affirms our senses by showing that change is real, while yet upholding Parmenides' assertion that something cannot come from nothing. And then he even goes beyond that to explain how plants, animals, and human beings have come into existence, and indeed why the whole world as we know it appears the way it does. This is one powerful scientific theory!

Let's take a moment here, looking at Empedocles' incredible accomplishment, to appreciate how far we have come. Before Thales, no one had ever considered these questions. And now we have an entire system—with four elements and two opposite forces—that explains the entire universe and even answers a very difficult philosophical challenge about the possibility of change.

But do you see how we got here? You have probably, by now, caught on to the pattern—the pattern that makes this sort of theory possible. Each natural scientist that we have read about has responded to those that came before him, attempting to keep the strengths of their theories, and fix the weaknesses. These scientists were listening and responding to one another and are thus in *conversation* with one another. It is through being a part of a conversation like this that the best scientific discoveries can be made.

Keep in mind, as we continue reading, that we ourselves are *listening in* on that conversation. Indeed, our entire study of Chemistry will be listening to a great conversation, between some of the world's greatest natural scientists, about the ultimate material causes of the universe. As you read and study, you are listening—when it comes time for you to speak, what will you say?

²⁰ He actually wrote so many other things that also fit in with this theory—theories on the soul and the afterlife, on evolution, on how to live virtuously, on how to be healthy—but we do not have time to discuss them here.

Name: _____
Section & Course: _____
Teacher: _____
Date: _____

Friday: “Empedocles” on NoS pg. 99:

1. According to the second sentence, what does Empedocles say are the causes of materials “coming together” or being “borne apart” (meaning broken apart)?

2. What are the four most basic elements that Empedocles lists in the middle of the first paragraph?

3. If each element is “equal and of the same age” as the others, how many first principles does Empedocles believe there are? Does he believe that there is one first principle that the others come from, or four distinct first principles?

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Friday continued: “Chapter 9: Empedocles” on Special Readings pp. 26-28

4. According to page 27, how does Empedocles explain changes that we can observe in substances?

5. According to the third paragraph in the “**Conclusion**” section, what is the pattern that we’ve seen in all of the Pre-Socratic thinkers thus far?
