SCIENCE NOTEBOOK

PLANETARY SCIENCE

6TH GRADE

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Bird's-Eye Views

Record what you can see in each of the Earth images.

Altitude	Human-made structures	Natural structures
100 m above Earth (building)		
1,000 m (1 km) above Earth (neighborhood)		
10,000 m (10 km) above Earth (community)		
100,000 m (100 km) above Earth (area)		
1,000,000 m (1,000 km) above Earth (region)		
10,000,000 m (10,000 km) above Earth (planet)		

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Planetary Science Course
Investigation 1: Earth as a System
No. 1—Notebook Master

Response Sheet—Investigation 1

A boy was watching his favorite TV show when the question came up, "Where do you live?" He didn't know, so he asked his older sister. She replied, "You live in Austin, Texas."

Later, the boy asked his mom the same question, to which she replied, "Honey, you live in the United States."

He was a little confused. He thought, "How can I live in two places at the same time?"

Who was right? His sister or his mom? Explain your answer.

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Planetary Science Course
Investigation 1: Earth as a System
No. 2—Notebook Master

Focus Question Where are you when you are in science class?	Focus Question Where are you when you are in science class?

Earth System Interactions

Geosphere: The system of rocky material that makes up Earth, including the core, mantle, and crust.

Atmosphere: The system of gases surrounding Earth.

Hydrosphere: The system of water (solid, liquid, and gas) that is found on, below, or above Earth's surface.

Biosphere: The system of interacting living organisms on Earth.

Image	G	A	H	B	Evidence of interactions
1					
2					
3					
4					
5					
6					
7					
8					

How does the scale or frame of reference of what you are observing affect the complexity of a system?

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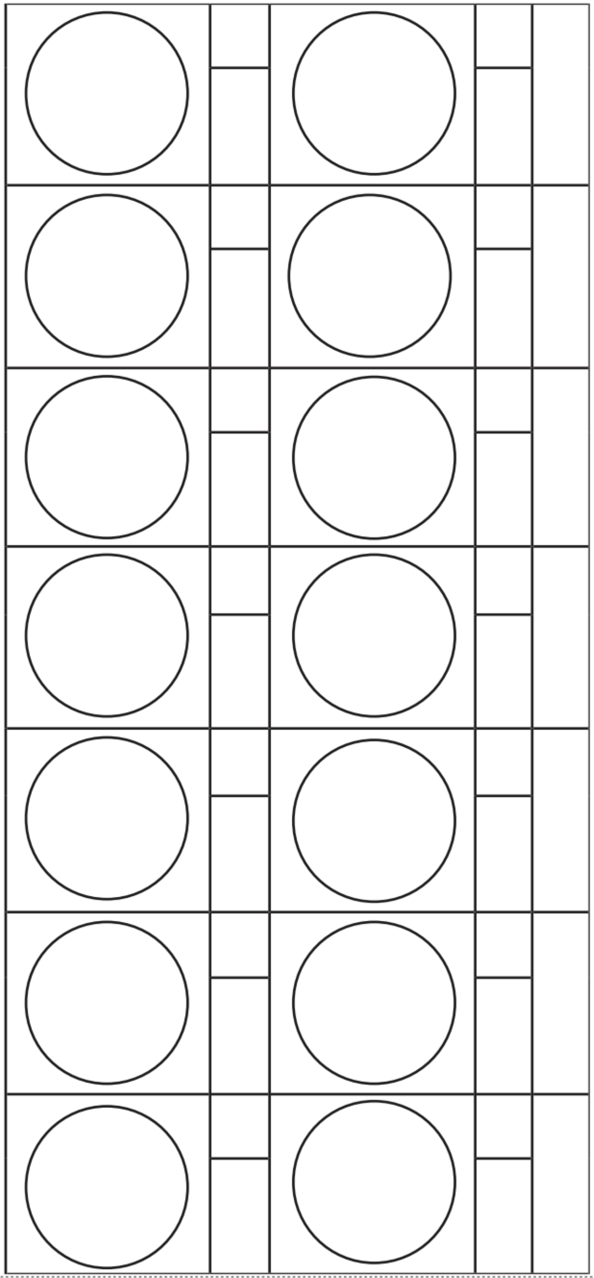
Investigation 1: Earth as a System
No. 3—Notebook Master

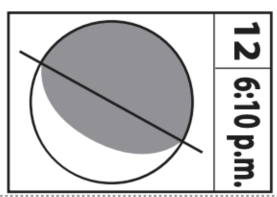
Focus Question Why is Earth described as a system?	Focus Question Why is Earth described as a system?

Moon Log A



Moon log for the month of ______________

1. Observe the Moon, day or night.
2. Record your observations, including shape and orientation.
3. Record the time of your observation.



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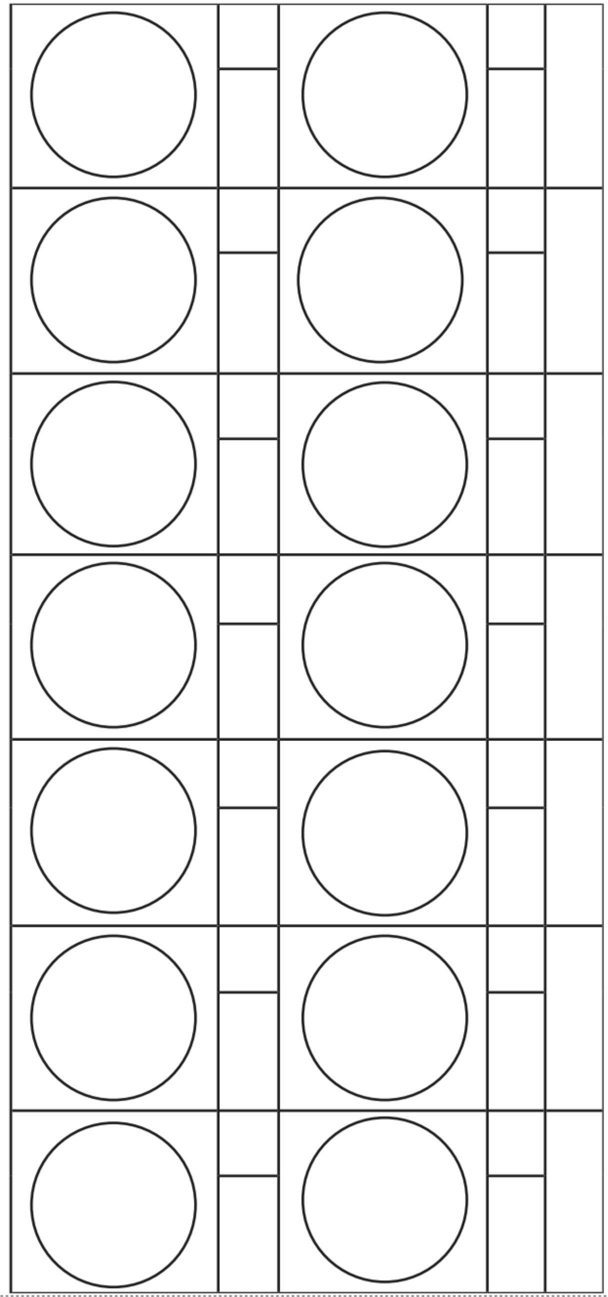

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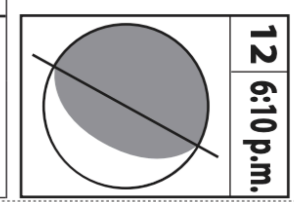

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No. 4—Notebook Master

Moon Log B

Moon Log B

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Investigation 1: Earth as a System
No. 5—Notebook Master

Focus Question How does the Moon change day by day?	Focus Question How does the Moon change day by day?

Day/Night Think Questions

1. Why is it dark at night?
2. At any given time, how much of Earth is in daylight and how much is in darkness?
3. What makes the Sun "come up" and "go down"?
4. Does the Sun come up in the morning all over the world? Explain.
5. Is it daylight all over the world at the same time, then nighttime all over the world at the same time? Explain.
6. Which side of Earth is in daylight?
7. How long is daytime, and how long is nighttime?
8. Does the Moon have day and night? Explain.
9. How long is one day/night cycle on the Moon?
10. Does the Sun have day and night? Explain.
11. If Earth did not rotate on its axis, would there be daytime and nighttime on Earth? Explain.
12. If Earth did not revolve around the Sun, would there be daytime and nighttime on Earth? Explain.

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Investigation 2: Earth/Sun Relationship
No. 6—Notebook Master

Focus Question What causes day and night?	Focus Question What causes day and night?

Solar Angle

1. How do you explain the different shapes of the light spots?

2. When is the area of the spot largest?

3. Which spot delivers the greatest amount of energy to the floor?

4. If you put a penny in each light spot, explain which one will receive the most energy.

5. If you used a heat lamp instead of a flashlight, which penny would get the hottest? Explain why.

6. What influence does solar angle have on the heating of Earth?

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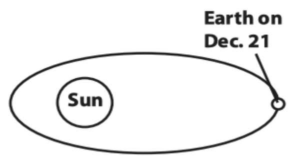
Investigation 2: Earth/Sun Relationship
No. 7—Notebook Master

Response Sheet—Investigation 2

Below are three students' explanations of the reasons for the seasons. Read each entry, then write a short paragraph explaining to each student what they need to change about their thinking.

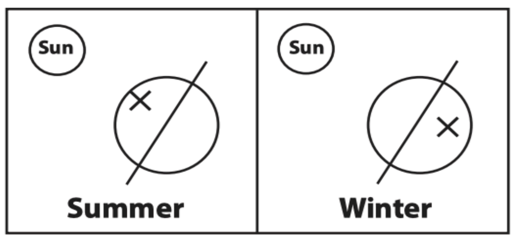
Student 1 wrote,

The reason for the seasons is that Earth revolves around the Sun in an elliptical orbit. When Earth is farthest from the Sun, it is winter. When Earth is closest to the Sun, it is summer.



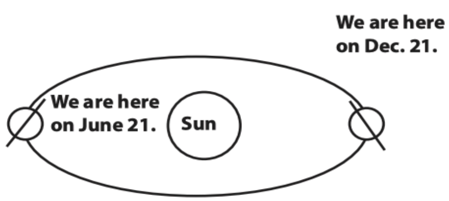
Student 2 wrote,

Summer is when we are facing the Sun. Winter is when we are facing away from the Sun.



Student 3 wrote,

The tilt always leans toward the Sun. It takes 365 days for Earth to rotate one time. So when we are on the side toward the Sun, it is summer. When we are on the side away from the Sun, it is winter.



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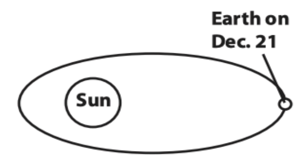

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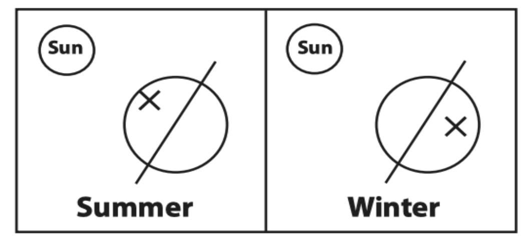

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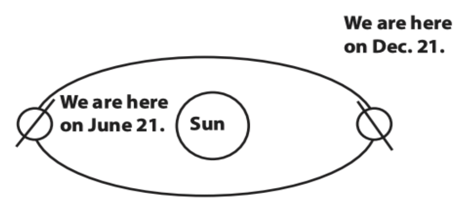

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Investigation 2: Earth/Sun Relationship
No. 8—Notebook Master

Focus Question Why is it hotter in the summer?	Focus Question Why is it hotter in the summer?

Local Sunrise/Sunset Times

Sunrise and sunset times for__________________________			
Date	**Sunrise (a.m.)**	**Sunset (p.m.)**	**Hours of daylight**
January 21			
February 21			
March 21			
April 21			
May 21			
June 21			
July 21			
August 21			
September 21			
October 21			
November 21			
December 21			

In the space below, calculate the hours of daylight for each day. Enter your answers in the table above.

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Date	**Sunrise (a.m.)**	**Sunset (p.m.)**	**Hours of daylight**
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July 21			
August 21			
September 21			
October 21			
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December 21			

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Investigation 2: Earth/Sun Relationship
No. 9—Notebook Master

Sunrise/Sunset Times for 2020

Sunrise and sunset times for the year 2020 in Berkeley, CA			
Date	**Sunrise (a.m.)**	**Sunset (p.m.)**	**Hours of daylight**
January 21	7:21	5:20	
February 21	6:52	5:54	
March 21	7:10	7:23	
April 21	6:25	7:51	
May 21	5:54	8:18	
June 21	5:47	8:35	
July 21	6:04	8:27	
August 21	6:30	7:53	
September 21	6:57	7:07	
October 21	7:24	6:23	
November 21	6:57	4:53	
December 21	7:21	4:54	

In the space below, calculate the hours of daylight for each day. Enter your answers in the table above.

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July 21	6:04	8:27	
August 21	6:30	7:53	
September 21	6:57	7:07	
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In the space below, calculate the hours of daylight for each day. Enter your answers in the table above.

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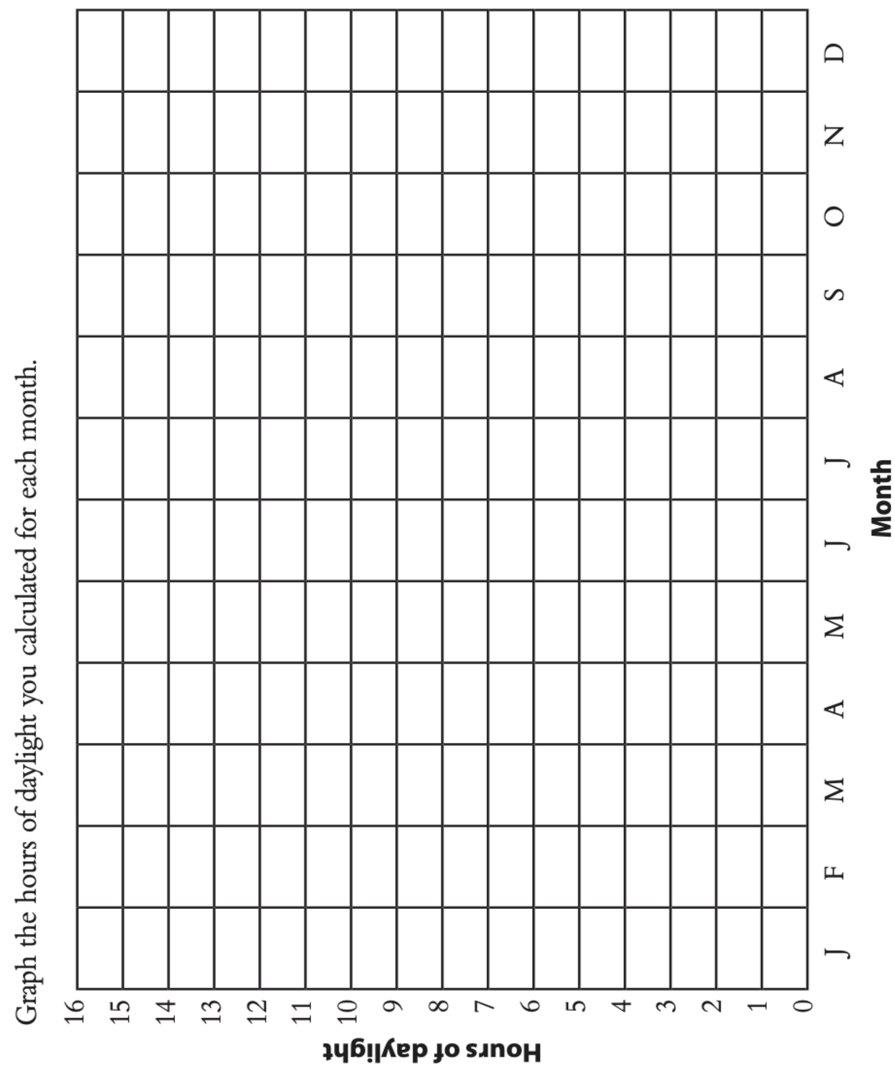
Investigation 2: Earth/Sun Relationship
No. 10—Notebook Master

Graph of Daylight Hours



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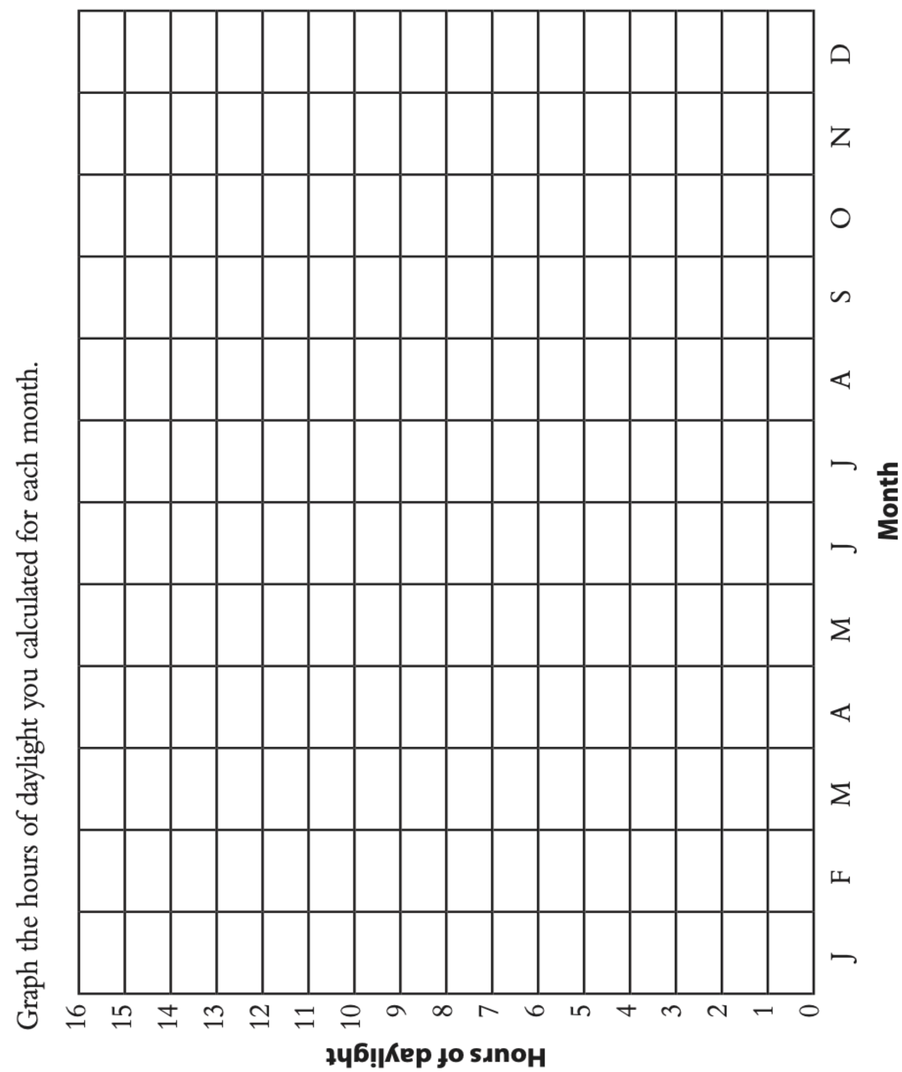

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Day–Length Questions

1. When one location on Earth has 14 hours of daylight, is the rest of the world having 14 hours of daylight as well? Explain.

2. Is the longest day of the year the same length all over the world? Explain.

3. Is the longest day of the year the same date all over the world? Explain.

4. Are the days with the longest daylight always in the summer? Are the days with the shortest daylight always in the winter? Explain.

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Investigation 2: Earth/Sun Relationship
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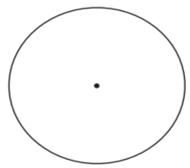
Seasonal Changes

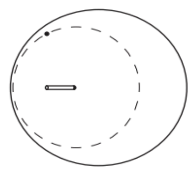
1. Open the "Seasons" simulation. Select **Berkeley** from the first list of cities. Click through the year, month by month, stopping at the equinoxes and solstices.
2. Look at the hours of light in the chart. Circle the description that best describes the amount of light and dark experienced in a day by people living in Berkeley at the times listed below.

Spring equinox (Mar. 21)	More light	Equal	More darkness
Summer solstice (June 21)	More light	Equal	More darkness
Fall equinox (Sept. 21)	More light	Equal	More darkness
Winter solstice (Dec. 21)	More light	Equal	More darkness

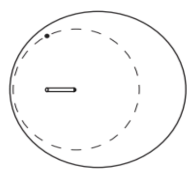
3. Change Earth View to North Pole. What shape is the path traced by Berkeley as Earth completes one rotation? Describe and draw the shape.



4. Change Earth View to Top. Shade in the diagram to indicate day and night at the summer solstice. How long is the daylight?



5. Shade in the diagram to indicate day and night at the spring equinox. How long is the daylight?



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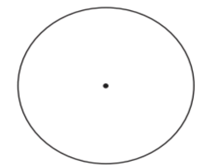

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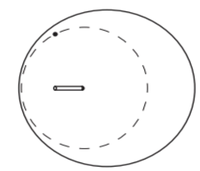

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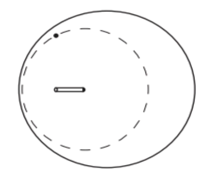

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No. 13—Notebook Master
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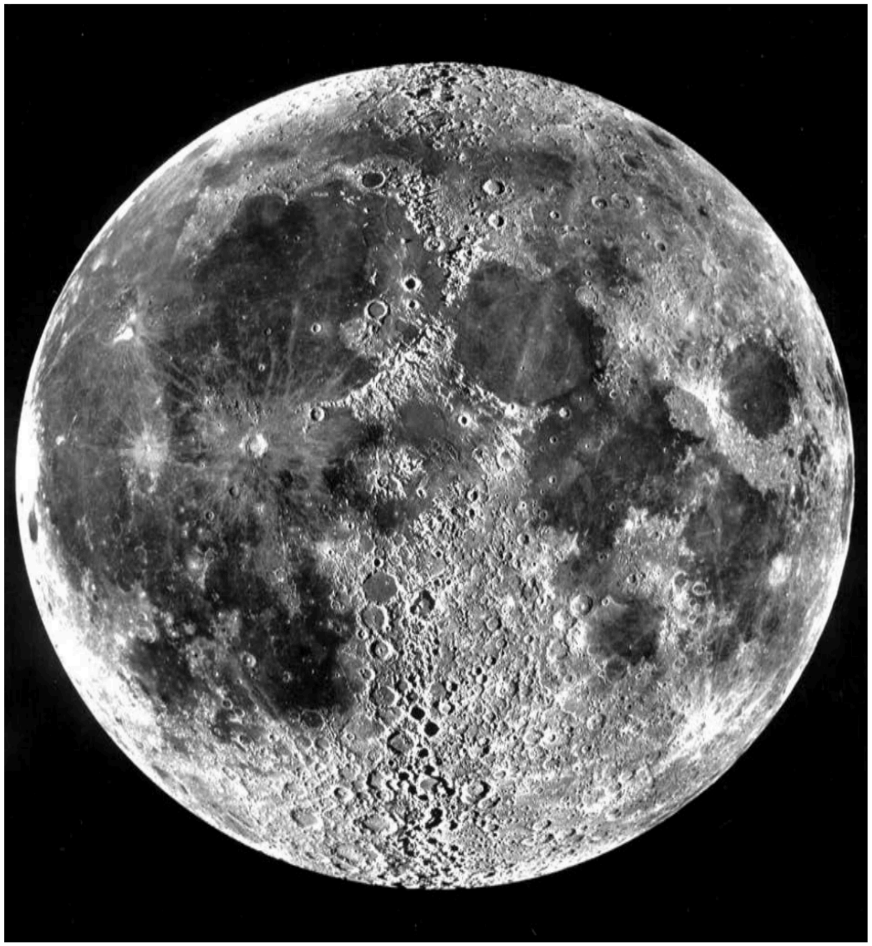
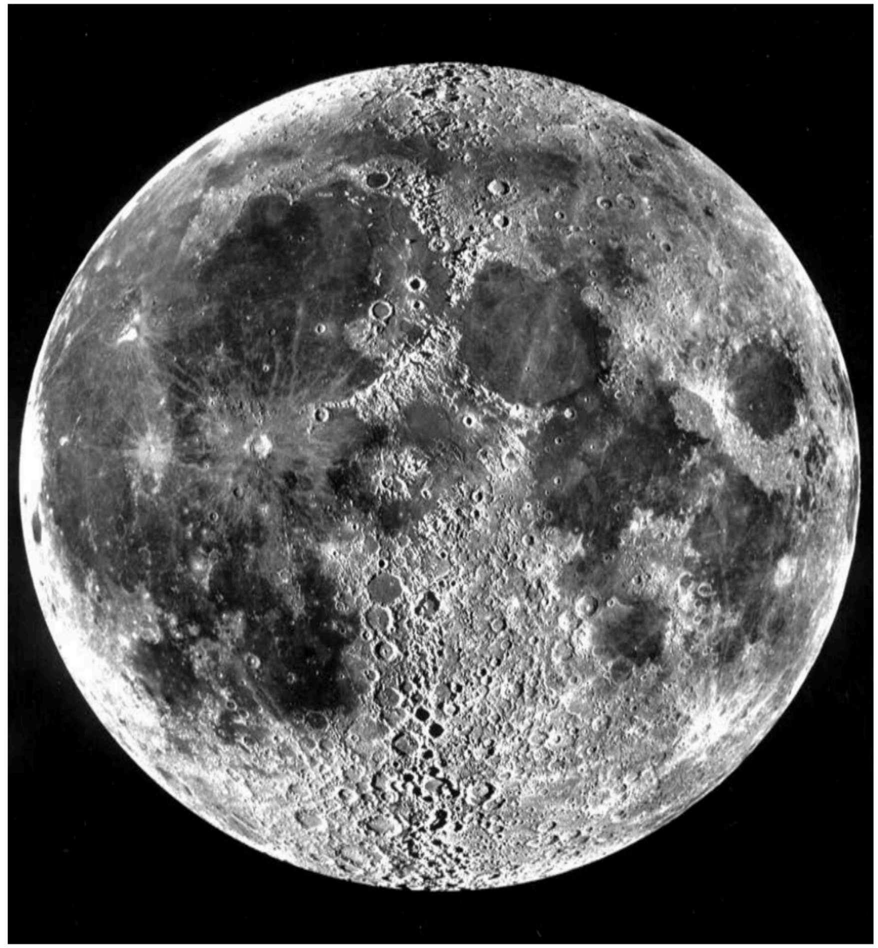
Focus Question Why are there more hours of sunlight in the summer?	Focus Question Why are there more hours of sunlight in the summer?

Moon Image



Moon Image



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Planetary Science Course
Investigation 3: Moon Study
No. 21—Notebook Master

Moon-Picture Observations

Part 1: What two kinds of features dominate the lunar surface?

Part 2: Definitions of lunar features

Moon-Picture Observations

Part 1: What two kinds of features dominate the lunar surface?

Part 2: Definitions of lunar features

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Planetary Science Course
Investigation 3: Moon Study
No. 22—Notebook Master

Questions about the Moon

After looking at the Moon photograph by myself, these are my five questions about the Moon.

After discussing the Moon photograph as a group, we decided that these are our five most important questions.

Questions about the Moon

After looking at the Moon photograph by myself, these are my five questions about the Moon.

After discussing the Moon photograph as a group, we decided that these are our five most important questions.

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Investigation 3: Moon Study
No. 23—Notebook Master

Moon Statistics

1. How old is the Moon?
2. What is the diameter of the Moon?
3. What is the radius of the Moon's orbit around Earth?
4. How long does it take the Moon to orbit Earth?
5. Does the Moon have day and night?
6. How long is a day/night cycle on the Moon?
7. As seen from Earth, how long does it take the Moon to rotate on its axis?

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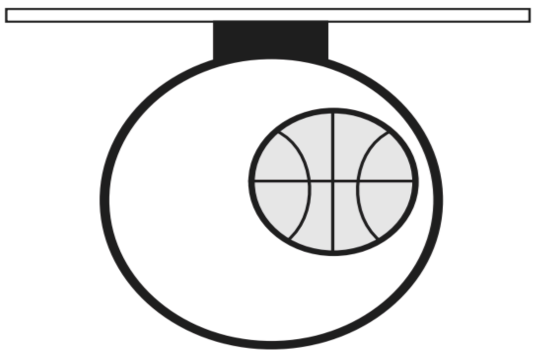
Investigation 3: Moon Study
No. 24—Notebook Master

Calculating a Scaling Factor A

Regulation basketball hoops are 46 cm in diameter. Use this scale drawing of a regulation hoop and a regulation basketball to determine the diameter of a real basketball.



How much smaller is this drawing than a real basketball and hoop? To find out, you will need to determine what each centimeter in the drawing is equal to in reality. This number is the **scaling factor**.

Calculating a Scaling Factor A

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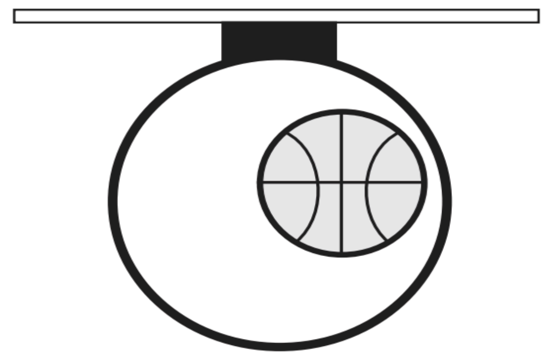

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Planetary Science Course
Investigation 3: Moon Study
No. 25—Notebook Master

Focus Question What is visible on the Moon?	Focus Question What is visible on the Moon?

Calculating a Scaling Factor A

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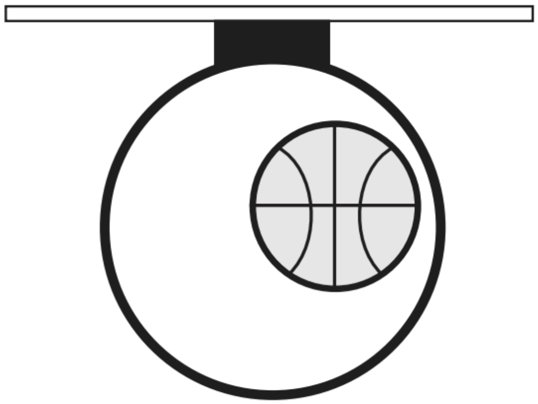

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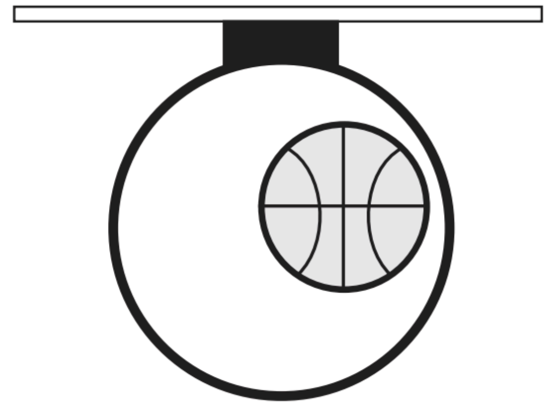

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Planetary Science Course
Investigation 3: Moon Study
No. 25—Notebook Master

Calculating a Scaling Factor B

1. **Diagram.** Draw a diagram showing two objects.
2. **Label.** Draw an arrow and use an *uppercase* letter to label the length of each object in the diagram. Use *lowercase* letters when you represent the real length of the two objects.
3. **List.** List the two uppercase and two lowercase letters and describe what each one represents.

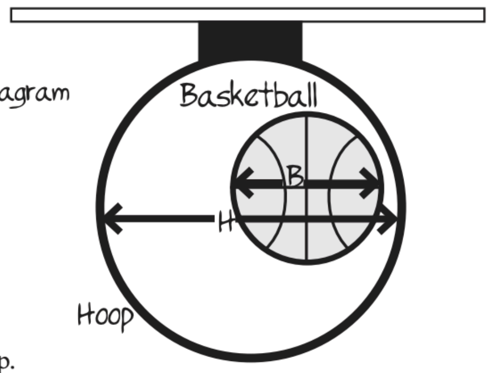
   Example:

   B = size of basketball in diagram

   H = size of hoop in diagram

   b = size of real basketball

   h = size of real hoop



4. **Ratio.** Set up a ratio with corresponding letters lined up.

   Example:

   $$\frac{H}{h} = \frac{B}{b}$$

5. **Plug in.** Put in numbers for the known lengths.
6. **Solve.** Solve for the unknown length.

Calculating a Scaling Factor B

1. **Diagram.** Draw a diagram showing two objects.
2. **Label.** Draw an arrow and use an *uppercase* letter to label the length of each object in the diagram. Use *lowercase* letters when you represent the real length of the two objects.
3. **List.** List the two uppercase and two lowercase letters and describe what each one represents.

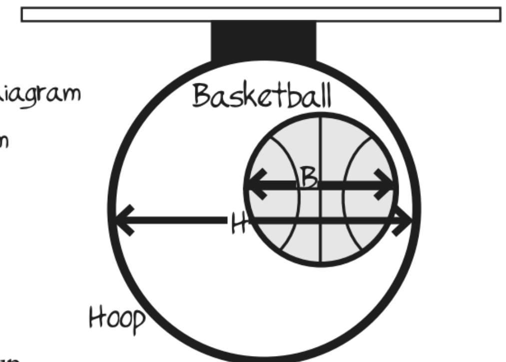
   Example:

   B = size of basketball in diagram

   H = size of hoop in diagram

   b = size of real basketball

   h = size of real hoop



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Investigation 3: Moon Study
No. 26—Notebook Master

Scaling Practice

Use the scaling factor for the Earth/Moon system that you calculated in class to solve these puzzles.

1. A regulation basketball is about 23 cm in diameter. If the basketball was a model Earth, what size sphere would make an appropriate Moon to accompany the basketball, and how far apart would the two balls be?

2. If you used the 23 cm basketball as your Moon sphere, how big would an Earth sphere be, and how far would it be from the basketball?

3. A student prepared an Earth/Moon model in which the two spheres were 100 m apart. What were the diameters of the spheres?

Scaling Practice

Use the scaling factor for the Earth/Moon system that you calculated in class to solve these puzzles.

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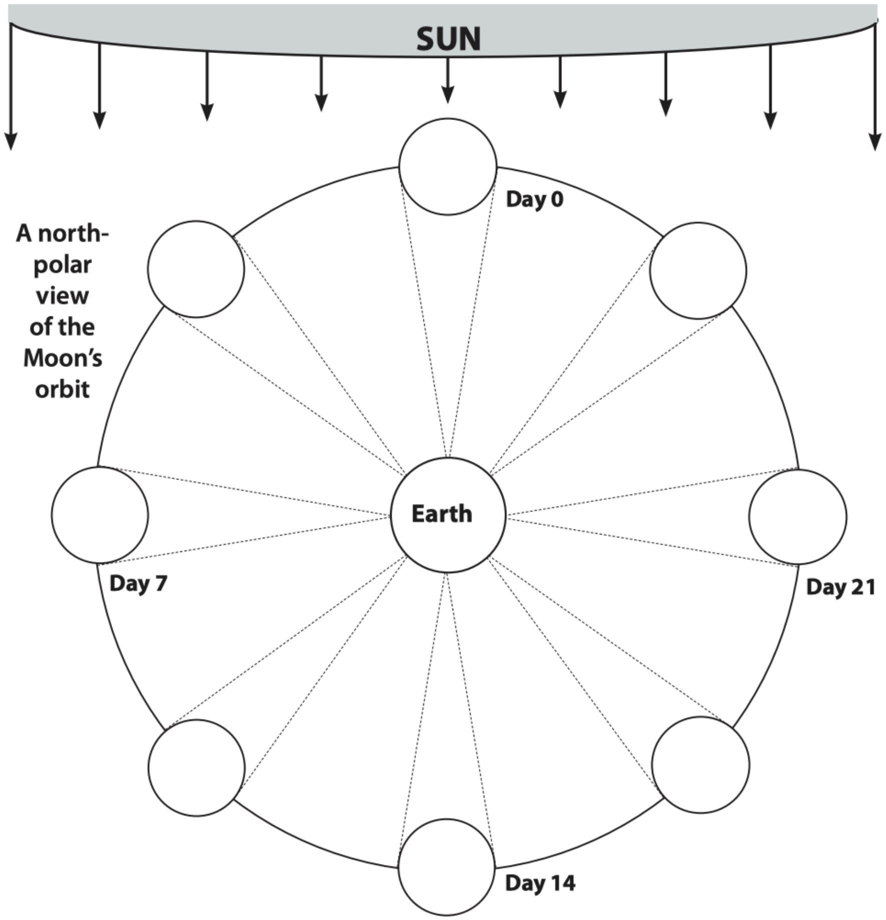
Investigation 3: Moon Study
No. 27—Notebook Master

Focus Question What does an Earth/Moon scale model look like?	Focus Question What does an Earth/Moon scale model look like?

Focus Question What Moon-phase patterns can be observed?	Focus Question What Moon-phase patterns can be observed?

Looking at the Moon from Earth

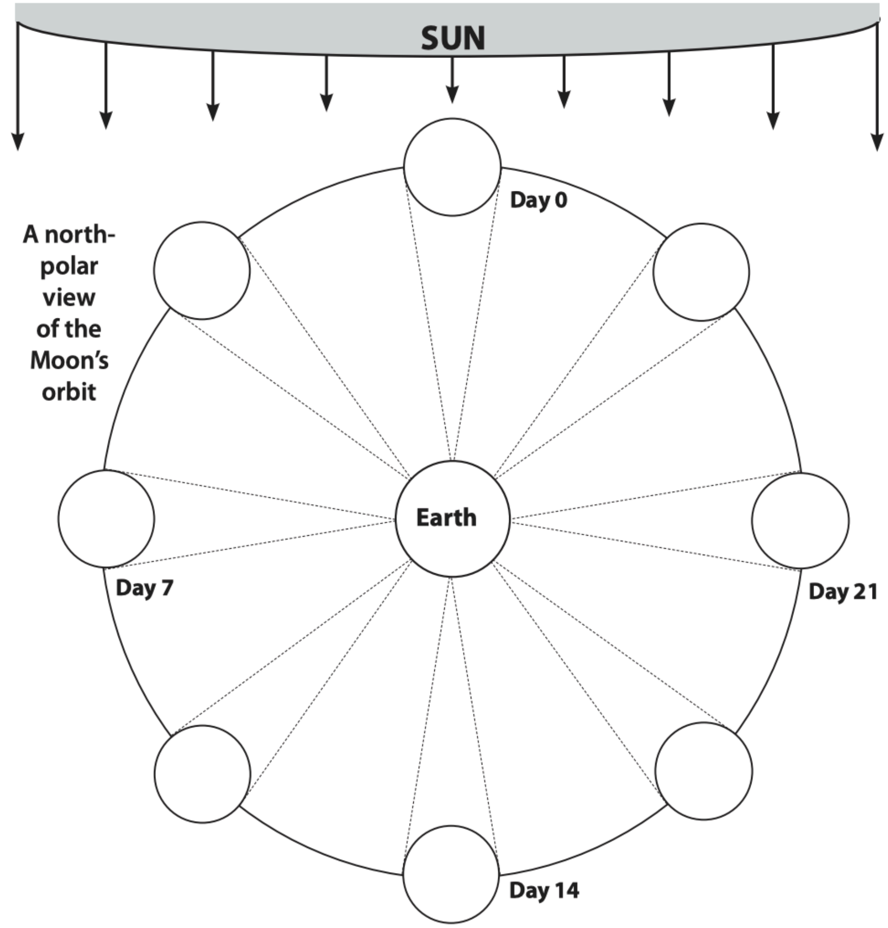


The view of the Moon from Earth (what we see)

Day 0		Day 7		Day 14		Day 21	

Names of corresponding Moon phases

Looking at the Moon from Earth



The view of the Moon from Earth (what we see)

Day 0		Day 7		Day 14		Day 21	

Names of corresponding Moon phases

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Planetary Science Course
Investigation 4: Phases of the Moon
No. 28—Notebook Master

Response Sheet—Investigation 4

A student wrote in her notebook,

The new Moon happens when Earth casts a shadow on the Moon. This happens once a month.

Do you agree with this student? Explain why or why not.

Response Sheet—Investigation 4

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Investigation 4: Phases of the Moon
No. 29—Notebook Master

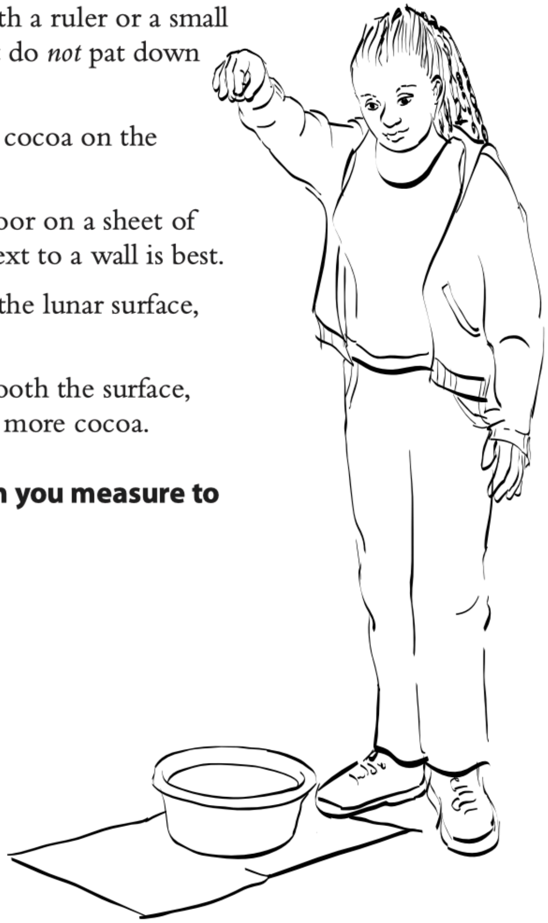
Focus Question What causes Moon phases?	Focus Question What causes Moon phases?

Focus Question How do models help us understand phases of the Moon?	Focus Question How do models help us understand phases of the Moon?

Lunar Crater Formation

Procedure

1. Get a basin with 1.5 liters of flour. This is your small area of lunar regolith.
2. Smooth the surface with a ruler or a small piece of cardboard, but do *not* pat down the flour.
3. Sprinkle a *thin* layer of cocoa on the surface of the flour.
4. Put the basin on the floor on a sheet of newspaper. A place next to a wall is best.
5. Drop meteorites onto the lunar surface, and observe.
6. After several drops, smooth the surface, and sprinkle on a little more cocoa.



What crater features can you measure to compare craters?

NOTE: Do *not* throw the marbles into the flour—just drop them.

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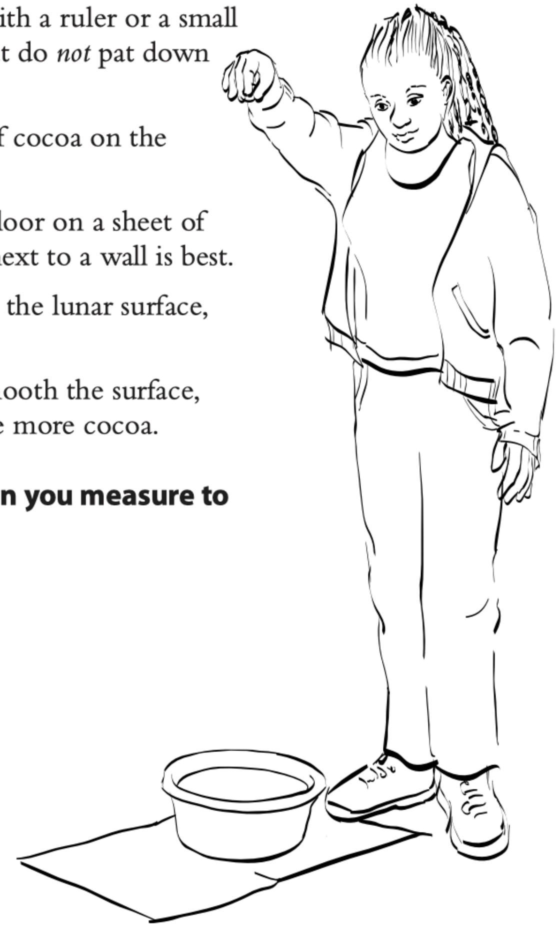

What crater features can you measure to compare craters?

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Investigation 5: Craters
No. 30—Notebook Master

Crater-Investigation Planning

1. What variable will you investigate?

2. What procedure will you use?

3. What will you measure?

4. How will you record your data? How many trials will you do? (Set up a table.)

5. How will you display your results? (Design a graph on the next page in your notebook.)

Crater-Investigation Planning

1. What variable will you investigate?

2. What procedure will you use?

3. What will you measure?

4. How will you record your data? How many trials will you do? (Set up a table.)

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Investigation 5: Craters
No. 31—Notebook Master

Model Impact Craters—Speed

1. In your group, prepare the lunar surface.
2. Set up your station to measure the heights from which you will drop the objects. (Remember, higher drop heights = faster impact speed.) Speed is your **independent variable** because you are changing it.
3. Record your **dependent variable** in the table below: diameter, depth, or ray length.
4. Drop objects, record data, calculate averages, and graph the results.

Drop height (cm)	Dependent variable: ______________			
	Trial 1	Trial 2	Trial 3	Average
50				
100				
150				
200				

Title: ____

Dependent variable: ______________

Independent variable: ______________________________

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Independent variable: ______________________________

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Investigation 5: Craters
No. 32—Notebook Master

Model Impact Craters—Mass

1. In your group, prepare the lunar surface.
2. Determine the mass of your four objects. Mass is your **independent variable** because you are changing it.
3. Set up your station to measure the height from which you will drop the four objects. (150 cm is a good height.)
4. Record your **dependent variable** in the table below: diameter, depth, or ray length.
5. Drop objects, record data, calculate averages, and graph the results.

Object mass (g)	Dependent variable: ____________			
	Trial 1	Trial 2	Trial 3	Average

Title: ______________________________

Dependent variable: ____________

Independent variable: ____________

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Object mass (g) | Dependent variable: ____________ | Trial 1 | Trial 2 | Trial 3 | Average

Title: ______________________________

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Independent variable: ____________

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Investigation 5: Craters
No. 33—Notebook Master

Focus Question Are Moon craters the result of volcanoes or impacts?	Focus Question Are Moon craters the result of volcanoes or impacts?

Asteroid Size and Impacts

Use the 20:1 crater-to-asteroid ratio to determine the size of the asteroid that created these Earth craters.

Earth crater	Diameter (km)	Asteroid size (km)
Manicouagan (p. 144)	100	
Chicxulub (p. 60)	300	
Gosses Bluff (p. 143)	24	
Barringer (p. 142)	1.2	

Lunar crater	Diameter (km)	Asteroid size (km)
Archimedes (p. 138)	83	
Aristillus (p. 138)	55	
Clavius (p. 141)	225	
Copernicus (p. 139)	93	
Posidonius (p. 140)	95	
Stöfler (p. 141)	126	
Tycho (p. 141)	85	
Sea of Rains	1,000	

Why are there more craters on the Moon than on Earth?

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Why are there more craters on the Moon than on Earth?

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Investigation 5: Craters
No. 41—Notebook Master

Counting Major Impacts

Data gathering

1. Where is the best place to count major impact craters (Earth, the Moon)?
2. Maria were formed approximately 4 billion years ago. Why is this information needed to calculate frequency?
3. How big is a "major" impact crater?
4. Record the number of major impact craters you found.

Data processing

5. What is the class average of craters counted in the maria?
6. Multiply the average number of craters counted in the maria by 4 because maria represent approximately one-fourth of the Moon's surface. How many major impacts hit the entire Moon during those 4 billion years?

Conclusion

7. How many major impacts hit Earth in that same period of time (4 billion years)? Hint: The surface of Earth is approximately 16 times larger than the surface of the Moon.
8. On average, how many years are there between major impacts on Earth?
9. What effect do you think a major impact would have on Earth today?

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Investigation 5: Craters
No. 42—Notebook Master

Focus Question Will Earth experience a major impact in the future?	Focus Question Will Earth experience a major impact in the future?

Looking at the Cosmos

Part 1: Solar system

List the kinds of objects found in our solar system.

Part 2: Milky Way galaxy

List the kinds of objects that exist outside our solar system, but are still in our galaxy.

Part 3: Deep space beyond our galaxy

List the kinds of objects that exist in deep space beyond our galaxy.

Looking at the Cosmos

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List the kinds of objects found in our solar system.

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List the kinds of objects that exist outside our solar system, but are still in our galaxy.

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List the kinds of objects that exist in deep space beyond our galaxy.

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Planetary Science Course
Investigation 6: Beyond the Moon
No. 43—Notebook Master

Focus Question What is in the solar system?	Focus Question What is in the solar system?

Formation of the Solar System

1. Look at the drawings for the formation of the solar system, and read the descriptions on the back.
2. Put the drawings in the order you think they occurred.
3. List the formation stages in the "Predicted sequence" column from *beginning* to *present time*.

	Predicted sequence	**Current theory**
Beginning		
Present time		

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	Predicted sequence	**Current theory**
Beginning		
Present time		

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Investigation 6: Beyond the Moon
No. 44—Notebook Master

Focus Question Where did the solar system come from?	Focus Question Where did the solar system come from?

Scale Model 1 of the Solar System

Use the table to record your data and calculations.

Planet	Planet radius (km)	Planet diameter (km)	Distance from Sun (km)	Model 1 1 cm = 1 million km	
				Diameter	Distance

Scale Model 1 of the Solar System

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Investigation 7: The Solar System
No. 45—Notebook Master

Scale Model 2 of the Solar System

1. Locate your school with Google Earth™.
2. Set a placemark on your school to indicate the location of the Sun.
3. Set the ruler tool to meters. Measure the scaled distance from the Sun to Mercury.
4. Describe this map location in the table below.
5. Repeat steps 3 and 4 for each planet in the solar system.

Planet or other object	Model 2 1 m = 1,390,000 km		Location in model
	Diameter	Distance	

Scale Model 2 of the Solar System

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	Diameter	Distance	

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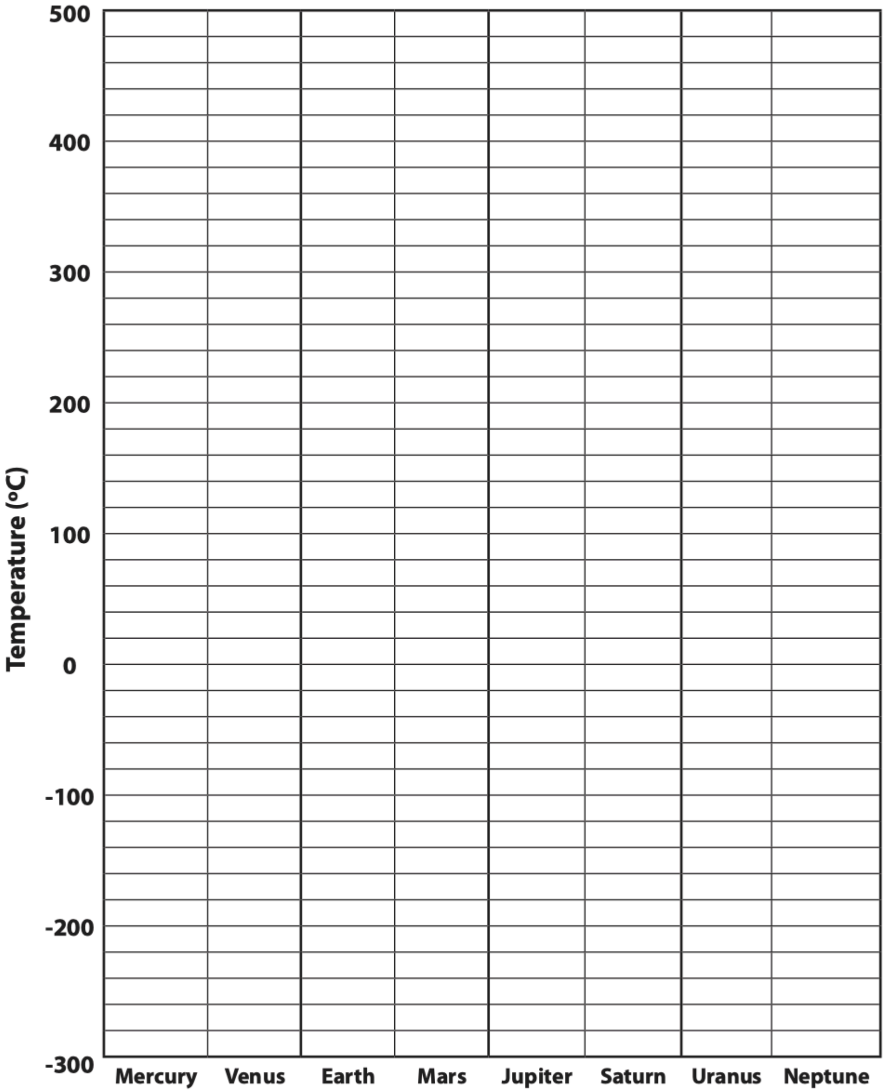
Focus Question Where are the planets in the solar system?	Focus Question Where are the planets in the solar system?

Temperature Ranges

Draw a line to show what you think the average high and low temperatures are on each planet.



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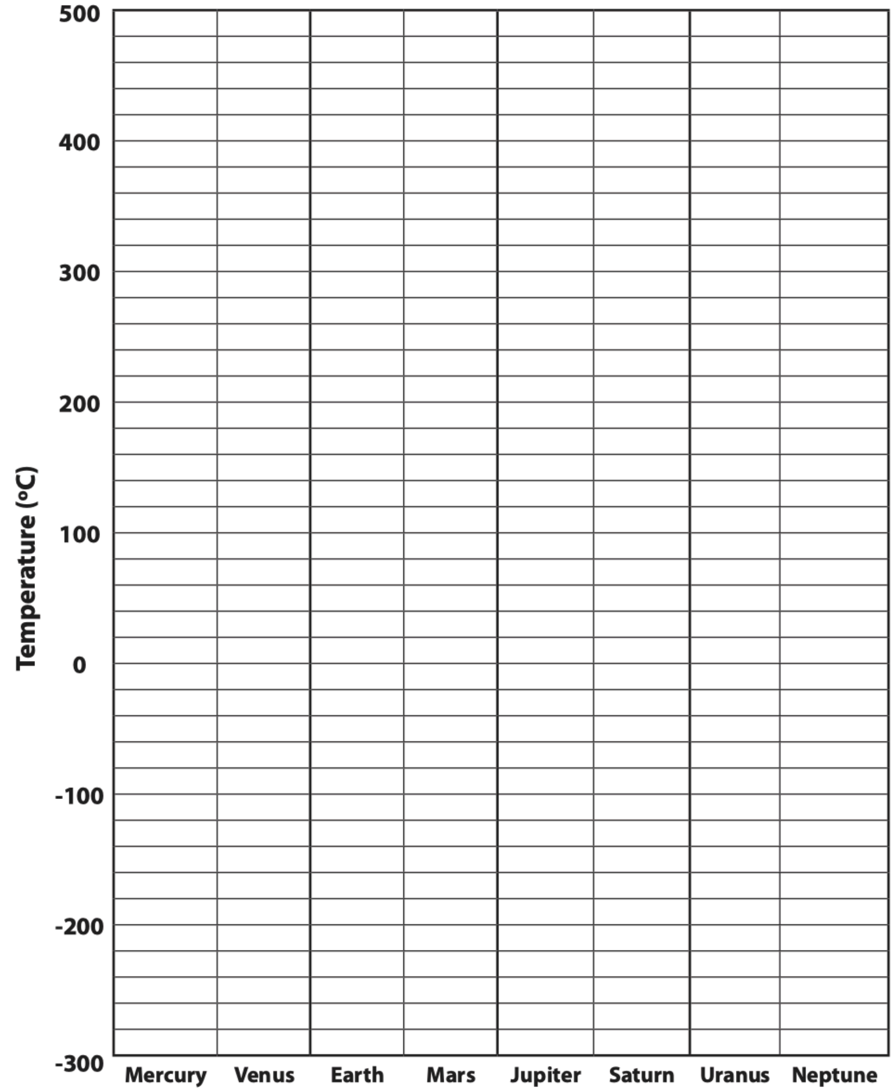
Investigation 7: The Solar System
No. 47—Notebook Master

Temperature Ranges

Draw a line to show what you think the average high and low temperatures are on each planet.



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Investigation 7: The Solar System
No. 47—Notebook Master

Focus Question Which planet is most like Earth?	Focus Question Which planet is most like Earth?

Water on Earth

1. Look at the Earth images. Decide what types of landforms are visible.
2. Write the letter for the image in each category where you think it is present.
3. After you have looked at all the Earth images, review the images for each landform category, and describe the common features of each landform.

Landform	Image	Description
River/ stream		
Delta		
Lake		
Ocean		
Island		
Glacier/ice		
Clouds		
Mountain		
Desert		
Other		

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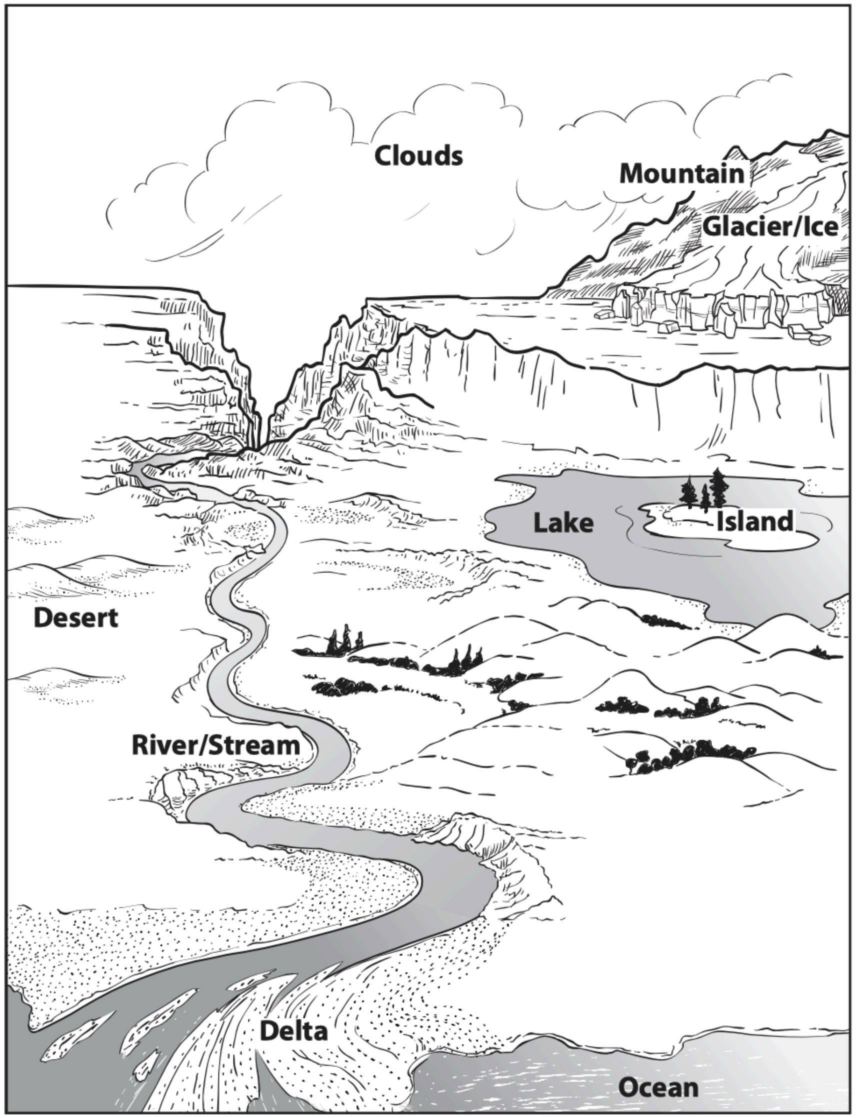
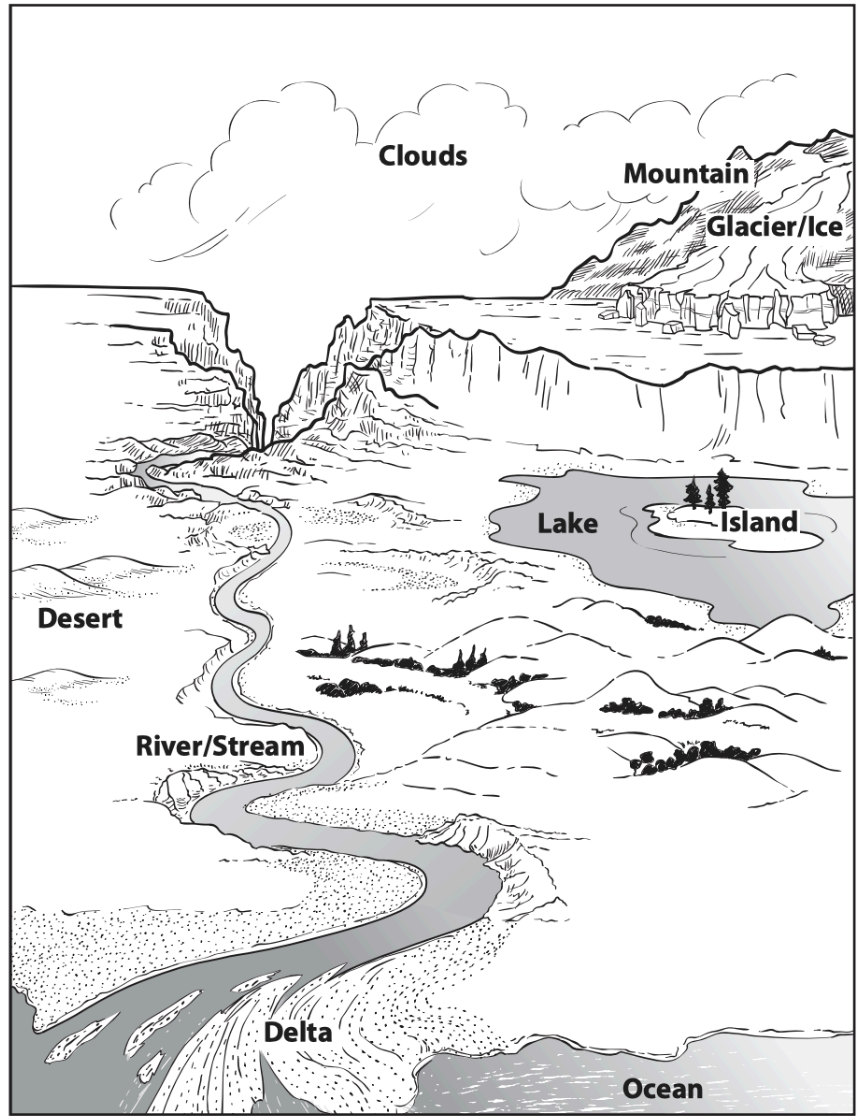
Landform Vocabulary



Landform Vocabulary



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Investigation 7: The Solar System
No. 49—Notebook Master

Water in the Solar System

1. Look at images from different objects in the solar system.
2. List the types of water landforms you observe. Use the online database "Search for Water" to look for more evidence of water.

Solar system object	Water landforms observed

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Solar system object	Water landforms observed

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Investigation 7: The Solar System
No. 50—Notebook Master

Focus Question Where is the water in the solar system?	Focus Question Where is the water in the solar system?

Human Impact on Earth's Systems

As you look at each set of images, answer these questions.

a. What systems are involved?
b. How have humans changed these systems?
c. How do humans benefit from modifying Earth's systems?
d. What are other effects of modifying these systems?

Image set _____

Image set _____

Human Impact on Earth's Systems

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Image set _____

Image set _____

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Investigation 7: The Solar System
No. 51—Notebook Master

Focus Question What impact do humans have on Earth's systems?	Focus Question What impact do humans have on Earth's systems?

Focus Question Why is light important in astronomy?	Focus Question Why is light important in astronomy?

Response Sheet—Investigation 8

A student told her friend,

"Astronauts are the most important way we learn about the solar system. They've traveled to distant places, measured the atmosphere, and collected samples that are sent back to Earth."

If you were the friend, what would you say to the student to help her understand the ways we learn about the solar system?

Response Sheet—Investigation 8

A student told her friend,

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If you were the friend, what would you say to the student to help her understand the ways we learn about the solar system?

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Investigation 8: Space Exploration
No. 52—Notebook Master

Focus Question What are the big questions that guide space exploration?	Focus Question What are the big questions that guide space exploration?

Jupiter's Moons—Data Collection

Use this table to organize your orbital period and orbital radius data for each of Jupiter's moons.

Jupiter's Moons—Data Collection

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Investigation 9: Orbits and New Worlds
No. 53—Notebook Master

Jupiter's Moons—Data Analysis

1. What are the names of the four moons in order from closest to farthest from Jupiter?

   Closest ________________________

   ____

   ____

   Farthest ________________________

2. What happened to moon 3 on night 8?

3. Which moon has the shortest period? ____________________

   Which moon has the longest period? ____________________

4. Using this data, what can you conclude about the relationship between the orbital period and the orbital radius?

Jupiter's Moons—Data Analysis

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   Closest ________________________

   ____

   ____

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Planetary Science Course
Investigation 9: Orbits and New Worlds
No. 54—Notebook Master

Focus Question What can be learned by studying the moons of Jupiter?	Focus Question What can be learned by studying the moons of Jupiter?

Questions for Exoplanet Transit Graphs

1. How many planets are orbiting each star?

   A ________________

   B ________________

   C ________________

   D ________________

2. What is the orbital period for each planet?

   A ____

   B ____

   C ____

   D ____

3. Which planetary system has the planet that is closest to its star?

   Why do you think so?

4. Which planetary system has the largest planet?

   Why do you think so?

5. Which planet has an orbit like Earth's?

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   A ________________

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Planetary Science Course
Investigation 9: Orbits and New Worlds
No. 55—Notebook Master

Focus Question How are exoplanets found?	Focus Question How are exoplanets found?

Focus Question Where are you when you are in science class?	Focus Question Where are you when you are in science class?