6th Grade Lesson Plan Packet

4/6/2020-4/10/2020

Remote Learning Packet

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

April 6 - April 10, 2020

Course: 6 World Cultures

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

Mr. Loomis joseph.loomis@greatheartsirving.org

Weekly Plan:

Monday, April 6

☐ Review Geographic Terms flashcards (15 minutes)
☐ Parent signature on quiz
☐ Take Geographic Terms Quiz (10 min)

Tuesday, April 7

☐ Make Timeline flashcards (15-20 min)
☐ Review Timeline flashcards (10 min)

Wednesday, April 8

☐ Review Timeline flashcards (5 min)
☐ Add dates to World Cultures Timeline from memory (10 min)
☐ Check your answers (10 min)

Thursday, April 9

☐ Trace world map
☐ Mark map with cultures/periods from the timeline flashcards

Friday, April 10

No classes

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 6

Good morning! Today you will take an open-note quiz on the material we learned and studied last week.

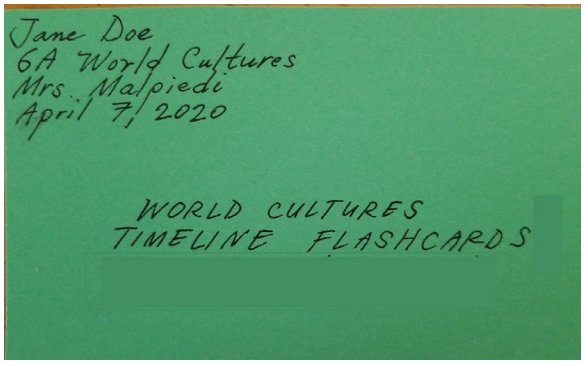
1. Review your Geographic Terms flashcards for up to 15 minutes.
2. Important: Before you take the quiz, found at the end of this packet, please have a parent sign the top noting that it is **not** an open-book quiz.
3. Take up to 15 minutes to take the quiz. Again, you may ***not*** use your flashcards or the textbook. You will have the chance next week to check your answers. Good luck!

Tuesday, April 7

Today you will make flashcards to study the start and end dates of the civilizations and major religions we have studied this year. If you don't have index cards, you can use cut-up pieces of paper. (You will need 11 cards total.)

1. On the first flashcard, add your heading to the top left corner. Then, write the following title in the middle of the card: **World Cultures Timeline Flashcards**

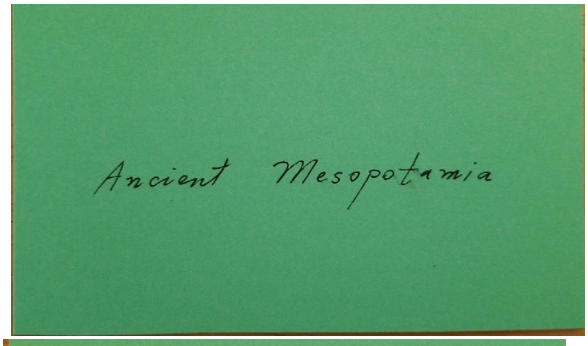
   For example:

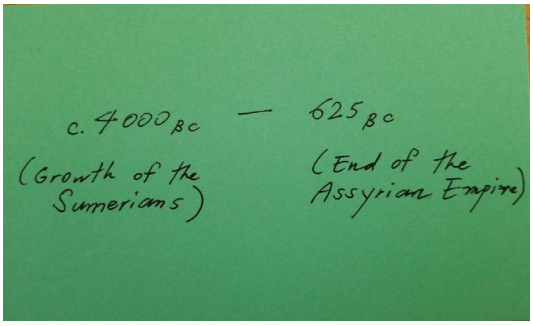


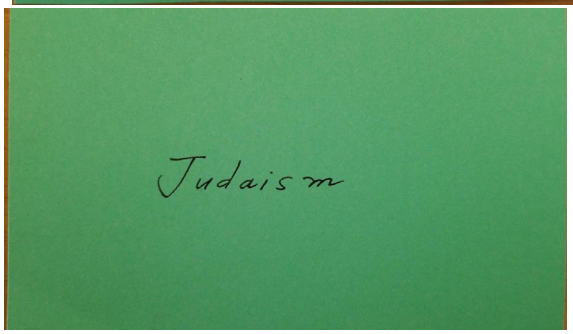
2. On the remaining cards, write down the name of the civilization or religion on one side, and the corresponding dates on the other. Use the information and spelling from the chart on the next page.

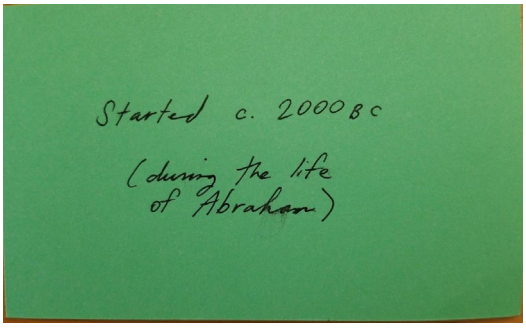
   For example:

(Front) (Back)









	Civilization/ Religion	Date Started	Date Ended
A	Ancient Mesopotamia	5000 BC (Sumerians settle in Mesopotamia and build city-states--the first civilization.)	625 BC (End of the Assyrian Empire)
B	Ancient Egypt	4000 BC (Towns develop along the Nile River. King Menes will unite Upper and Lower Egypt in 3300 BC.The New Kingdom, the time of Egypt's "Golden Age" will take place from 1550 to 1070 BC.)	525 BC (The Persians conquer Egypt)
C	Ancient India	c. 4000 BC (Civilization develops in the Indus Valley. The two largest cities by 2000 BC are Mohenjo-Daro and Harappa.)	AD 543 (End of the Gupta Empire)
D	Ancient China	c. 3000 BC (The first towns appear around the Huang He, or Yellow River.)	AD 906 (End of the Tang Dynasty)
E	Ancient Greece	c. 3200 BC (Growth of the Cycladic civilization)	146 BC (End the Hellenistic period)
F	Ancient Rome	753 BC As legend tells, Rome is founded by Romulus and Remus. Rome will see different phases in status and forms of government including the Roman Republic (509 to 27 BC), and the Roman Empire (27 BC to AD 476).	AD 476 (The last of the western Roman emperors is overthrown.)
G	The Byzantine Empire	AD 330 (Constantine founds Constantinople in modern-day Istanbul. The Byzantine Empire is also known as the Eastern Roman Empire.)	AD 453 (Fall of Constantinople to the Ottoman Turks)
H	Judaism	c. 1800 BC (God establishes the covenant, or sacred promise, with Abraham, the leader of the Hebrews and grandfather to Jacob (later renamed Israel.)	
I	Christianity	c. AD 30 (Jesus Christ is born around 3 BC. He begins teaching publicly at about age 30. His teachings were spread after his death on the cross in c. AD 30 throughout the Roman world and then beyond.)	
J	Islam	AD 622 (Muhammad is born in AD 570. At 40 years old he writes the Koran based on visions he has with the Archangel Gabriel. He and his followers flee to Medina in 622, and his following grows from there.)	

3. Review your newly created flashcards for 10 minutes.

Wednesday, April 8

Today you will test your knowledge of the dates we studied yesterday. You will need your Timeline flashcards and either a new page in your notes or a print-out of the worksheet.

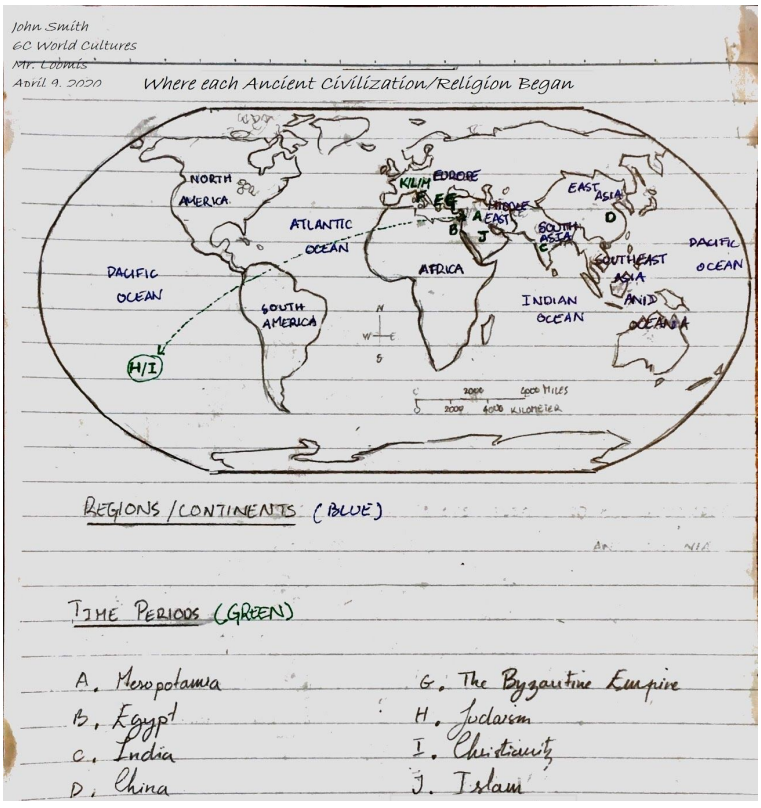
1. Review your Timeline flashcards for 5 minutes.
2. Look at the **World Cultures Timeline** worksheet located at the end of this packet. Either copy down the timeline and its dates on a new page in your notes (of course adding your heading and the title **World Cultures Timeline**), or print out the page.
3. *Without* using your flashcards, add as many dates and corresponding names to the timeline as you can. Time yourself. After 10 minutes have elapsed, check your answers and add what you missed.

Thursday, April 9

Today you will get a better sense of where history has taken place in the world. For this assignment, you will need a new page in your notes, the chart from Tuesday, and at least two different colored pens (one black and one blue, for example).

1. Take out a separate sheet of paper. Add your heading and the following title:

   Where Each Civilization/Religion Began
2. Trace the map of the world found on page 1 of the textbook. Outline and label all the continents and oceans.
3. Take out your World Cultures Timeline chart from the Tuesday, April 7 lesson plans (page 3 of this packet.) Match each civilization/ religion with the place it started *by adding the letter on the map*. Some notes:
   - We recommend using a different color pen or pencil for adding the letters.
   - When some of the letters overlap, be creative and find a way to make your work clear and easy to read.
   - Put a key at the bottom of the map!
   - Here is an example of a map tracing with a heading, proper title, a key at the bottom, and countries and oceans labeled:



_____
_____
_____
Monday, April 6, 2020

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I affirm that this is not an open-book quiz. My child does not have open any notes or the textbook as he/she takes it.

_____(Parent Signature)

Geographic Terms Quiz

This is not an open-book quiz. Match the number from the descriptions on the right with the terms on the left.

Term	**Description**
___ Bay	1. Body of water surrounded by land.
___ Tributary	2. Place where a river empties into a larger body of water.
___ Mountain	3. Area of raised land that is lower and more rounded than a mountain.
___ Cape	4. Part of a body of water that is partly enclosed by land.
___ Lake	5. Large area of high land that is flat or gently rolling.
___ Strait	6. High, steep, rugged land area that rises sharply above the surrounding land.
___ Mouth of a River	7. Place where a river begins.
___ Coast	8. Narrow point of land that extends into a body of water.
___ Source of a River	9. Large stream of water that empties into an ocean, a lake, or another river.
___ Isthmus	10. Narrow channel that connects two larger bodies of water.
___ Delta	11. Stream or small river that flows into a larger stream or river.
___ Peninsula	12. Ridge that separates rivers that flow in one direction from those that flow in the opposite direction.
___ River Valley	13. Broad area of fairly level land that is usually close to sea level.
___ Hill	14. Land drained or watered by a river.
___ Divide	15. Land that borders the sea or an ocean.
___ Plain	16. Area formed by soil deposited at the mouth of a river.
___ River	17. Piece of land that is surrounded by water on three sides.
___ Plateau	18. Narrow strip of land joining two large land areas or joining a peninsula to a mainland.

Wednesday, April 8, 2020

World Cultures Timeline

5000BC **4000**BC **3000**BC **2000**BC **1000**BC **1**AD

Remote Learning Packet

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April 6-10, 2020

Course: 6 Latin

Teacher(s): Miss Salinas annie.salinas@greatheartsirving.org
Ms. Baptiste deborah.baptiste@greatheartsirving.org

Weekly Plan:

Monday, April 6
☐ Complete pages 1-2 of the Stage 9 Study Guide

Tuesday, April 7
☐ Complete pages 3-4 of the Stage 9 Study Guide

Wednesday, April 8
☐ Complete page 5 of the Stage 9 Study Guide
☐ Practice your Stage 9 vocabulary

Thursday, April 9
☐ Complete pages 6-7 of the Stage 9 Study Guide

Friday, April 10
☐ No School!

Statement of Academic Honesty

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

_____
Parent Signature

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

Monday, April 6

Salve discipuli! This week, we'll be working on a study guide for Stage 9. Monday's assignment is to complete pages 1-2, the grammar section about nouns and pronouns.

> Q: We usually have a test right after we finish our study guides. Will we have a test next week?
> A: We're not sure yet how tests will be taking place while we work remotely! The admin will let us know as soon as we have an answer. We want to be prepared with our completed study guides, though, so it'll be easier once we do have tests again.

Use your memory to complete as much as you can each day. If you get stuck, refer to your textbook, grammar sheets, previous bellwork, or previous homework. You can also always reach out to your teachers via email with questions.

Tuesday, April 7

Complete pages 3-4 of your study guide, the section about verbs.

Wednesday, April 8

Complete page 5 of your study guide, the section about vocabulary.

Time to practice your Stage 9 vocabulary!

> 6A-D: If you have flashcards that you made before spring break, use those. Quiz yourself, then have a parent or sibling test you if you can!
> 6E: If you have your vocabulary checklist worksheet, practice using that!

If your sheet or flashcards have gotten lost in the shuffle in recent weeks, instead what you can do is re-write the vocab list (complete with the perfect tense of the verbs and the accusative case of the nouns) to practice. You may refer to your Stage 9 vocab sheet or the vocab list on page 130 of your red book.

Thursday, April 9

Complete pages 6-7 of your study guide, the culture section about the Roman Baths.

Nomen:
Magistra:
Classis:
Dies:

Stage 9 Latin Study Guide

Grammar

Nouns: singular and plural

A **noun** is a word that names a_____,_____,_____, or _____.

In Latin, if someone *does* something, we put them in the_____case. This makes them the_____of the sentence.

In Latin, if something *happens to* someone, we put them in the_____case. This makes them the_____of the sentence.

Complete the following noun chart:

	1st Declension	*2nd Declension*	*3rd Declension*	
Nominative Singular	puell_____	serv_____	mercā̆tor	leō̆
Accusative Singular	puell_____	serv_____	mercā̆tor_____	leō̆n____
Nominative Plural	puell_____	serv_____	mercā̆tor_____	leō̆n_____
Accusative Plural	puell_____	serv_____	mercā̆tor_____	leō̆n____

Complete the chart below for the Latin pronouns "I" and "you":

	1st Person (Latin)	*translation*
Nominative Singular	ego	I
Dative Singular		
Accusative Singular		

2nd Person (Latin)	*translation*
tu	you

In the following chart, please:

1) Identify which declension each Latin noun belongs to.
2) Then, check the box which gives the correct case and number of each noun.
The first example is done for you.

N.B. The words marked with an asterisk (*) have two possible correct answers.

Latin noun	Declension	Nominative singular	Dative singular	Nominative plural	Dative plural
portae*	1st		●	●	
gladiatoribus					
servus					
homini					
sanguines					
spectaculo					
feminae*					
silvis					
puer					
puella					
puellae*					
puellis					
tibi	pronoun				
ego	pronoun				
mihi	pronoun				
tu	pronoun				

Verbs: present, imperfect, and future tense

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.

I. **Person** refers to the_____of the subject.

A. For a **1st person** verb, the_____is the subject.
B. For a **2nd person** verb, the_____is the subject.
C. For a **3rd person** verb, someone or something_____than the speaker or the listener is the subject.

II. **Number** refers to **how many** subjects;_____(one) or_____(more than one). So far, we have only encountered singular subjects in our stories.

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

Fill in the following chart showing the personal verb endings and pronouns:

	Singular	
	Personal Ending	*English Pronoun*
1st Person	-o/-m	I
2nd Person		
3rd Person		

Plural	
Personal Ending	*English Pronoun*

Conjugations

Groups of verbs that follow specific patterns are called_____.

The irregular verb *est, sunt* does not belong to one of these conjugations, but follows its own pattern of endings:

	Singular	
	Latin	*English*
1st Person	sum	*I am*
2nd Person		
3rd Person		

Plural	
Latin	*English*

Tense

Tense refers to_____an action happens.

tense	when it happens	Latin clue	how it translates
_____ **tense**	happening now	normal personal endings	_____
_____ **tense**	continuous past	_____	_____
also known as the past progressive			used to verb kept verbing
_____ **tense**	completed past	-v-, -u-, -s-, -x-, etc.	_____

also known as the simple past

The endings for the **imperfect tense** are the same for all 4 conjugations and consist of the tense sign "-ba-" or "era-" and the personal endings (-m, -s, -t, -mus, -tis, -nt). Notice the imperfect tense always uses the letter "m" in the first person singular:

	Imperfect Ending	*Imperfect of Sum*
1st Person Sing.	- bam	eram
2nd Person Sing.	-	
3rd Person Sing.	-	
1st Person Pl.	-	
2nd Person Pl.	-	
3rd Person Pl.	-	

Vocabulary

Know the following words in both English and Latin. Be able to understand them in a sentence or story.

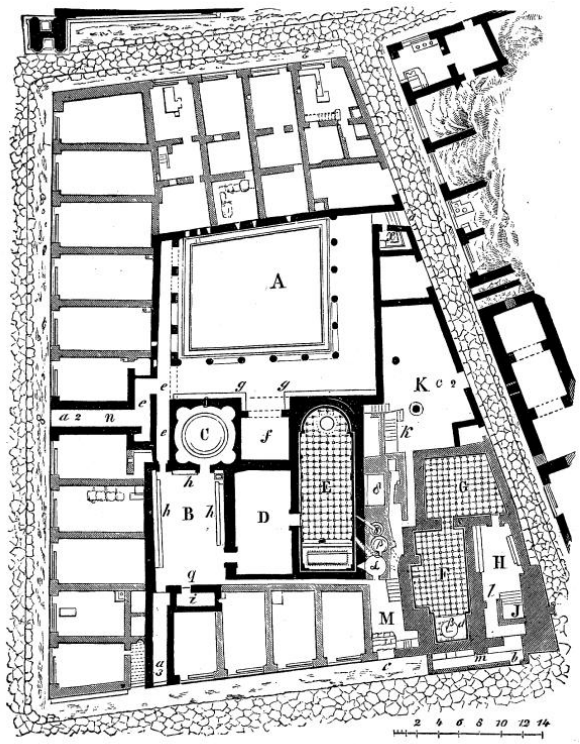
> *Remember: words like* "agnoscit : agnovit" *are verbs, and the two parts listed are the* ***present tense*** *and the* ***perfect tense****. Words like* "homo, hominem" *are nouns, and the two parts listed are the* ***nominative*** *and the* ***accusative****. In both cases, please practice both parts.*

agnoscit : agnovit	hospes, hospitem	ostendit : ostendit
celeriter	ille	post
cupit : cupivit	inspicit : inspexit	procedit : processit
dat : dedit	iterum	pulcher
dies, diem	manet : mansit	revenit : revenit
emittit : emisit	medius	tradit : tradidit
fert : tulit	mox	
homo, hominem	obfert : obtulit	

In addition, review all of the vocab from Stages 1-7, especially the following words:

ad	heri	servus, servum
ambulat : ambulavit	ingens, ingentem	statim
clamat : clamavit	inspicit : inspexit	sum
conspicit : conspexit	intrat : intravit	thermae, thermas
ego, me	iratus, iratum	toga, togam
eheu!	iuvenis, iuvenem	tradit : tradidit
et	meus, meum	tu, te
eum	multus, multum	tum
festinat : festinavit	pecunia, pecuniam	turba, turbam
filius, filium	quod	tuus, tuum
habet : habuit	quoque	venit : venit

Culture



Plan of the Old Baths at Pompeii. (Overbeck.)

Identify what the following spaces in the Roman baths were for, and what a Roman would do there. Then, label what letter they are on the map above. *(Use the map on pg 129 of your red book to help you.)*

palaestra:

apodyterium:

tepidarium:

caldarium:

frigidarium:

tabernae *(not labeled by a letter on the map, but see if you can find them anyway)*:

How were oil and strigils used in the baths?

What was the name of the heating system Romans improved for use in the public baths?

Using the following word bank, complete the sentences below to explain how this heating system worked. You will **not** *use all of the words in the word bank.*

brick piles coal theaters houses

hot air towels wood floor

furnace roof hot bath tepidarium walls

To provide heat, a.....was placed below the floor level.

The floor was supported on small …… .

The space beneath enabled ..... to circulate.

In this way, the.....was warmed from below.

Later, flues were built into the.....and warm air drawn up through them.

The water in the.....was kept at a steady temperature.

This heating system was used not only in baths but also in …… .

The most common fuel used to heat the baths was …… .

Remote Learning Packet

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April 6-10, 2020

Course: 6 Literature & Composition

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

Weekly Plan:

Monday, April 6
☐ practice poem
☐ read and annotate TWTW Chapter III

Tuesday, April 7
☐ practice poem
☐ answer the TWTW Ch III questions

Wednesday, April 8
☐ practice poem
☐ read and annotate TWTW Chapter IV

Thursday, April 9
☐ practice poem
☐ answer the TWTW Ch IV questions

Friday, April 10
☐ No School!

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 6

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 III. Pay special attention to the role of memory and story-telling.

Tuesday, April 7

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 III. 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 III Questions". Remember to write neatly, to include our usual header, and to write in complete sentences.

Wednesday, April 8

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 IV. Pay special attention to Badger's personality and how he shows hospitality to his various guests.

Thursday, April 9

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 IV. 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 IV Questions". Remember to write neatly, to include our usual header, and to write in complete sentences.

GreatHearts Irving

The Wind in the Willows Chapter III Reading Questions

1. Through the words of Ratty, what do we learn about Badger's personality? What is Ratty's attitude towards Badger's preferences, which are quite different from his own?

2. During what season does this chapter take place? What are some of Rat's hobbies/pastimes/activities during this season?

3. "Such a rich chapter it had been, when one came to look back on it all! With illustrations so numerous and so very highly coloured (p28) Explain this metaphor; what is being compared to a chapter? Describe at least two of the "illustrations", or examples, of this "chapter".

4. What is the role of recollection and story-telling in the animals' lives, particularly during the season of winter?

5. What literary device is used in this sentence: “Nature was deep in her annual slumber and seemed to have kicked the clothes off” (p29).

6. Contrast the different effects summer and winter have on Nature.

7. Name, in order, three “scary” things that Mole experiences as he walks through the Wild Woods.

8. After Rat finds and rescues Mole, he explains why he tried to shield Mole from the terrors of the Wild Wood. Did Mole act out of pride/stubbornness, ignorance, or mere carelessness when he set off to find Mr. Badger? Include one quotation to provide evidence for your answer.

9. What are the effects (both aesthetic and practical) of the snow? *(remember: aesthetic means concerned with beauty or appearance)*

10. What does Mole’s leg injury allow Rat to discover? What are the three clues that lead Ratty to this discovery?

_____
_____
_____
_____

GreatHearts Irving

The Wind in the Willows Chapter IV Reading Questions

1. Describe Badger's kitchen in your own words. On page 40, which literary device is used to describe the atmosphere of the kitchen? List at least two instances of this literary device.

_____
_____
_____
_____

2. Why does Badger think manners are unimportant? Why is it "narrow" to disregard manners and etiquette as Badger does? Despite this attitude, what kind of hospitality does Badger provide?

_____
_____
_____
_____

3. Rat and Mole express their concern for Toad. Why are they worried for him? Which flaw(s) of his do his actions reveal?

_____
_____
_____
_____

4. What new rule of animal-etiquette do we learn about?

_____
_____

5. What does Badger resolve to do once the weather changes?

_____
_____

6. Who appears at breakfast who had been sent to search for Ratty and Mole? What does this reveal about the people of the River-bank?

7. Mole and Badger understand one another's love for underground living. Why do they prefer the underground?

8. How did Badger's home come to exist? Who used to live there and built the walls and passageways which have been incorporated into Badger's home? What character trait of the badgers is revealed as Mr. Badger tells the history of the building of his home? What, according to Badger, is the only enduring thing?

9. How does Rat react to being confined underground?

10. Throughout the chapter, Badger is described as "kindly" and "paternal". What is the Latin root of "paternal"? Provide one quotation of Badger acting paternally. How does Badger exemplify the maxim "Never judge a book by its cover"?

_____Answer Key_____
_____
_____
_____

GreatHearts Irving

The Wind in the Willows Chapter I Reading Questions

1. What alliteration and metaphors are used to describe the personality of the River?

   Alliteration: sleek, sinuous; chasing, chuckling; a-shake, a-shiver
   Metaphors: full-bodied animal; man who holds one spellbound through exciting stories

2. Rat expresses a great love for the River and for boats. What do these loves reveal about Rat?

   Rat loves the River for both its rhythms/cycles and its unexpected & surprising nature. His love for boating reveals his love of freedom--freedom from worry (because one's mind is occupied) and freedom from the obligations and responsibilities of everyday life.

3. What is revealed about the following characters? What do we learn about their personalities, their likes and dislikes, and where they live?

Mole:
- *Very polite & clean; hardworking*
- *Not very clever; child-like*
- *Quiet and sensitive*
- *Homebody; not naturally adventurous*
- *Has moments of pride & jealousy (eg: when rowing the boat)*

Rat (Ratty):
- *Very clever; more knowledgeable about their world*
- *Generous & forgiving*
- *Loves the River and messing about in boats*
- *Very social*
- *Finds joy in life and simple things*

Otter:
- *Very social; prone to gossip*
- *Easily distracted*
- *Very fast-moving*

Badger:
- *Dislikes Company (new people & things)*
- *Likes what is familiar*
- *Lives in The Wild Wood*
- *Reserved and wise*

Toad:
- *Longs for adventure*
- *Constantly changes hobbies (is wasteful)*
- *Very wealthy*
- *Irresponsible; self-centered*

4. Describe the four "worlds" depicted in this chapter:

In the earth

- *Mole's world*
- *"Dark and lowly" but snug*
- *Represents the self*

The river

- *Rat's world (also Otter's, and somewhat Toad's)*
- *"Chasing and chuckling", full of life*
- *Represents the community/village (intimate community)*

The Wild Wood

- *Badger's world*
- *Dark and somewhat dangerous place*
- *Represents nearby but unknown communities*

The Wide World

- *"Where it's all blue and dim"*
- *Rat doesn't consider it important to discuss (the animals are so far removed from it)*
- *Represents the rest of the world*

5. What rules of "animal etiquette" have we learned so far?

Rule 1: Never dwell on possible trouble ahead, nor even allude to it
Rule 2: Never comment on the sudden disappearance of a friend

Pay special attention to the following quotations:

"Spring was moving in the air above and in the earth below and around him, penetrating even his dark and lowly little house with its spirit of divine discontent and longing" (p3)

This idea of "divine discontent and longing" is a constant theme throughout the book; pay attention to moments where the characters experience deeper connections with nature and nature's goodness. Begin to build an understanding of what is meant by "divine discontent".

"Believe me, my young friend, there is nothing--absolutely nothing--half so much worth doing as simply messing about in boats" (p6)

This famous line from Ratty expresses his idea of leisure: Ratty is so entranced by boats and boating because it symbolizes both his love for freedom and his love for cheerful work. The boat both ties him to his home and provides him with a means of escaping from it.

"He learnt to swim and to row, and entered into the joy of running water; and with his ear to the reed-stems he caught, at intervals, something of what the wind went whispering so constantly among them" (p14)

This is the second time we hear Nature calling/speaking to Mole. As he spends more time with Ratty, he becomes more sensitive to Nature and the divine. Pay attention to the wind and what it says to the characters.

_____Answer Key_____
_____
_____
_____

GreatHearts Irving

The Wind in the Willows Chapter II Reading Questions

1. What inspires Rat to compose a song?

Rat has an encounter with nature and beauty as he is playing with his friends, the ducks. After the ducks implored him to leave them alone and mind his own business, Rat left, observed them as they played, and wrote a song (poetry) about his observation.

2. Mole and Rat engage in a conversation regarding the value of poetry. What are their (opposing) views concerning poetry?

Mole doesn't think much of Rat's "little song," and Mole "was no poet himself." Having more of a candid nature, Mole does not yet understand the value or beauty of poetry as Rat does. Rat, on the other hand, after engaging in nature and passing time with the ducks, has seen beauty and been inspired to convey it.

3. How do the ducks understand poetry? What does this scene reveal about the active and contemplative life?

The ducks echo Mole's sentiments about poetry, and regard poetry as silly ('nonsense').

This scene portrays both the active and contemplative life as essential and good, as shown through Rat's positive experience of a life of 'activity' with the ducks, followed by his brief contemplation of the ducks, which then incites him to compose a song conveying truth about these creatures.

4. After Mole and Rat encounter Toad, Toad expresses his disdain for which "silly boyish amusement" that Mole and Rat enjoyed in the previous chapter?

Toad expresses his disapproval for boating, which is one of Ratty's favorite pastimes and an activity that Mole himself attempted and enjoys.

5. Toad instead wishes to devote his time to his new little cart, "show [Rat and Mole] the world" and "make animal[s] out of them." What might this little cart represent/symbolize?

Toad's new "little cart" offers a means to "travel, change, interest, excitement." The cart may symbolize a life of thrill and adventure, and the means of embarking on a journey into the unknown.

6. Contrast the River (Ratty's idea of a good life) with the Open Road (Toad's idea of a good life).

The river seems to be alive in that it moves along on its own and moves with it all who venture into it. The road is a product of man, not nature, and requires more effort from those who travel on it. The road is hard and dusty while the river is cool and clean. The road requires the traveler to make decisions about where to go and how quickly, while the river moves with its own purpose and will. For Toad, the road symbolizes "travel, change, interest, excitement" while the river is "dull" and "fusty". Rat finds the river cozy and home-like; he can find plenty of adventure while maintaining the ties of home.

7. Contrast Toad's vision of travel with the canary-coloured cart (p.18) with his vision of travel with the motor-car (p.24). How do these two visions reveal an inner conflict in Toad?

When Toad describes travel with the cart, he describes visiting and viewing various places ("the open road, the dusty highway, the heath, the common, the hedgerows); when he describes travel with the car, he has no mention of nature and spends no time enjoying anything but travel itself ("villages skipped, towns and cities jumped"). He becomes so obsessed with various objects that he no longer can enjoy life and nature around him.

8. Compare Ratty's description of Toad (p16-17) with Toad's actions throughout the chapter (particularly how he convinces Mole to go on the journey with him). Is Ratty accurate in his understanding of Toad's nature? Does Ratty's description change how you view Toad's actions?

Ratty describes Toad as always good-tempered, simple, and not very clever. However, when Toad wanted to convince them to travel with him, he watched them very closely and then "proceeded to play upon the inexperienced Mole as on a harp". Toad realized that Ratty wants to make Mole happy and would go along with Toad's plan if Mole asked him to. Ratty's description would lead us to view Toad more favorably and gently, rather than just viewing him as selfish and manipulative.

9. Contrast Toad's view of Nature with Ratty's.

Ratty is intimately connected with nature; he stops and observes it and so is able to see beauty. He follows the rhythms of nature and sees the changes that happen with each passing day and each passing season. Toad, however, does not interact with nature in nearly so personal a level. He passes through nature; he does not stop to truly see it.

Remote Learning Packet

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

April 6-10, 2020

Course: Math Fundamentals

Teacher: Ms. Schweizer rose.schweizer@greatheartsirving.org

Weekly Plan:

Monday, April 6
☐ Read Prime Factorization: Page 1
☐ Exercises: Section 5.4 pg. 162 13-33 odd

Tuesday, April 7
☐ Read GCF and LCM: Pages 2-3
☐ Exercises: Self-Test B pg. 169 1-12 all

Wednesday, April 8
☐ Read Fractions: Pages 4-5
☐ Exercises: Self-Test A pg. 225 1-15 all

Thursday, April 9
☐ Read Order of Operations: Pages 6-7
☐ Exercises: Section 1.5 pg. 17 27-37 odd
☐ Exercises: Section 8.5 pg. 262 19-31 odd

Friday, April 10
☐ No School!

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 6

This week we are reviewing various properties of numbers. Read Page 1 of the packet on Prime Factorization and complete the exercises in Section 5.4 on a separate sheet of paper, just as you normally do for your homework. You may also look over your old notes with the examples that we did together in class to help refresh your memory. Remember to show all of your work, and once you have completed the assignment, use either the back of the book or the attached answer key to correct your work and show any corrections in PEN.

Tuesday, April 7

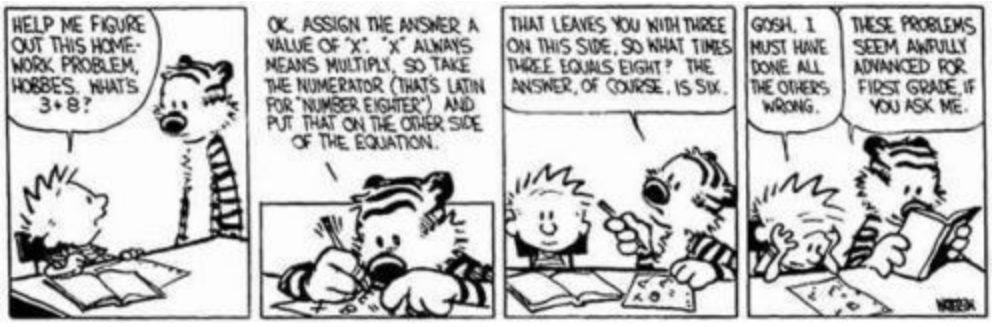
Continuing with the properties of numbers, read pages 2-3 in the packet to refresh your knowledge of the GCF and LCM, then complete the exercises in the book. Correct them with the attached answer key and show corrections in pen.

Wednesday, April 8

Use your knowledge of the GCF and LCM to make your work with fractions easier. Read pages 4-5 in the packet to review and then complete the exercises in the book, correcting them when you are done.

Thursday, April 9

Properties of numbers are related to properties of operations, so read pages 6-7 in the packet on the order of operations and inverse operations. Join the mathematical world and use this knowledge to complete the exercises. Note that the exercises come from two separate sections today. If you use the same piece of paper, make sure you label each section clearly. As always, show all your work and make corrections in pen.



Answer Key:

Section 5.4 pg. 162 13-33 odd

13. $2^2 \cdot 3$

15. $2^3 \cdot 3$

17. $3 \cdot 13$

19. $2 \cdot 3 \cdot 11$

21. $2 \cdot 3^3$

23. $2^2 \cdot 3 \cdot 7$

25. $2^2 \cdot 7^2$

27. $2^2 \cdot 7 \cdot 11$

29. $2 \cdot 3 \cdot 19$

31. All other even numbers have 2 as a factor.

33. odd+odd=even

Self-Test B pg. 169 1-12 all

1. Composite $2^2 \cdot 3^3$
2. Prime
3. Composite $3 \cdot 29$
4. Prime
5. 30
6. 14
7. 1; relatively prime
8. 15
9. 140
10. 189
11. 195
12. 450

Self-Test A pg. 225 1-15 all

1. 13/17
2. 19/32
3. 11/27
4. 8 ½
5. 2 5/16
6. 6 11/12
7. 25
8. 7/32
9. ⅜
10. 1/25
11. 9/20
12. 1 ⅛
13. 4 13/18
14. 4 ⅘
15. 11 3/7

Section 1.5 pg. 17 27-37 odd

27. 87

29. 37

31. 172

33. 176

35. 78

37. 9

Section 8.5 pg. 262 19-31 odd

19. 4 ⅓

21. 22 ½

23. 7 ½

25. 3 ⅓

27. 1 7/9

29. 1 17/21

31. 4 3/7

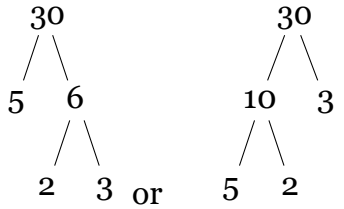
1 Prime Factorization

Today is a review of how to find the prime factorization of a number. Recall that the prime factorization of a number is the product of prime factors expressing a number. In essence, it is all the prime numbers we multiply together to get the composite number.

Take for example the prime factorization of $30 = 2 \times 3 \quad 5$. Note that each factor is *prime*, it has no other factors.

The prime factorization can be found using a *factor tree*, where the bottom of each strand is a prime number.

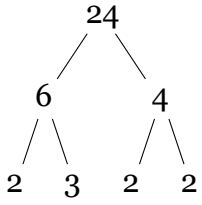
For example:



Notice how the final primes are the same in both factor trees.

Sometimes a prime factor may appear more than once, which can be written using exponents.

Ex:



The prime factorization of $24 = 2 \times 2 \times 2 \times 3$ or $24 = 2^3 \times 3$.

The **Fundamental Theorem of Arithmetic** tells us that any whole number can be broken down into prime factors.

Theorem 1 (Fundamental Theorem of Arithmetic) *Every composite number greater than 1 can be written as a product of prime factors in exactly one way, except for the order of the factors.*

2 Greatest Common Factor

The greatest common factor is the factor that two or more numbers have in common that is the greatest. Somewhat self-explanatory there. One way, of course, to find the GCF is to list all the factors of both numbers.

Ex. Find the GCF of 18 and 32
18: 1, 2, 3, 6, 9, 18
32: 1, 2, 4, 8, 16,32
Thus, the GCF is 2.

However, this approach is less useful the more factors a number has. The number 1050 seems nice, but has 24 factors! It's also hard to tell if you have actually found all the factors or are still missing some. Fortunately, we can use the *prime factorization* of both numbers to solve this problem.

Ex. Find the GCF of 540 and 495.
1. Find the prime factorization of both numbers.
$540 = 2^2 \times 3^3 \quad 5$
$495 = 3^2 \times 5 \quad 11$
2. Next see which prime factors the numbers have in common. In this case they have $3^2 \times 5$ in common, so their GCF is 45.

Look at each prime factorization and use the *lowest* power of each prime factor that is in *both* numbers.

A final note:

Definition 1 *Two numbers are* ***relatively prime*** *if their GCF is one.*

3 Least Common Multiple

The least common multiple is the multiple that two or more numbers have in common that is the least (except zero). Helpfully-named. In order to find the LCM, you can certainly find the LCM by listing of multiples of each number until you reach the least common one.

Ex. Find the LCM of 8 and 6.

1. Multiples of each number:
8: 0, 8, 16, 24, 32, 40 ...
6: 0, 6, 12, 18, 24 ...
2. LCM (8,6)=24

Like the GCF, this method becomes more difficult for larger numbers, so again we turn to the prime factorization to help us out. With the GCF, we were looking for a *factor*, so something smaller than the number, hence the reason we used the lowest powers. With the LCM we are looking for a *multiple*, so something larger than the numbers so we will use the largest powers.

Ex. LCM(250, 56)
1. Find the prime factorization of each number.
$250 = 2 \times 5^3$
$56 = 2^3 \times 7$
2. Now take the largest power of each prime factor that appears. In this case, LCM(250, 56)= $2^3 \times 5^3 \times 7 = 7000$.

Look at each prime factorization and take the *greatest* power of all the prime factors that appear in *either* prime factorization. If a number appears in either prime factorization, it should appear in the LCM as well.

4 Adding and Subtracting Fractions

When adding and subtracting fractions, remember that you must first always have a **common denominator**. A good choice for a common denominator is the LCM of the denominators. This keeps the numbers as small as possible and easiest to work with.

Ex.

$$\frac{4}{9} + \frac{5}{12}$$

$$LCM(9, 12) = 36$$

$$\frac{8}{36} + \frac{15}{36} = \frac{23}{36}$$

Using the LCM also puts the fraction closer to lowest terms than if you used a larger multiple, so it makes simplifying the fraction easier.

5 Multiplying Fractions

When adding and subtracting, the LCM was helpful, and for multiplying or dividing fractions the GCF will be helpful. Multiplying fractions is simple: multiply across, multiplying the numerators together and multiplying the denominators together.

Ex.

$$\frac{4}{15} \times \frac{3}{10}$$

1. *Multiply across* : $\frac{4 \times 3}{15 \times 10} = \frac{12}{150}$

2. *Simplify* : $\frac{12}{150} = \frac{2}{25}$

However, it is often easier to simplify *before* multiplying across. Note that as long as one number in the *numerator* and one number in the *denominator* share a common factor, you can **cross-cancel**.

Ex.

$$\frac{4}{15} \times \frac{3}{10}$$

1. *Simplify* : $\frac{4}{15} \times \frac{3}{10} = \frac{4}{5} \times \frac{1}{10}$

since GCF(3,15)=3

$\frac{4}{5} \times \frac{1}{10} = \frac{2}{5} \times \frac{1}{5}$

since GCF(4,10)=2

2. *Multiply across*: $\frac{2}{5} \times \frac{1}{5} = \frac{2}{25}$

Again, this becomes more useful as the numbers grow larger and harder to work with.

6 Dividing Fractions

Dividing fractions is related to multiplying fractions. Recall that multiplication and division are **inverse** operations. In order to divide fractions, we can use this fact to turn it into a multiplication problem, which we already know how to solve! In order to do this we use the **reciprocal** of the divisor (the second number). The reciprocal functions as the inverse number, so we can use it with our inverse operation.

Ex.

$$\frac{21}{32} \div \frac{7}{24}$$

1. Change the division to multiplication and use the reciprocal of the divisor. (Use the inverse operation and the inverse number.)

$$\frac{21}{32} \times \frac{24}{7}$$

2. Cross-cancel

$$\frac{21}{32} \times \frac{24}{7} = \frac{3}{4} \times \frac{3}{1}$$

3. Multiply

$$\frac{3}{4} \times \frac{3}{1} = \frac{9}{4} = 2\frac{1}{4}$$

7 Order of Operations

When solving an equation, it is important to follow the **order of operations**. Without an order of operations, the same equation might give multiple answers and mathematics would be frustrating and inconsistent. In order to avoid this terrible fate, remember to use the order of operations! Mathematicians have universally agreed to the following order in which to perform operations:

1. Grouping Symbols [parentheses (starting with the inside ones)]
2. Exponents
3. Multiplication and Division from left to right
4. Addition and Subtraction from left to right

An easy way to remember the order is with the acronym **PEMDAS**
Parentheses
Exponents
Multiplication
Division
Addition
Subtraction

The following example illustrates the importance of following the order of operations:

Ex.

$$10 \div 2 \div 2$$

$$5 \div 2$$

$$2.5$$

Ex.

$$10 \div (2 \div 2)$$

$$10 \div (1)$$

$$10$$

No matter whether the equation has fractions, decimals, or variables, you must always follow the order of operations.

8 Inverse Operations

Recall that we often use **inverse operations** to solve for a variable. Since we are using inverse operations, we must also use the *inverse* of the order of operations. Since we are "undoing" the equation to find the value of the variable, we must work in reverse order, that is, undo addition and subtraction, then multiplication and division and so on. See the following example.

Ex.

$$13a - 3 = 49$$

$$13a - 3 + 3 = 49 + 3$$

$$13a = 52$$

$$13a \div 13 = 52 \div 13$$

$$a = 4$$

Remote Learning Packet

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

April 6-10, 2020

Course: Physical Education

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

Weekly Plan:

Monday, April 6
☐ Mobility Routine

Tuesday, April 7
☐ Workout

Wednesday, April 8
☐ Mobility Routine

Thursday, April 9
☐ Workout

Friday, April 10
☐ No School!

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 6

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 7

1. 3 minute run
2. 20 squats
3. 20 lunges
4. 3 minute run
5. 10 jump squats
6. 10 jump lunges
7. 3 minute run
8. 10 squats, 10 jump squats
9. 10 lunges, 10 jump lunges
10. 3 minute run

Wednesday, April 8

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

Thursday, April 9

1. **7 minute run**

2. Set a timer for 8 minutes. Try to continuously do this workout for the duration.

    1. 1-3 pushups
    2. 5 meter bear crawl forwards
    3. 1-3 pushups
    4. 5 meter bear crawl backward
    5. 1 slow pushup (15-30 second count on the way down)
    6. 5 meter crab walk forward
    7. 1 slow pushup (15-30 second count on the way down)
    8. 5 meter crab walk backwards
    9. REPEAT

Remote Learning Packet

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

April 6-10, 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 6
☐ Read pg. 89 of the *Nature of Science*
☐ Read Supplementary Material: Introduction to Chemistry (see below)
☐ Complete the day's reading worksheet questions

Tuesday, April 7
☐ Read pg. 90 of the *Nature of Science*
☐ Read Supplementary Material: The Pre-Socratic Natural Philosophers(see below)
☐ Complete the day's reading worksheet questions

Wednesday, April 8
☐ Read "Thales" on pg. 91 of the *Nature of Science*
☐ Read Supplementary Material: Thales (see below)
☐ Complete the day's reading worksheet questions

Thursday, April 9
☐ Read "Anaximander" on pg. 91 of the *Nature of Science*
☐ Read Supplementary Material: Anaximander (see below)
☐ Complete the day's reading worksheet questions

Friday, April 10
☐ No School!

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

Throughout this week, there will be the same three steps to follow for each daily lesson.

1. Read the correct page or section in the *Nature of Science* textbook.
2. Read the special reading assigned for that day, which is found in this packet.
3. Complete that day's reading worksheet questions, which are found after each relevant special reading in this packet.

We hope you enjoy! Remember that you (or your parents) can reach out to us with questions.

Monday, April 6

1. NoS p. 89
2. Special Reading: Introduction to Chemistry
3. Worksheet

Tuesday, April 7

1. NoS p. 90
2. Special Reading: The Pre-Socratic Natural Philosophers
3. Worksheet

Wednesday, April 8

1. NoS p. 91 ("Thales" section only)
2. Special Reading: Thales
3. Worksheet

Thursday, April 9

1. NoS p. 91 ("Anaximander" section only)
2. Special Reading: Anaximander
3. Worksheet

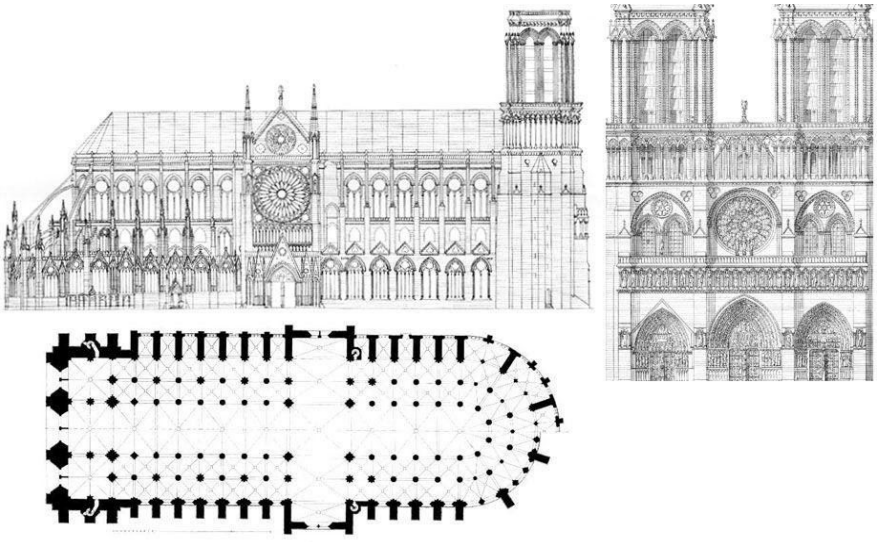
Chapter 1: Introduction to Chemistry

What is Chemistry a Study of?

I once heard a Chemistry professor say that Chemistry is the "study of *everything*." He reasoned thus:

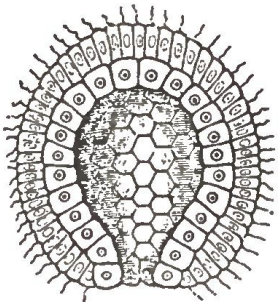
> Everything is made of matter.
> Chemistry is the study of matter.
> Therefore, chemistry is the study of everything.

I am not sure if the good professor was joking or just very confused, but this syllogism is neither valid nor sound[1], and the conclusion is certainly false. The falsity of it is obvious enough through examples. Say you are studying medieval cathedrals; cathedrals are made out of material, but you are certainly not doing *chemistry* when studying them! Take a look at the "blueprint" of Notre Dame cathedral, below.



Look very carefully at this blueprint. Does it tell you anything about the building? What *specifically* does it tell you? Notice that the emphasis is *not* on the material, but on the *form*: its structure, layout, relation of parts to each other, etc. When an architect or historian studies a cathedral, then, their attention is focused primarily on the *form* of buildings. And that is something—a very *real* and *important* something—that chemistry does *not* study.

Indeed, you should be familiar with this idea now from your study of Biology. From the very beginning, we emphasized that we were concerned with *formal cause* and not so much with *material cause.* When we studied the heart, for example, we did not think so much about material it was made of, but rather the *form* it was in. When we studied embryology, and we looked at the Gastrula stage, we were not concerned with the material it was made of, but the form it was in. And finally, form became *especially* important to us in biology when we realized that the soul is the *form* of an organized natural body—that is, soul is the *form*, not the material.



Chemistry: the Science of Matter *as Matter*

These two examples alone—from architecture and biology—suffice to show that the professor's conclusion that "chemistry studies everything" is most certainly false. There is one true premise in this syllogism, however:

[1] The syllogism is unsound because the premise "Everything is made of matter" is false. Remember the Ten Categories of Being—accidents, such as quantity or quality, are real things, but they are not made of material.

namely, that *chemistry is the study of matter*. Let us be careful, though, to avoid the mistake the professor made. It is the study of matter *as matter*. All material things, like cathedrals and hearts and embryos, are combinations of matter and form. Chemistry studies *only* the matter, and does not consider the form.[2]

But what is that like, studying matter *only* as matter? What sorts of things can you think about? Try for a moment to think about *Notre Dame* cathedral in this way. You could not say anything about its beautiful towers or arches or windows, because all of that is about the *form*.

Below is a list of some properties of matter—properties that always belong to matter and never to anything else—which are important to consider if you are trying to think about matter by itself.

Volume

All material bodies *take up space*. Imagine you are packing a moving truck. When you first open the truck, there is a lot of empty space. But after putting box after box into the truck, the space is filled up. This happens because each box takes up space. The amount of space a material object takes up is called its *volume*. *All* material things have volume, even of things you might not immediately think of, such as air. To see that air takes up space, simply blow air into a balloon and watch its volume increase.

Weight

Another property of all material is weight. Weight is the heaviness or lightness of a material object, or its downward tendency. You all have had plenty of experience with this property of matter, and have probably used the word correctly for a long time now. There is an interesting little experiment that you can do, however, that will improve your understanding of what weight actually is. To begin, let me ask you this seemingly simple question: *Is a 10 lb. weight twice as heavy as a 5 lb. weight?*

The answer is no—it is *not* twice as heavy. Remember that weight is a proper sensible of touch, and that proper sensibles can only be measured on *ordinal scales.* And ordinal scales, as you'll remember, can tell you more or less, but *not by how much*[3]. Therefore, since heaviness is a proper sensible, you cannot truly say that one thing is twice as heavy as another.

If you do not believe me, try it out for yourself. Ask a family member or friend—maybe your dad or older brother—if they have a set of weights, and do a little blind test. Ask them to give you two different weights, and you will guess how many times heavier one is than the other. You will see that it is actually impossible to judge.

Mass

But wait, why is that if I put two 5 lb. weights together, they feel just as heavy as a 10 lb. weight? Great question! Although a 10 lb. weight is not twice as *heavy* as a 5 lb. weight, it *is* twice in some respect: namely, it has twice as much *mass*.

Mass is the amount of matter in a material thing. Imagine you have a ball of cotton and a ball of lead that are exactly the same size. Which of these do you think has more matter in it? Easy, right? The ball of lead seems to have way more matter, because it is all packed in really tightly, while the ball of cotton is kind of loose and airy. We would say that the ball of lead has more **mass**.

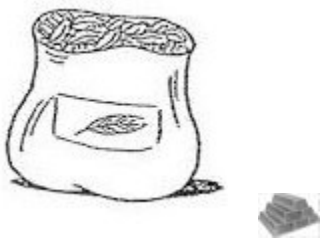
Mass and weight are closely connected because of the force of gravity here on Earth—the more mass an object has (that is, the more *mass*ive it is), the heavier it will be.[4]

[2] Notice that biology does the opposite, studying form without considering the matter.

[3] Remember, when we measured roughness, we could say more or less rough, but not twice as rough or three times as rough.

[4] The close connection between mass and weight is the reason we tend to think we can say one is *twice* as heavy as another.

Density
What weighs more: a pound of feathers or a pound of lead?



They weigh the same, silly! One pound each!

This old joke works because of an interesting relationship between the properties we just discussed: volume, weight, and mass.

Imagine that the feathers and the lead in the picture above have the same *weight*. This means, as we said earlier, that they must have the same *mass* (amount of matter). But how can they have the same amount of matter, when they clearly have different *volumes*? The answer is *density*.

Density is a relation of mass and volume—that is, a relation of the amount of matter in an object to the amount of space it takes up. The feathers and the lead, in the example above, have the same amount of matter, but take up different amounts of space. The feathers have more volume because their matter is more "spread out"; the matter in the lead, on the other, is more "tightly packed together." We say that the lead is more dense, and that the feathers are less dense.

Inertia
You may not have thought too much about it, but inertia is a property of all material and is part of your everyday experience of the world. Inertia is *the tendency of a body to resist changes in its state of motion or rest*.

To understand what is meant by inertia, imagine you are bowling. Before you roll the bowling ball down the lane, the ball is *at rest* and is *resisting* your attempts to change it to being *in motion*—it takes some effort to get it going! But then, once moving, it speeds along the lane on its own and shows no sign of stopping! Now, imagine attempting to stop the bowling ball on the other end, before it hit the pins—the ball would *resist* your attempts, and it would take strength and toughness on your part to stop it.

Inertia is something we can experience with any material object, though we tend to notice it less with lighter things (like a pencil) and more with heavier things (like a bowling ball). Next time you're at the grocery store, and your mom has loaded the cart with heavy groceries, try pushing it—you will notice that the cart resists your efforts to move it, but then, once you get it going, it will keep moving and will resist your efforts to stop it.

Temperature
You know what temperature is—the hotness or coldness of a body. But it is interesting to think about the fact that it is a property of matter *only*. Nothing can be hot or cold, unless it is material. It is also interesting to note that temperature is measured with an *ordinal* scale—2 degrees Fahrenheit is warmer than one degree, but you would never say it is twice as warm! Similarly, you would never say that an 80 degree day in spring is twice as warm as a 40 degree morning in winter.

Name:_____
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Teacher:_____
Date: _____

Monday: Introduction to Chemistry, NoS pg. 89

1. Copy the definition of chemistry from the first sentence of the reading.

_____

_____

2. At the start of the second paragraph, what is the origin of the word "matter"? Why is this important?

_____

_____

_____

3. List the six properties of matter discussed today and include their definitions, found on NoS 89.

Property of Matter	Definition

4. On the first page of the lecture, what seems to be the main difference in what biology and chemistry each study?

_____

_____

_____

Chapter 2: The Pre-Socratic Natural Philosophers

The Very First Scientists

"Why do we pay so much attention to the Ancient Greeks?" a student might ask himself after studying at Great Hearts for some time. There are actually many good reasons for this, but one very important reason is that they were the very first people ever recorded to have done *science* and *philosophy*. The very first of the Ancient Greeks to do it are known as the "Pre-Socratic Natural Philosophers."

Before the Pre-Socratic philosophers, natural phenomena were not given scientific explanations. Instead, they were given mythical or supernatural explanations. To the question, for example, "What do you know about the sun?" an ancient Egyptian would have answered that the sun is a god that sailed in a boat through the waters of the sky every day. Now, before you say that this is "wrong," pause for a moment—doesn't it capture something true about the sun? Not a scientific truth, of course, but a *poetic* kind of truth, capturing some of the beauty and meaning that we see in the sun. If you asked an astronomer in today's world what the sun is, you would likely get a very different answer: the sun is a massive ball of burning hydrogen and helium, for example. Both statements contain truth—very different kinds, but both very important[5]. Up until the Pre-Socratics (according to the written records we have, at least), people only thought about the poetic or mythical kind of truth.

"What is Going on Here?"

I want you to imagine that you were living in the time of the Pre-Socratic natural philosophers—let's say 620 B.C, when things were just getting started. You look at the world around you and see grass, bushes, trees, sky, moon, stars, sticks and stones, water flowing in a little stream, wind moving through the trees, a campfire burning brightly, little insects buzzing around, and so on. The world is filled with such a variety of things, all so different from one another.

But wait! You look a little more closely at the fire and see the burning logs.

"Those logs used to be a tree!" you say.

You look below it and see a pile of ashes.

"Those ashes used to be a log!"

And that is when an incredible thought strikes you: although there is a lot of variety in the material world, *there is also some kind of unity: some things can turn into other things*! But how*?*

With thoughts and questions like these, science has begun.

Although wood turning into ash is a very common experience, it contains an important and bewildering truth—a truth that the Pre-Socratic philosophers all saw. To see it as they did, we are going to have to think very carefully about *change*.

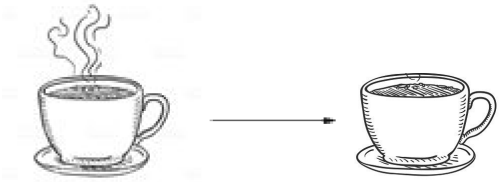
[5] People nowadays often make the mistake of favoring the scientist's answer too much, to the point that they dismiss poetic or mythical truth completely. But think for a moment how wrong it would be to think of our beloved sun—the sun that shines so brightly in the spring, a source of warmth and cheer, of growth for plants, of light for us to see, the source in some way of all life and a symbol of goodness and truth—as just a big ball of burning gas. It *is* a big ball of burning gas, but it is not *just* that.

Change

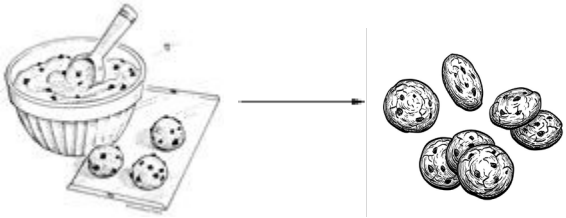
Change is happening all around us all of the time—we almost take it for granted. Let's take a look at some examples of change and do some induction to answer the question: what does all change have in common (or, what is *universal* about all change?).

A green apple ripens and becomes a red apple.

My hot coffee, after some time, sadly, becomes cold coffee.



The cookie dough that you put in the oven becomes cookies.



A blacksmith melts down a statue and makes it into a sword.

There is something common to every example—do you see it? Aristotle points out that, in every change, there are always **three things**: 1) what the change is *from*, 2) what the change is *to*, and then of course 3) the thing that is actually changing. The first two—the *from* and *to*—are called the ***"terms"*** of the change, and the third—the thing that changes—is called the "***underlying***" (because it underlies and persists through the change.) Can you identify all three things in each of the examples above?

Green Apple — Ripening — Red Apple

TERM (*FROM)* **TERM *(TO)***

The apple itself is the **UNDERLYING**, since it persists through the change.

In the example of the apple, green and red are the terms, the apple is the underlying.

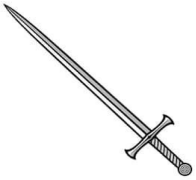
In the coffee example, hot and cold are the terms of the change, and the coffee is the underlying.

When a statue becomes a sword, in the blacksmith example, it might be a little trickier—what are the terms and what is the underlying?

Statue

TERM (*FROM)*

Sword



TERM *(TO)*

The metal material is the **UNDERLYING**, since the metal alone is what persists through the change.

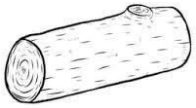
Since it changes *from* a statue, and changes *to* a sword, the terms of the change are statue and sword. The underlying is the tricky part. The underlying, in this case, must be the *metal* that both statue and sword are made of.

Are you getting the hang of it? Pause for a moment, and try it out for yourself on some other changes that you have noticed.

What Change Means about the Material World

It was in thinking about change like this that Pre-Socratics hit on one of the first and most important scientific questions. The question—as you will see in a moment—arises when we look at some trickier examples of change. Think back to the change we noticed in the campfire: a log becomes a pile of ashes. What are the terms and what is the underlying?

Log



TERM (*FROM)*

Ashes

TERM *(TO)*

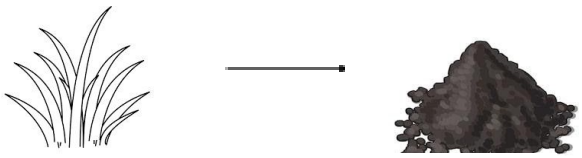
But what is the **UNDERLYING**?
What persists through the change?

Do you see the problem? The terms of the change are clear enough. But what is the underlying? When the statue became the sword, the underlying was the metal—the *material* out of which both things were made. But what are logs and ashes both made of? Are ashes made out of wood? Or is wood made out of ashes? Neither

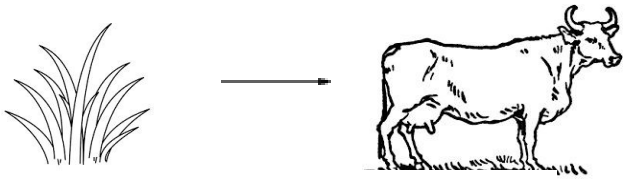
claim seems reasonable. *But there **must** be an underlying*! It seems necessary, therefore, that they are both made out of something else—something that is neither wood, nor ash, but is the material in both of them. *But what is it? What are wood and ashes both made of?*[6]

And, as if that's not difficult enough, there's more: this is not just true of wood and ashes. First of all, lots of different things turn to ashes when they are burned. Grass, for example, if thrown into a fire, will turn to ashes. But that's not all grass can become—if a cow eats the grass, the grass turns into the cow's body. And, to top it all off, if a cow dies and its body is burned, the cow's body turns to ashes.

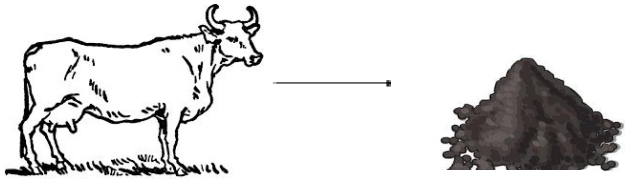
Grass turns to ashes.



Grass turns into the cow.



The cow turns to ashes.



Do you see what is happening? It looks like grass, cows, and ashes are all made out of the same stuff! That is, *they must all have the same underlying*. And it was when the Pre-Socratics realized this that the really big and important question came to them:

Is there some underlying material in the universe,
out of which every existing thing is made?

This was a *big* question! And other questions quickly followed: If there is one material, *what is it*? Is there just one material, or are there more than one? What would they be? These are important questions for understanding our world, but they are also very difficult to answer.

To see the difficulty of answering the question of what everything is made of, let's take a stab at it ourselves.

First of all, is everything made of *one material*, or are there *many* materials? Well, we already saw that grass and cows and ashes must have some common material out of which they are all made; and since many other things turn into ashes as well, we can tell that a lot of seemingly different things must actually be made of the same stuff. This seems like good reason to suspect that everything in the universe is ultimately made of the same one material.

[6] If you try to say there is no underlying, then you are saying that, as it burns, the log actually just "pops" out of existence—into thin air—and ashes just "pop" into existence where the log used to be. But this is a ridiculous idea.

But what could that one material be? Based on the example we were just looking at, we might guess—could it be that everything is made of grass? Maybe *grass* is the underlying in every change, the very stuff everything in the universe is made of…

Not a bad attempt, but we immediately see some problems with this theory. First of all, grass seems to be made of other things too. For example, you might notice that grass needs water, soil, and sunlight in order to grow. It seems somehow, in one way or another, to be made of those things. So perhaps it is one of *these*—say soil, or earth—that everything is made out of. Grass is made of earth, and thus cows are made of earth. And actually this theory works out rather nicely, because it seems to make sense of the fact that, when a cow dies, its body decays and becomes earth. But again, some problems arise: what about other things that do not appear to have any such connection to earth, such as air or water.

Do you see the difficulty? Since we see material things change from one thing into another, we know there must be an underlying material that is the same in both. But what *is* it? What is everything made out of? The Pre-Socratics—the world's very first scientists—were asking these very important and very difficult questions. In the coming weeks, we will see what answer each of them gave.

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

Be sure to answer in complete sentences.

The Pre-Socratic Philosophers
***Nature of Science* textbook: p. 90**
Supplementary Readings: pp. 6-10 in this packet

1. The ancient Greek philosophers were the first people ever recorded to have done _____ science and_____.

2. This first group of Greeks are quite ancient and lived before_____.
   a. Socrates (c. 470 BC – 399 BC)
   b. Plato (c. 428 BC – 327 BC)
   c. Aristotle (384 BC – 322 BC)
   d. All the above

3. One crucial – but also quite common – thing that the Pre-Socratic philosophers thought very carefully about was_____.
   a. Measurement
   b. Change
   c. Motion
   d. Gravity

4. With every change, there is what something changes_____to what it changes_____. Together, these are called the **terms** of the change.

(worksheet continues on the next page)

5. It's crucial to understand these three parts of change if you are to grapple with the concepts the Pre-Socratics did. So let's practice!

Description of change that occurs	**(1) Term** (from)	**(2) Term** (to)	**(3) Underlying**
Example: An apple ripens	Green apple	Red Apple	Apple
Coffee cools	Hot Coffee	_____ Coffee	_____
Blacksmith melts statue and makes sword	Statue	Sword	_____
Girl grows	Short girl	Tall girl	_____
Potter forms jar	Unshaped block of clay		Clay
Carpenter harvests tree so he can make furniture	Tree	Table	_____
Warmer temperatures come and melt snowman	_____	Puddle	_____
A couple decide to re-decorate their dining room	Blue wall	_____	Wall
Now, invent your own and complete the three parts of a change.			
Invent another:			

6. These reflections on change led the Pre-Socratics to very important and fundamental natural scientific questions. Consider the log that was burnt.

Description	**Term** (from)	**Term** (to)	**Underlying**
A log was burned on a campfire	Log	_____	What was underlying?

Copy down the four very important questions the Pre-Socratics pondered very carefully:

1._____

2._____

3._____

4._____

Chapter 3: Thales

Pre-Socratic Questions

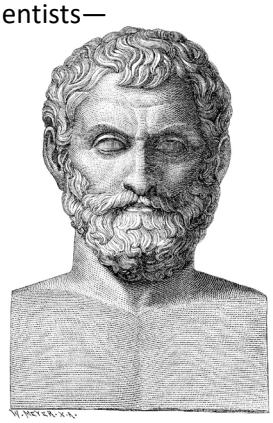
Do you remember reading about the Pre-Socratic natural philosophers in the last chapter? These men were the first to seek *scientific* explanations of the world around them, rather than poetic or mythical explanations. They were the world's very first natural scientists!

These scientists of nature noticed a very profound truth about the natural world, and they noticed it when they looked at *change*. How can one thing *change* into another thing? As we saw when we looked at change in the last chapter, the fact that one thing can change into another thing must mean that they are both made from the same material (or materials). For example, if grass can turn into ashes when it is thrown in the fire, but it can also turn into a cow if the cow eats the grass, then grass, cow, and ashes must all be made of the same material.

Observations like this led these first natural scientists to wonder: What is everything in the universe made of? Is it all made of the same basic stuff? In this chapter, we will meet the very first of these natural scientists: the *very first* natural scientist in history![7] And his name was… [drumroll, please!] …

Thales

The very first of these first natural scientists was named Thales (pronounced "THAY-lees"). Thales was a legendary figure in the ancient world. He is mentioned by many ancient historians and scientists—including Aristotle, who lived about 250 years later—and many wonderful tales were told of him, and great feats attributed to him. Several of these stories have survived to this day.



Much that we might want to know about him, however, has been lost to history. For example, we do not know the exact year of his birth, but we think it must have been around the year 620 B.C. Based on the stories we have, we can tell that he was known throughout the ancient world for his scientific genius. But unlike many scientific geniuses of the past, Thales never wrote any of his ideas down. In fact, all of our knowledge of Thales depends on the stories that other ancient authors wrote about him.

One such story tells how he famously predicted an eclipse that occurred in 585 B.C. on the day of an important battle.[8] For the people in Thales' time, an eclipse—when all of the light from the sun is suddenly extinguished, and everything is dark in the middle of the day—was an unexplainable phenomenon, connected to fate and to the realm of the gods. Thales' prediction amazed everyone, for it seemed to them like he had gained some kind of power divine prophecy, or of control over the heavens, just by using his mind.

Another time, as legend has it, Thales was in the army and his commander was trying to figure out how they were going to get to the other side of a large, uncrossable river. Thales immediately set to work—he traveled upstream, close to the source of the river, and dug a channel to divert some of the water, dividing the river into two rivers that were then easily crossed by the army.

Thales, indeed, was such a thinker, especially about the natural world and the heavens above, that he sometimes did not pay as much attention to more practical things. There is an amusing tale, told by Aristotle's teacher, Plato,

[7] It should be noted that he is the first scientist *in history*—that is, ancient historians wrote that there were some others before Thales, but that Thales was so much greater than all of them, that only Thales was remembered.

[8] We now know that the moon is blocking out the light from the sun, but this was not known in Thales' time.

of how Thales was walking along through a field one night, and he was looking up at the stars in the night sky, thinking scientific thoughts about them, when suddenly he tripped and fell into a well. Plato recounts how a Thracian servant girl saw the whole thing and "mocked Thales . . . declaring that he was eager to know the things in the sky, but that what was behind him and just by his feet escaped his notice."

Thales' Big Question

These stories are wonderful illustrations of Thales' character and give us some sense of what kind of person he was, as well as his legendary status in the ancient world. More important for us, however, as students of the natural world, were Thales' answers to that question we have been asking:

What is everything in the universe made of?

Indeed, Thales was the first person ever known to ask this question. He noticed what we noticed in the last chapter—that things change into other things—and realized what that meant. There must be some ultimate material or materials that everything in the universe is made of, and he was determined to know what it was.

As we saw in the last chapter, seeing *that* all material things might be made of the same stuff is easy; knowing *what* it is all made of is much more difficult.

Thales' Answer

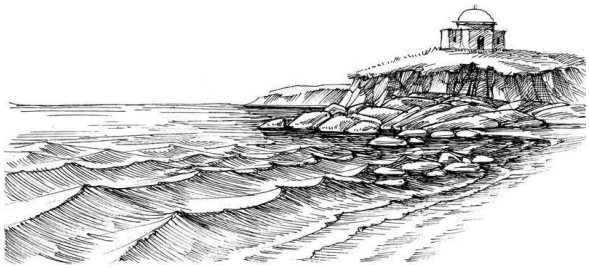
Thales declared that everything is indeed made of a single substance, and that that substance is…*water*!

Why Water is an Excellent Choice

"*Water*? Everything is made of *water*?" you might ask. Students sometimes think this sounds strange, but that is probably just because they have never given this answer much thought. Indeed, most people have never even given this *question* much thought! But if you do start asking this question, and you really consider Thales' answer, you start to realize that water is actually, in our search for ultimate-substance-that-everything-is-made-of, one of the best answers you can give. What makes water such a great candidate, you say? Well, let's get started!

a) <u>Water is Everywhere</u>

Just outside my window, at this very moment as I sit here typing this account of Thales' ideas, water is pouring in heavy droplets out of the sky. Indeed, it doesn't take much observation, especially during the spring here in Texas, to see that water is everywhere. Now, Thales did not live in Texas, of course, but he did live in a part of Ancient Greece called Ionia, right on the Mediterranean Sea. He knew, in a special way, that water was everywhere, and—more importantly—that all *land is surrounded by water*.



Water is everywhere, and there is so much of it, and everything is surrounded by it. Well—what do you think? I suppose these facts alone do not mean that water *has to be* the ultimate material cause of everything, but I'd say they are certainly some strong points in its favor.

b) <u>Water is Basic</u>

The next point in favor of choosing water is that water is *basic*. Do you remember, in the last chapter, when we guessed that everything was made of grass? It was not a terrible guess—we do see that some animals seem, at least in some manner of speaking, to be made of grass. But grass itself seems to be made of other things. For example, there is clearly water in grass. And it wouldn't make sense to say that the water that is *in* grass is also *made of* grass. It is pretty safe to say, therefore, that *anything that is obviously made of other things is automatically out of the running*.

You can see the truth of this pretty easily when you look at extreme examples—what would you say, for example, if I told you that I thought that *everything* in the universe is made out of peanut butter and jelly sandwiches? (You might rightly respond "Even peanut butter?") Ridiculous examples like this illustrate the need for something *basic*—something that is *in* other things, but that does not seem to have any ingredients itself. Water certainly seems to fit this description. After all, have you ever seen water being made? You don't see people mixing ingredients together in a bowl and ending up with a bowl of water.

Chalk up another point for water!

c) Water is Traditional

Whenever you are searching for truth, one of the best things to do is to look back at the tradition of those who came before you, to consult the wisest among them to see what they said about it.[9]

For us in the 21st century, this is easy enough. History has preserved thousands of years of human wisdom and we can turn to it whenever we are seeking the truth about anything. For Thales, as the first scientist ever recorded, there were no scientists of the past to turn to. There *was*, however, a great tradition of story-telling and poetry and myths. (Remember the *poetic* kind of truth that we talked about in the last chapter?) Many of these stories were about the creation of the world, and in each of them, water plays a prominent role. Some stories told of how, in the beginning, there was only water, and the land came from it; other stories, like those from Egypt, even said that the entire sky was water too, and that the sun and moon sailed across it each day.

Looking back at tradition then, even though the wisdom he found was not *scientific* wisdom, still the wise men of old had seen some importance in water, and this gave support to his idea.

d) Water is Essential to Life

You cannot watch a mountain grow. You will never witness a rock getting bigger and bigger over time. But if you cannot see a thing being made or growing, it is hard to tell what it is made of.

Although there are certain things that you cannot see being made or growing, you *can* watch living things grow! We see it all the time. And what do all living things need? You guessed it – water! Water is essential to all living things. If you give a plant water, it will grow; if you do not, it will die. The same is true of animal life as well. As Aristotle suggests, "Maybe he [Thales] got this idea from seeing that the nourishment of all things is moist." Furthermore, it is easy to see that living things have water *in* them. If you dissected a fruit last week, you probably needed a paper towel to wipe up all the wetness afterwards.

e) Water is Fluid

Another point in favor of water is that water is *fluid*—that is, it can easily change its shape. If you pour water into a glass, the water instantly takes the shape of the glass that it is in. If you pour water into a glass that is shaped like a star, the water will be star-shaped. And so on. This ability to change shape seems like an important quality in something that is the material that *everything* is made out of.

f) Water is Solid, Liquid, and Gas

"But really?" a student might here say, "*Everything* is water? What about hard, heavy, solid things like stones? Or what about things that are lighter than water, such as air?"

[9] We do this all the time here at Great Hearts. In fact, that is what we are doing *right now*—as we seek the ultimate material cause of the universe, we turn back to the wise Thales to see what he had to say about it.

Great question! For you see, this is why water is, again, such a perfect choice. We actually *experience* water becoming hard and solid, like a stone, when it freezes into ice! And we actually *experience* water turning into something light, like air, when it evaporates or turns into steam!



This indeed seems to be strong evidence that water is the underlying material in everything.

Legacy

Water sure has a lot of things going for it. I think that if I lived at the time of Thales, I would have been entirely persuaded by these arguments and would have believed that everything came to be from water. After all, there has to be *some* material that everything is made of—and really, *what else could it be*?

Indeed, Thales had many such devoted followers and students. In the coming days, however, we will be looking at some of those who followed Thales that were *not* convinced by Thales' idea, but argued that the material cause of everything was not water, but something else instead.

As we read on, and we encounter some of these new, excellent ideas, let us not forget what we have seen from Thales here—not only his brilliant theory, but the scientific tradition that he started. After all, when people disagree with Thales, and think it is not water but something else, they are really only following along the very path to truth that Thales himself first discovered.

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Wednesday: "Thales" on NoS pg. 91:

1. What group of people Aristotle seem to be talking about when he refers to "those who first pursued philosophy"?

_____

_____

2. At the start of the second paragraph, what does Aristotle say Thales declared to be the first principle? Where does Aristotle suggest Thales got the idea?

_____

_____

_____

_____

Wednesday continued: Thales supplementary lecture (pp. 14-17 in this packet)

3. **Circle the correct word:** Thales lived **(before / after)** Aristotle, around **(620 B.C. / 350 B.C.)**.

4. What is Thales' "big question"? _____

_____

5. List the six reasons in today's lecture for why it might make sense for Thales to pick water as the first principle of material things:

a.
b.
c.
d.

e.
f.

6. Which choice best explains what it means to say that “water is basic”, according to the lecture?

   a. Water is a complex substance made of many heterogeneous parts.
   b. Water is uninteresting.
   c. Water doesn’t taste sweet or sour.
   d. Water seems to be a simple and homogeneous substance.

7. List at least three objects that you can see right now that clearly gain nourishment from water.

_____

_____

_____

Chapter 4: Anaximander

So Far, So Good

A few days ago, we embarked upon our study of chemistry. Chemistry, as you will recall, is the study of matter *as matter*. We started off this study of matter as matter by considering some properties that all matter has—such as volume, mass, density, and so on. Then, we turned to history's first natural scientists—the "Pre-Socratics"—and asked, along with them, some of the biggest and most important questions you can ask about the natural world: what is everything made of, and how is change possible? In the last chapter, we looked at Thales, who answered that the ultimate material principle of the universe is water, and we saw the many reasons that made this such a good choice.

Anaximander

We will be focusing, in this chapter, on the Thales' successor: Anaximander (pronounced "an-AX-i-MAN-der"). Anaximander was only about fourteen years younger than Thales, lived in the same city as Thales did, and was—historians think—actually Thales' student! (And, even if he wasn't Thales' student, I am sure they had many great conversations in which they shared their ideas about the natural world.)

Like Thales, Anaximander did not leave us any writings. If he did write anything, it has all been lost to history. We do, however, have a direct quotation from him, copied down by another author, so we will be able to look at his own words later on in this chapter. Anaximander was very thorough in his thinking—indeed, he seemed to have had an explanation for everything that we experience in the natural world. We will be looking at a couple of those ideas today.

Anaximander Disagrees with Thales

"Wait, what? Anaximander *disagreed* with Thales?" you all exclaim after reading the title of this section. "How can you disagree with such a convincing argument? And he was Thales' *student!*" Yes, well, sometimes students disagree with their teachers, and that is not necessarily a bad thing.[10] Anaximander *did* indeed disagree with Thales on what he thought was the ultimate material principle of the universe. You will have to judge for yourself who you think had the better answer.

Some Difficulties with Water

As good as Thales' theory was, there were, admittedly, some reasons to be skeptical. The first reason is one that we have been aware of this whole time—that some things just seem too different from water to have actually come from it. Looking at a pile of the driest, dustiest sand you have ever seen, for example, might make you pause.

It seems that Anaximander may have had this sort of hesitation. But this does not just happen with water—choose anything you like, and you will run into this sort of problem. As you were reading about

[10] But don't get any ideas.

Thales' ideas, you may have picked up on this and said to yourself something like "I don't think its water, but…ah! I don't know what it is!... It's just *stuff*!" And with those words, some vague kind of material "stuff" came into your imagination, not like anything we ever encounter in the world—something like material with no form at all. If you thought of something like this, you might have been thinking along the same lines as Anaximander.

The Indefinite

Anaximander rejected Thales' idea of water, and declared that everything was made out of what he called the "*indefinite*." It was something like that vague, formless "stuff" we were just thinking about above, as you will see.

The word he used for indefinite in Greek had two meanings. It meant:

1) unlimited or infinite, and 2) without a definite form.

The first meaning is easy enough to understand: if the whole universe was made from it, it would make sense for there to be a limitless supply. But this claim is not really what distinguished him from Thales. What *really* distinguished his idea and made what he said important and new, was the second meaning: *without a definite form*. For this was his answer to that all-important question about what everything is made of. When Anaximander says that everything is made of the "*indefinite,*" he means something like what we meant earlier when we said it was some kind of vague "stuff"—not any actual material we see on earth, but just some formless stuff that, in the beginning, was used to make everything else we know.

This idea sounds very reasonable indeed, and may solve some of the hesitations that we had about water. To really appreciate this idea of the indefinite, however, we need to understand it, as Anaximander did, as the solution to a much *bigger* problem in Thales—in order to see what this problem was, however, we must first take a look at how Anaximander understood *change*.

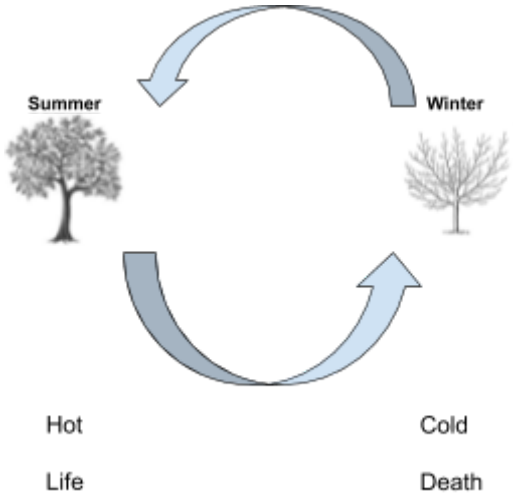
Change: "Retribution for Injustice"

We look at the world around us and see motion and change *everywhere*. Things are moving, things are coming and going, things are being born, things are growing, things are dying, and so on—but *why*? Why doesn't everything just stay perfectly still, and never change at all?[11] The mere fact that everything is made of the same stuff does not mean it has to be constantly in motion and in change from one kind of thing to another. "How do you explain change in the world?" asked Anaximander. Thales had no answer.

Anaximander started paying very close attention to change, and noticed a profound and interesting pattern that seems to run all through the natural world. Changes, he noticed, seem to cycle back and forth between opposites. Day, for example, *always* becomes Night; and then, *without fail*, Night turns back to Day. It continues to change in this way, always going back and forth between the opposites of light and dark.

[11] Have you ever asked this question? It's a *really* good question!

This same pattern is also apparent in the change of seasons: hot summer eventually gives way to cold winter, which is then again followed by another hot summer.



Do you see the cycle? Do you see how these opposites are actually opposite in *multiple* ways? In summer and winter, we see not only *hot and cold*, but also *life and death*. In day and night, we see not only *light and dark*, but *waking and sleeping* as well. The more you think about the natural world with this in mind, the more you will begin to see this pattern everywhere. Fire and ice, sunshine and rain, land and sea, war and peace—the list goes on. Can you think of more?

The natural world, observed Anaximander, is full of these opposite forces, and things always pass back and forth, like a pendulum, between them. All change, he declared, was the result of a kind of war between opposite forces. Here are Anaximander's exact words (the only words of his that we still have):

"…according to necessity; for they pay penalty and retribution to each other for their injustice in accordance with the ordering of time…"

The opposite forces in the world, says Anaximander, are paying penalty and retribution to each other for their injustices. What does this mean? Let's think about an example of two opposites: day and night.

During the night, there is no light at all. This is an "injustice" to the day.

So the sun rises, and night "pays the penalty" for its "injustice" to day.

But then it is so bright during the day, that it is an injustice to night.

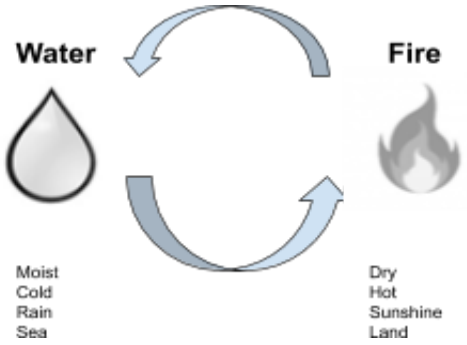
So the sun sets, and day "pays retribution" for its "injustice" to night.

And so on.

I imagine something like this happened to me when I was growing up. My brother and I would be fighting—the cause long ago forgotten—and he would hit me, so I would have to hit him back; but then

he had to hit me back; so I had to hit him! And so, it seemed, it would continue on forever and ever—or it would have, if our mother hadn't stepped in.
One of the key ideas here is that the opposed forces are always *balanced*. It wouldn't have worked if my brother was one million times stronger than me. Light and dark are opposite but *balanced* forces. If they were not balanced, the stronger would overwhelm and destroy the weaker.

The Real Problem with Water
Can you see now why Anaximander had a problem with the idea that everything came to be from water? Water, said Anaximander, is caught up in the same war that the rest of the natural world is!



Water is opposed to fire. And water's qualities, such as wetness and coldness, have opposites of their own, like dryness and heat. How, Anaximander asks, could fire ever come to be from water if they are opposed? Imagine being there at the creation of all things—everything is water. How would fire ever come to be? And if, somehow, it did, how would it stand a chance against all that water? The same can be said of all of them: how could dry land ever come from water, if the dry is at war with the wet. Remember, for everything to work, the opposites had to be *balanced.* But if everything in the beginning was water, there is no balance at all. Fire, heat, dryness, land—all of this would never stand a chance of existing at all.

This was Anaximander's greatest insight: *the material that everything comes from cannot be opposed to any other kind of material*. But in the natural world, *all* of the materials that we find have opposites. What is the solution? We need some *other* kind of material, *not* found in the natural world, that is *not* opposed to the other materials—and that, says Anaximander, is the *indefinite.*

Conclusion
One of the brilliant things about Anaximander's theory of the indefinite is that it works *together with* his theory of change. It works together, too, with many other theories of his that we have not discussed here: for example, about the origin of the universe, the structure of the world and of the heavens, and the origin of plants, animals, and human beings.

We have now heard two different theories about the ultimate material principle of the universe. What do you think? Whom do you agree with more? In the days to come, we will meet many more scientists, all with different answers to these questions. As you read about them, keep asking yourself those questions—What are the strengths of each theory? What are the weaknesses? And ultimately, whose theory is closer to the Truth?

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Be sure to answer in complete sentences where you can.

The Pre-Socratic Philosophers: Anaximander
***Nature of Science* textbook: p. 91**
Supplementary Readings: pp. 20-23 in this packet

1. Anaximander was_____years younger/older (circle the right answer) than Thales.

2. Thales made a compelling argument that_____made up everything, but Anaximander argued that the_____made up everything.

3. Why does the existence of dry sand or fire cause a problem for Thales' idea?

_____
_____
_____

4. Copy the two different meanings of the **indefinite**:

   a. _____ or _____
   b. _____ ___ _____ _____

5. It's very important to understand how Anaximander understood_____.

   a. Life
   b. Death
   c. Change
   d. Water
   e. Fire

6. An important insight Anaximander had was that many, many things in the universe appear to be _____

   a. Growing
   b. Opposites
   c. Interconnected
   d. Dying
   e. Partners

(Worksheet continues on the next page)

7. Additionally, many things are opposed in more than one way. For example, Summer and Winter are opposites in (at least) two ways. Which ones?

a. Hot/Cold & Green/White
b. Wet/Dry & Full/Empty
c. Wet/Dry & Green/White
d. Hot/Cold & Life/Death
e. None of the above

8. Just as the reading suggests, now it's your turn! Consider the world around you. What are some other opposites? Think of **three** that were not mentioned in any of the readings.

First Opposite	**Second Opposite**	**Ways they are Opposed**
Day	Night	Brightness/Darkness
Water	Fire	Moist/Dry; Cold/Hot; Rain/Sunshine; Sea/Land

9. Copy down Anaximander's **greatest insight** (the text indicates which was his greatest).

_____
_____
_____