Students engage in locally relevant phenomena to develop models that explain how the rotation and revolution of the earth, along with the rotation of the moon, lead us to make decisions about things such as choosing what to wear.

Student Science Performance	
6th Grade Earth Science	**Title**
Topic: Earth-moon-Sun	Motion of the Earth-Moon-Sun

Performance Expectation for GSE:

S6E2. Obtain, evaluate, and communicate information about the effects of the relative positions of the sun, Earth, and moon.

a. Develop and use a model to demonstrate the phases of the moon by showing the relative positions of the sun, Earth, and moon.

b. Construct an explanation of the cause of solar and lunar eclipses.

c. Analyze and interpret data to relate the tilt of the Earth to the distribution of sunlight throughout the year and its effect on seasons.

S6E3. Obtain, evaluate, and communicate information to recognize the significant role of water in Earth processes.

d. Analyze and interpret data to create graphic representations of the causes and effects of waves, currents, and tides in Earth's systems.

S6E5. Obtain, evaluate, and communicate information to show how Earth's surface is formed.

d. Ask questions to identify types of weathering, agents of erosion and transportation, and environments of deposition. (Clarification statement: Environments of deposition include deltas, barrier islands, beaches, marshes, and rivers.)

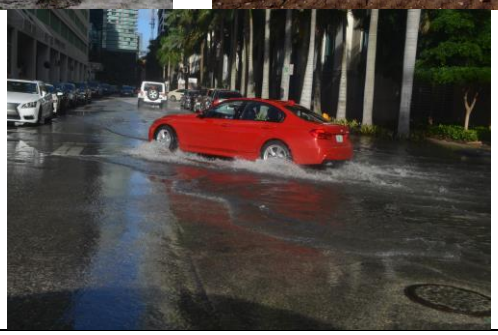
Students will continuously obtain, evaluate, and communicate information about the patterns of the earth-moon-sun positions and its effects on life on earth. The engage phase is intended to set the context for learning, with subsequent explore-explain phases that can be presented in any order. Though presented in a linear fashion, this learning cycle is not intended to be perceived as a linear process. The overarching idea of how patterns of motion of the earth-moon-sun positions affect life is intended to be an explicit pervasive theme for each explore-explain phase, therefore allowing the teacher to rearrange the sequence of instruction appropriately for the students. Furthermore, students will communicate through writing and discussions to allow for formative assessment for each explore-explain. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners	*Obtaining* Students obtain information about their own ideas associated with how the motion of the earth-moon-sun affect their experiences. *Resource:* PowerPoint of Earth-Moon-Sun Photo Gallery (Presentation is on the Teacher Resource Link) *Teacher Hint: Use a photo gallery of related phenomena such as the PowerPoint to elicit students' current understandings. Allow time for students to brainstorm additional phenomena similarly explained by the motion of the Earth, moon, and Sun. Use the engage phase to establish expectations for thinking, modeling, and explaining how the motion of the Earth-moon-and Sun contribute to patterns for both every day and unique phenomena.*
Explore *(Eclipses)*	**Phenomenon:** Research a picture or video of The Total Eclipse. *Obtaining* Students obtain information about the causes and effects of a total solar eclipse by listening to others' experiences in the August 2017 total eclipse. Teacher will research a video or articles of The Total Eclipse *that occurred in*

	the US in August 2017.
	Evaluating/Communicating Prompt students to evaluate their thoughts on the causes and effects of a total solar eclipse. Students develop an initial model to communicate their thoughts, then compare models with a partner.
	Obtaining/Evaluating Students obtain additional information about why a total solar eclipse is phenomenal phenomena from the video at Why is the total eclipse such a big deal? Students revise initial models based on information obtained. Students then evaluate their models using Total Solar Eclipse View as an exemplar. Students then apply newly obtained information to develop a new model that would represent the causes and effects of a lunar eclipse. *Communicating* Students communicate strengths and limitations of the models. Students brainstorm additional phenomena that are caused by the motion of the earth and moon in relation to the sun. Have students follow this same procedure with a lunar eclipse. After looking at pictures of a lunar eclipse ask them: 1. How is this different than a solar eclipse? 2. What phase of the moon would a lunar eclipse occur? 3. How is this different than a solar eclipse and when it happens? *Teacher Hint:* Post these ideas followed by purposeful instruction that addresses most of the phenomena. Guide students toward asking questions or posing phenomena associated with lunar cycle, tides, and seasons.
Explore *(Relative positions)*	*Obtaining/Evaluating* Students obtain information via simulation about the motions of the sun, earth, and moon. Resource: Gravity Simulation of Solar System
	Communicating Students use data from spreadsheet in simulation to identify and communicate patterns. *Teacher Hint:* Guide student data analysis by narrowing their focus toward performance objectives consistent with GSE and the simulation. This includes: 1) Use data to support a description of the relationship between the Sun, Earth, moon and space station, including orbits and positions 2) Use data from the simulation spreadsheet to explain how gravity controls the motion of the Earth and moon in relation to each other and the larger solar system. 3) Use data to identify the variables that affect the strength of gravity between Earth and moon.
	Obtaining/Evaluating/Communicating Students obtain and evaluate two data sets to determine the patterns of the lunar cycle and tides. Students apply information obtained to develop new models that represent both the lunar cycles and tides.

	Teacher Hint: Questions from Gravity Simulation of Solar System ● Describe the relationship between the Sun, Earth, Moon and space station, including orbits and positions. ● Describe the size and distance between the Sun, Earth, Moon and space station. ● Explain how gravity controls the motion of our solar system. ● Identify the variables that affect the strength of gravity. ● Predict how motion would change if gravity was stronger or weaker. Resource: Phases of the Moon and Tides *Obtaining/Evaluating/Communicating* Through a think-pair-share, students obtain, evaluate, and communicate additional information about factors of tidal intensity. Think: Individual thinking recorded based on guiding questions. *Guiding Questions:* ● How do you think tides change based on the weather? ■ ...currents? ■ ...waves? ■ ...shape of oceanic crust? ■ ...shape of continental crust? ■ …shape of surface features? ■ ...proximity (distance) from moon? ■ ...proximity from sun? ● How do you think tidal intensity impacts the coastline? ■ ...estuaries? ■ ...marshes? ■ ...people living nearby? ■ ...geography/surface features? Pair: Students will partner to evaluate their thoughts and plan a research investigation into factors they are unsure about. As partners retrieve accurate information, one student should produce visual representations while the other writes speaking notecards for their future presentation. *Communicate*: Students display/compile their explanations onto one poster and prepare to share at least one cause/effect related to tidal intensity. *Teacher Hint:* As you monitor students on task, listen for ideas they are struggling with versus those that come easily. Encourage students to use language of the standard (e.g. weathering, erosion, deposition).
Explaining	**Phenomenon: Tides of the Georgia Coast** *Obtaining* Engage students in a photo gallery of Georgia coastlines as a means for eliciting their current understandings for how these landscapes are formed

(Relative positions, Tides)	and continue to evolve. *Teacher Hint:* As photos are shown ask them to describe what they see, how they think it came to be shaped this way, whether it stays the same over time or if it is always changing, etc. Guide students to brainstorm/ identify sources for this phenomenon (e.g. tides, waves, and currents) and begin to question other factors (causes) that contribute to this motion of the oceans (e.g. lunar cycle, rotation of earth, density of warm versus cold ocean water, waves). Make explicit connections to earth surface features that are a result of areas of weathering, erosion, and deposition (S6E5d). See guiding questions for suggestions. Sample Photos: Explaining Tides *Guiding Questions:* ● How do you think the water moved into this area? ● Do you think this was a slow or quick process? ● What factors do you think impact how much water moves onto the coast? the roads? the farmland? ● What factors do you think impact how quickly it moves in and out of these areas? ● What do you think the water brings with it? (sediment, etc.) ● How might this change the land? How might it change the water? ● What do you think the water takes away with it? ● How might this change the land? How might it change the water?
	Teacher Hint: Inform students that the current focus will be on the cause and effects of tides on Georgia coastline, but that these other causes for our ever-changing coastline will be revisited at a later time. *Evaluating* Student evaluate tide tables to develop initial explanations and models on the causes and effects of the earth-moon relationship to tidal cycles. *Photo of Tide Table:*  *Resource for Student Use:*

	Sample Tide Table *Obtaining* Students obtain additional information about the effect of gravity on tidal cycles through a teacher led demonstration using a model. Teacher research: Tide-o-matic to help. *Teacher research this Resource:* Oceans, Tides, and the Moon *Evaluating* Students evaluate their initial understandings of the causes and effects by improving upon their initial models to encompass gravitational force. *Teacher Hint:* Consider additional photographs of both high and low tides. Group students so that all groups have different photos to explain through their model. (A quick internet search will yield multiple images.) This would also allow for an extension where students identify the patterns of the cause and effect of a high tide and low tide.
	Communicating Students present their models with peers providing feedback in the form of strengths (glows) and weaknesses (grows).
Elaborating *(Relative positions, Tides, Weathering, erosion, deposition)*	**Phenomena:** **Tidal Floods**   
	Obtaining Students are divided into expert groups (e.g. marine biology, farmer, park ranger, tourist) to obtain information about problems experienced by these individuals due to tidal floods experienced along the Georgia coast. *Communicating* From these perspectives, students will communicate causes, effects, and anticipated future problems to their home group.

	Teacher Hint: Consider a jigsaw approach for students to obtain and communicate their information in smaller group settings. In discussion, make explicit connections to S6E5d. See guiding questions for suggestions. *Guiding Questions from handout Tidal Floods:* ● How do you think the debris left behind impacts the sea turtles habitats? What other kinds of animals do you think may be impacted by these tidal floods? ● Why do you think these tidal floods are different than the daily tides? ● How do you think the water left behind impacts the farmers? ● What do you think it's like for the _____ (this blank would be filled in by the expert group) when the water is at its highest point? ● Considering terms like weathering, erosion, or deposition, which of these terms would you use to label tidal floods? Why? ● If there weren't people inhabiting this area and if nature had its way, what kind of ecosystem label do you think we would use to call these different areas?
	Evaluating From the presented information, have students pick one of the problems from the tidal flooding and then choose a perspective of one of the following: ● farmer, ● member of the Jekyll Island Sea Turtle Rehabilitation Center, ● seagrass beds, ● horseshoe crabs, ● plovers (type of seabird found on GA coastline), ● Cumberland Island National Park ranger, ● tourist, ● other Students obtain and evaluate additional information for potential solutions; and if possible develop a model of their proposed solution.
	Communicating Students take turns to share the causes, effects, and potential solutions to their classmates in a timed gallery walk. Students should prepare a 3-4-minute presentation to give as their classmates come by. As students rotate through presentations, they record at least one question that the presentation made them wonder about. This question will be given to the presenter during post reflection time. Students then switch roles. Those that were presenting now become the rotating audience.
Evaluation	***Assessment of Student Learning***
	Evaluate students' ability to both develop and use models of the lunar cycle and construct explanations by completing the *Lunar Lollipops Worksheet* to visualize the phases of the moon.
Formative Evaluation *(Transition Activity)*	*Evaluating* Students evaluate their new thoughts associated with the phenomena presented at the onset of the instructional segment. Students revise their models based on what they have now learned about the patterns of positions of the Earth-Moon-Sun. *Communicating* Students share their new thoughts with elbow partners or in

	small groups. *Teacher Hint: Allow students with accurate models to post their models for whole group benefit. Facilitate discussion that supports students in explaining the phenomena via their new models.*

Engaging *(Seasons)*	**Phenomenon:** Four Seasons in Georgia
	Obtaining Students obtain information about average temperature and precipitation throughout the year in Atlanta. *Teacher Hint: During discussion of average weather remind students of weather phenomena presented in the engage phase. Guiding Question: Based on the data presented here, is a weather forecast like the one that was presented even possible? How?*
	Evaluating Students analyze and apply patterns in temperature and precipitation as supporting data to organize the months into four seasons. Students add qualitative generalizations to the analysis. For example, for winter students may have included December, January, and February with average precipitation at 113 mm, 7.3 C, cold, and rainy. Suggested Organizer

	J	F	M	A	M	J	J	A	S	O	N	D
P												
Is this an increase (^), decrease (v), or about the same?												
T												
Is this mild (MI), moderate (MO), or extreme (E)?												

	Evaluating/Communicating Students prompted with three scenarios (see below) to evaluate and communicate their thoughts. *Teacher Hint:* Encourage students to use data to support answers. Possible Scenarios: 1) Your aunt is coming to town for the 4th of July weekend. Among several other things, she wants to hike Stone Mountain. She's from Seattle, Washington. In Seattle it's typically overcast with mild temperatures.

	What should you suggest she pack for her visit? Why? 2) For the weekend around New Year's Day your family wants to go to Jekyll Island to look for sea turtles. Jekyll Island is on the Georgia coast. What clothes should you pack for yourself? Why? 3) It's Halloween and you're trying to decide on a costume. Based on weather, what costume will you choose for your younger sister to wear: fairy princess without tights or fairy princess with tights and a light jacket? Why?
Exploring	*Obtaining* Students obtain information about how to develop a model of Earth that will support observations of both day/night and seasons. Students then use the model to observe, collect, and analyze data about the effects of the sun and earth relationship. Teacher will research a resource using the words: *Developing a Model of the Earth.* *Teacher Hint:* The above resource provides excellent teaching hints for guiding student observations. Be mindful that you may need to work within the suggestions for one-hour blocks rather than the two-month option.
	Communicating Students communicate new understandings of seasons through a visual representation of the 3D model observed.
	Evaluating Students evaluate each other's models, making suggestions for labels and captions that their peer may have omitted. *Teacher Hint:* Provide students a peer checklist consistent with performance expectations of GSE.
Explaining	*Obtaining* Students obtain additional information about the relationship of the tilt of the earth as explanation for seasons by developing more sophisticated models. Teacher can research models of the tilt of the Earth and why it causes the seasons. Resource: Reasons for the Seasons *Teacher Hint:* The above resource supports data analysis and interpretation but will require modifications based on your class schedule since the activity takes four 45-minute class periods with the second taking place three months after the original activity is completed.
	Evaluating Working in small groups, students evaluate the model to determine how the shadow created at various angles supports an explanation for direct and indirect sunlight heating up the earth. Resource: Activity 4: Heating Up Direct and Indirect Sunlight *Teacher Hint:* Students may determine that the model needs revision to better reflect the combined explanation for seasons. If so, provide students with an

	opportunity to revise using three dimensional objects or list suggestions with visual representations.
	Communicating Students explain their final model to another group. The listening group should provide feedback in terms of strengths (glows) and weaknesses (grows) of the oral explanation and strengths and weaknesses of the model.
Elaborating	**Phenomenon: What to wear?** Resource: Common Misconceptions about Day and Night, Seasons *Click* What to wear? assessment probe that is listed under: "Probing for Student Understanding."
	Obtaining Students obtain information about Maria, Alice, and Mattie who live in different places around the world.
	Evaluating Students evaluate the information to determine what each was wearing during December break.
	Communicating Students communicate scientific explanations of their decisions. *Teacher Hint:* Encourage students to provide a thorough scientific explanation. Consider modifying the resource to include a writing checklist and/or rubric consistent with these more rigorous expectations.
Evaluation	***Assessment of Student Learning***
	Evaluating Students revisit and revise their models of the phenomena presented in the engage phase. *Communicating* Students communicate their final models, pose questions about those phenomena that remain unclear to them, and via discussion explain how rotations and/or revolutions contribute to the patterns of events. Additional Resource: Assessment Suggestions
Engaging	**Phenomenon:** Show students – **Phases of the Moon Presentation** (on Teacher Resource Link).
Exploring	Students should obtain information about the different phases of the moon by finding images of the phases of the moon. Have them use **Phases of the Moon Presentation** - to draw pictures of the way the Moon looks from the Earth using the handout. Presentation is in Teacher Resource Link.

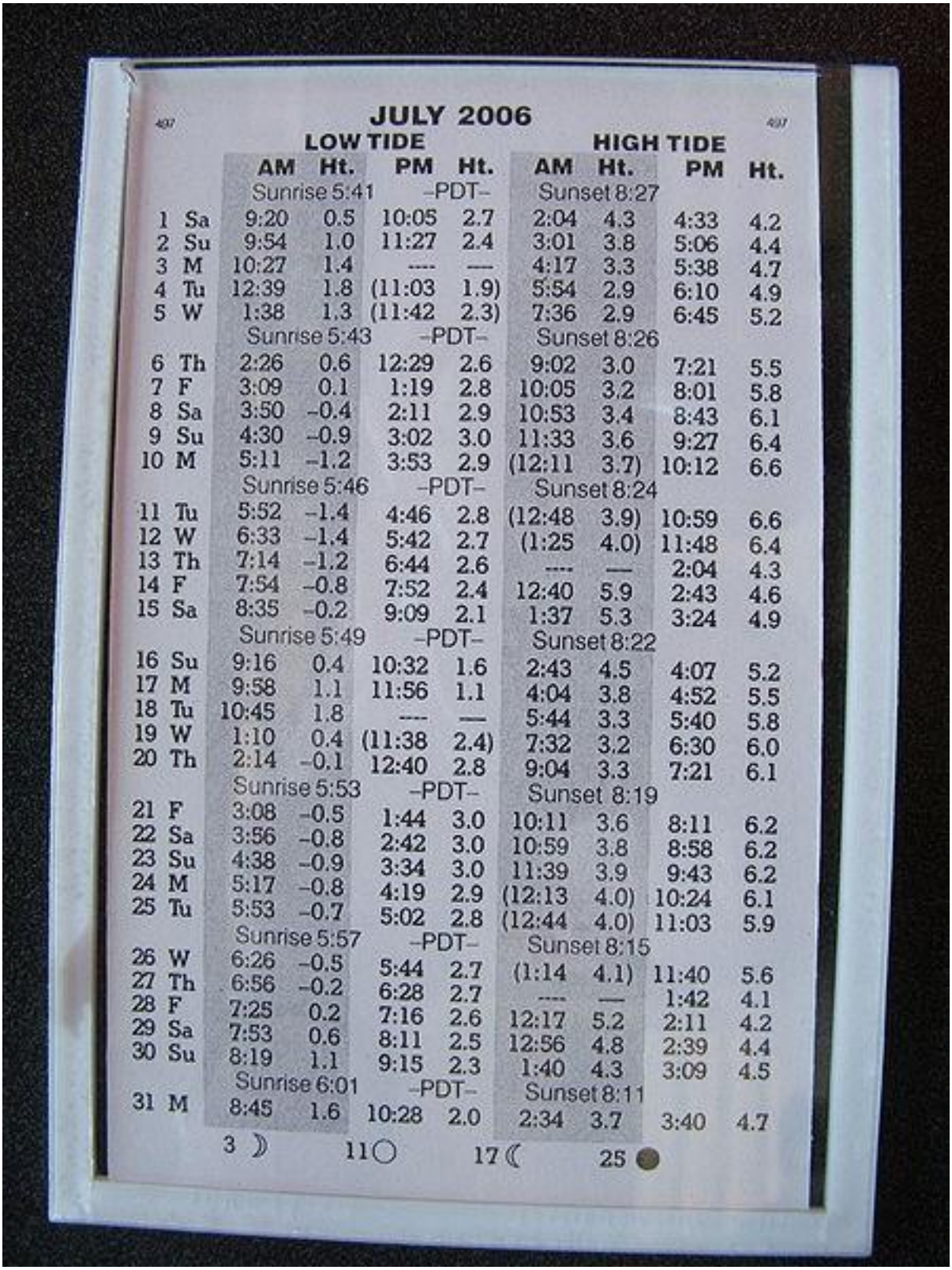
	Teacher Note: Phases of the Moon lesson is another resource.
Explaining	Students will now use the picture where they drew the shadows to explain to a partner the phases of the Moon and the relationships between the Sun, Earth, and the Moon using the following terms: New, Full, Waning, Waxing, Crescent, Gibbous, First and Last (Third) Quarter.
Elaborating	Have students discuss and draw a model of the phases using the back of their handout depicting, "How would the light that is reflected from the Sun be different if the Sun was on the other side of the page?"
Evaluation	Students will pick one or more phases of the Moon and draw a model of the phase showing the position of the Sun, Earth and the Moon.
Engaging	Show students a world map and ask them to wonder **What the climate is like in the United Kingdom and Ireland?** Presentation is in Teacher Resource Link.
Exploring	Have students use the link to Ocean Currents to explore what causes currents and how they impact the land.
Explaining	Students will pair up and discuss different types of ocean currents and how they affect the land as well as humans.
Elaborating	How do currents affect climate?
Evaluation	Students will make a slideshow or poster that explains the different types of currents.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	• Developing and using models • Constructing explanations • Analyze and interpret data • Ask questions
Crosscutting Concepts	• Cause and Effect • Systems and System Models • Structure and Function • Patterns
Disciplinary Core Ideas	• **ESSA1.A:** The Universe and Its Stars • **ESSA1.B:** Earth and the Solar System

Explaining Tides

[Return to Instructional Segment]

Georgia Department of Education
May 2018

Sample Tide Table



JULY 2006

		LOW TIDE AM	Ht.	PM	Ht.	HIGH TIDE AM	Ht.	PM	Ht.
		Sunrise 5:41		–PDT–		Sunset 8:27			
1	Sa	9:20	0.5	10:05	2.7	2:04	4.3	4:33	4.2
2	Su	9:54	1.0	11:27	2.4	3:01	3.8	5:06	4.4
3	M	10:27	1.4	----	----	4:17	3.3	5:38	4.7
4	Tu	12:39	1.8	(11:03	1.9)	5:54	2.9	6:10	4.9
5	W	1:38	1.3	(11:42	2.3)	7:36	2.9	6:45	5.2
		Sunrise 5:43		–PDT–		Sunset 8:26			
6	Th	2:26	0.6	12:29	2.6	9:02	3.0	7:21	5.5
7	F	3:09	0.1	1:19	2.8	10:05	3.2	8:01	5.8
8	Sa	3:50	–0.4	2:11	2.9	10:53	3.4	8:43	6.1
9	Su	4:30	–0.9	3:02	3.0	11:33	3.6	9:27	6.4
10	M	5:11	–1.2	3:53	2.9	(12:11	3.7)	10:12	6.6
		Sunrise 5:46		–PDT–		Sunset 8:24			
11	Tu	5:52	–1.4	4:46	2.8	(12:48	3.9)	10:59	6.6
12	W	6:33	–1.4	5:42	2.7	(1:25	4.0)	11:48	6.4
13	Th	7:14	–1.2	6:44	2.6	----	----	2:04	4.3
14	F	7:54	–0.8	7:52	2.4	12:40	5.9	2:43	4.6
15	Sa	8:35	–0.2	9:09	2.1	1:37	5.3	3:24	4.9
		Sunrise 5:49		–PDT–		Sunset 8:22			
16	Su	9:16	0.4	10:32	1.6	2:43	4.5	4:07	5.2
17	M	9:58	1.1	11:56	1.1	4:04	3.8	4:52	5.5
18	Tu	10:45	1.8	----	----	5:44	3.3	5:40	5.8
19	W	1:10	0.4	(11:38	2.4)	7:32	3.2	6:30	6.0
20	Th	2:14	–0.1	12:40	2.8	9:04	3.3	7:21	6.1
		Sunrise 5:53		–PDT–		Sunset 8:19			
21	F	3:08	–0.5	1:44	3.0	10:11	3.6	8:11	6.2
22	Sa	3:56	–0.8	2:42	3.0	10:59	3.8	8:58	6.2
23	Su	4:38	–0.9	3:34	3.0	11:39	3.9	9:43	6.2
24	M	5:17	–0.8	4:19	2.9	(12:13	4.0)	10:24	6.1
25	Tu	5:53	–0.7	5:02	2.8	(12:44	4.0)	11:03	5.9
		Sunrise 5:57		–PDT–		Sunset 8:15			
26	W	6:26	–0.5	5:44	2.7	(1:14	4.1)	11:40	5.6
27	Th	6:56	–0.2	6:28	2.7	----	----	1:42	4.1
28	F	7:25	0.2	7:16	2.6	12:17	5.2	2:11	4.2
29	Sa	7:53	0.6	8:11	2.5	12:56	4.8	2:39	4.4
30	Su	8:19	1.1	9:15	2.3	1:40	4.3	3:09	4.5
		Sunrise 6:01		–PDT–		Sunset 8:11			
31	M	8:45	1.6	10:28	2.0	2:34	3.7	3:40	4.7

3 ☽ 11 ○ 17 ☾ 25 ●

Return to Instructional Segment

Tidal Floods

1. How do you think the debris left behind impacts the sea turtles habitats? What other kinds of animals do you think may be impacted by these tidal floods?

2. Why do you think these tidal floods are different than the daily tides?

3. How do you think the water left behind impacts the farmers?

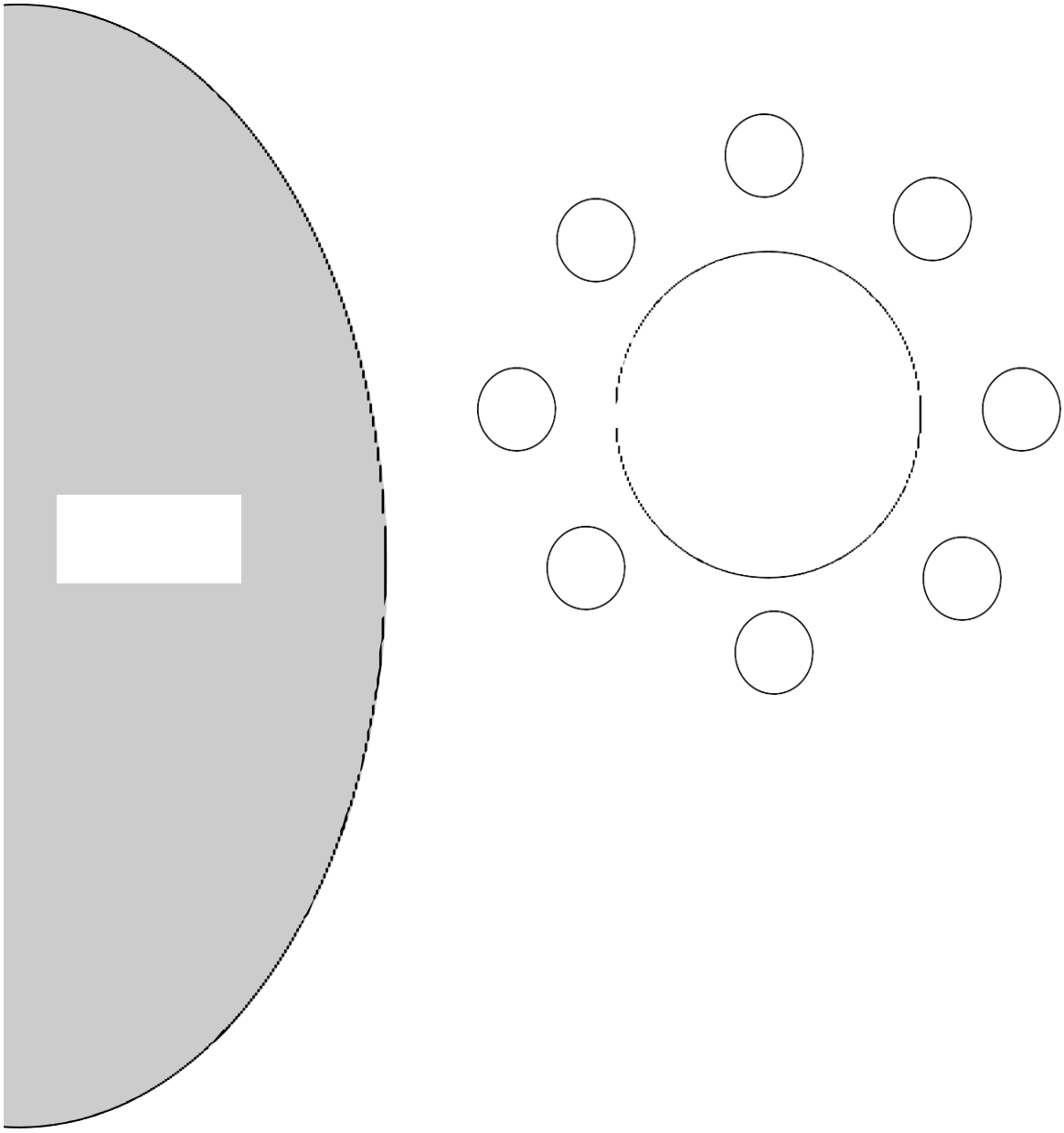
4. What do you think it's like for the _____ when the water is at its highest point?

5. Have you heard of terms like weathering, erosion, or deposition? Which of these terms would you use to label tidal floods? Why?

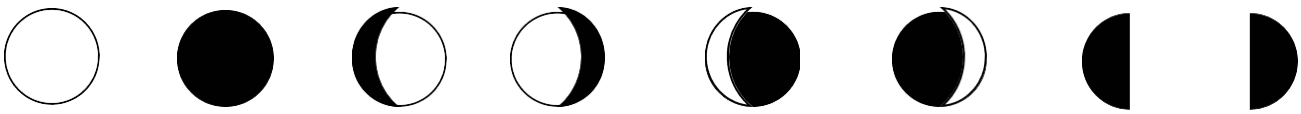
6. If there weren't people inhabiting this area and if nature had its way, what kind of ecosystem label do you think we would use to call these different areas?

Return to Instructional Segment

Lunar Lollipop Worksheet



Eight Phases



Return to Instructional Segment

Climate

Marietta has a humid subtropical climate (Köppen climate classification *Cfa*).

Climate data for Marietta, Georgia													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Record high °F (°C)	80 (27)	80 (27)	89 (32)	93 (34)	96 (36)	101 (38)	104 (40)	104 (40)	99 (37)	92 (33)	86 (30)	80 (27)	104 (40)
Average high °F (°C)	52 (11)	56 (13)	64 (18)	73 (23)	80 (27)	87 (31)	89 (32)	88 (31)	83 (28)	73 (23)	64 (18)	54 (12)	71.9 (22.3)
Average low °F (°C)	30 (−1)	33 (1)	39 (4)	46 (8)	55 (13)	64 (18)	68 (20)	67 (19)	60 (16)	48 (9)	39 (4)	32 (0)	48.4 (9.3)
Record low °F (°C)	−12 (−24)	−2 (−19)	7 (−14)	21 (−6)	32 (0)	40 (4)	50 (10)	48 (9)	30 (−1)	22 (−6)	9 (−13)	−4 (−20)	−12 (−24)
Average precipitation inches (mm)	4.86 (123.4)	5.36 (136.1)	5.07 (128.8)	3.93 (99.8)	4.12 (104.6)	4.07 (103.4)	5.10 (129.5)	4.35 (110.5)	4.10 (104.1)	3.42 (86.9)	4.30 (109.2)	4.49 (114)	54.63 (1,387.6)

Return to Instructional Segment

Data Organizer:

	J	F	M	A	M	J	J	A	S	O	N	D
Precip.												
Is this an increase (^), decrease (v), or about the same?												
Temp.												
Is this mild (MI), moderate (MO), or extreme (E)?												

Return to Instructional Segment

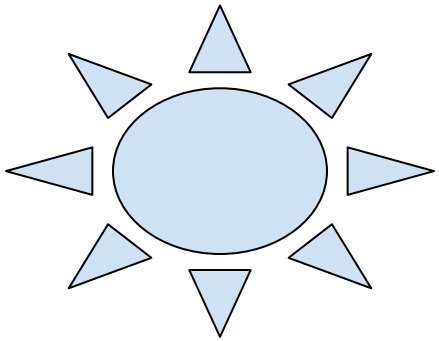
Phases of The Moon

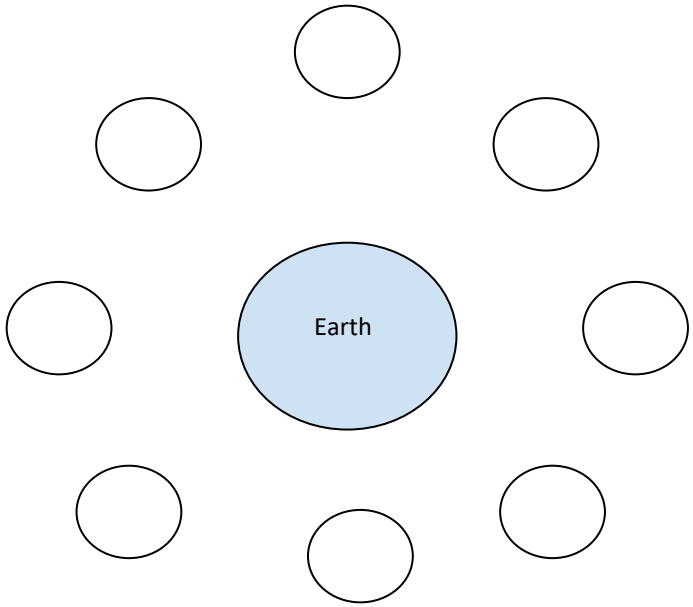
Name: _____

Shade in where the “shadow” that the Sun would produce on the Moon from the perspective of being on the Earth.

Remember where the Sun is as well as where the light on the side of The Moon must be compared to where the Sun is.

Not to scale -





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