Space Science

2019 - 2020

Student Name ________________________________

Teacher Name________________________________

Guidelines for Safety in Science Classroom

Before the Investigation

- Listen carefully to your teachers instructions.
- Use only those materials or chemicals needed in the investigation.

During the Investigation

- Don’t eat, drink, or chew gum in the lab area.
- Wear safety goggles for any investigation that uses chemicals.
- Don’t engage in horseplay in the classroom.
- Contribute to the success of your lab group.
- Not sure what to do? Ask!

After the investigation

- Dispose of all materials as instructed by your teacher.
- Clean up your work area.
- Return all equipment to its proper place.
- Wash your hands after each experiment.

Cut Here --

I, ____________________________________, have read the guidelines for Safety and have discussed them in my classroom. I agree to follow all of these rules during science class and investigations.

Signature:____ Date: ______________________

Science Interest Inventory

1. My interest in science is: (circle one) low medium high
2. The thing I like least about science is: ____
3. The thing I like the most about science is: ____________________________________
4. My favorite area of science is: (circle one)

   Life Science Earth/Space Science Physical Science

5. My favorite way to learn science is through: (Check all that apply)

- ❑ Reading books and articles
- ❑ Games and puzzles
- ❑ Problem solving
- ❑ Looking for patterns
- ❑ Role playing
- ❑ experimenting
- ❑ Collecting data about objects and events
- ❑ Watching videos, slide shows, or PowerPoint presentations
- ❑ A variety of physical activities
- ❑ Investigations outdoors or in the community
- ❑ Exploring nature
- ❑ Projects, such as making models
- ❑ Caring for and studying animals
- ❑ Working with others
- ❑ Working alone
- ❑ Using magnifiers and microscopes
- ❑ Other (please add)____

6. The topic in science I would most like to learn about is: ___________________________

Science Partners

In the empty spaces below, choose a person in this class, and write their name in the space provided. You may not have the same person twice on your list.

Solar Partner: ____

Lunar Partner: ____

Equinox Partner: ____

Solstice Partner: ____

Name__________________________________ Class Period ___________

Red Solo Cup Stack Challenge

Problem: How fast can your team build a pyramid out of cups without touching the cups directly with your hands?

Hypothesis: (If, Then, Because)

If the string and the rubber band are used to stack the cups, then our group will be able to ____because ___________________________
____
____
_.

Materials: 6 cups, 4, 2 foot pieces of string, a rubber band

Procedure:

1. Use only the supplies provided
2. The pyramid must be constructed on a flat surface
3. You may not touch the cups with your hands directly.
4. BE CREATIVE!
5. The TASK Manager should raise their hand when your group is done.

Flow Chart Before Stacking

Step #	Description	Picture

Observations/Data: Flowchart of how you actually stacked the cups

Step #	Description	Picture

Conclusion:

1. Was your hypothesis correct? Explain using at least 2 observations that helped you come to this conclusion.

2. Which problem that you encountered was the most difficult for your group?

3. List one thing that you would do the same and one thing you would change if you attempted the challenge again.

Design Your Own Experiment

Group Members: ____________________________________

____

____

____

1. You and your team will decide on an experiment that you think would be super cool and interesting!
2. Materials used for the experiment **should be easily found around your house.**
3. You will conduct your experiment in class.
4. **You will need to include the following information on your slides:**

   ____Problem: Question mark at the end of sentence

   ____Hypothesis: Uses the words **If, then, because** in your hypothesis

   ____Materials: Must be complete

   ____Procedure: Must be numbered and identify the control and variable

   ____Observations: Shows data table or what you will you use to collect data

   ____Conclusion: Restates hypothesis and discusses if hypothesis is correct or incorrect. Make sure to use two (2) pieces of evidence from your experiment. (Qualitative or Quantitative Observations)

5. **Each group will present their google slides to the class.**
   - Slide 1: Title Slide: Name, Period, Teacher Name (2 pts)
   - Slide 2: Problem (3 pts)
   - Slide 3: Hypothesis (3 pts)
   - Slide 4: Materials (3 pts)
   - Slide 5: Procedure (10 pts)
   - Slide 6: Observations (10 pts)
   - Slide 7: Conclusion (4 pts)

Scientific Method/Parts of Lab Report Practice

Directions: Given below are the details of an experiment. Read the experiment, then answer the questions.

Four jars were filled with pond water. Five drops of bromothymol blue (BTB) were added to each jar. Bromothymol blue turns green in the presence of carbon dioxide. A snail was places in jar 2. A piece of Elodea, a plant was placed in jar 3. Both a snail and a piece of elodea were placed in jar 4. All four jars were sealed with paraffin wax a placed in the light for two days. At the end of the two days, the water in jar 2 was green. The water in jar 3 was blue. The water in jar 4 was blue at the top and green at the bottom.

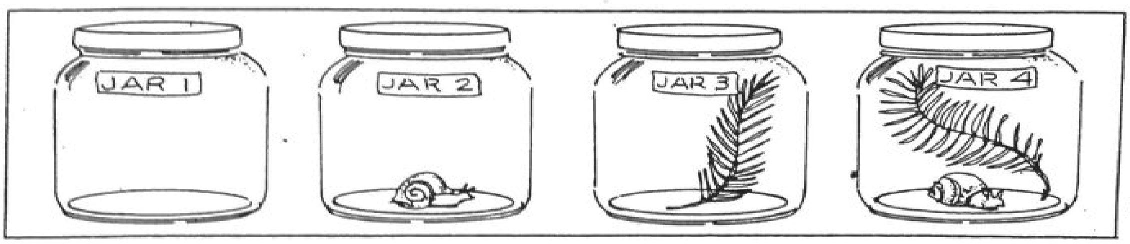

FIGURE 1—1

1. Give the experiment a title in the form of a question.

____

2. What is a possible hypothesis for this experiment?

____
_
____
____
____
___

Using the paragraph above:

3. Underline the sentences that describe the procedure.

4. Draw a box around the sentences that contain observations.

5. What purpose does jar 1 have in the experiment?

____
_

6. What conclusion can you draw from the observations?

____
_

The Scientific Method: How Penicillin Was Discovered

In 1928, Sir Alexander Fleming was studying Staphylococcus bacteria growing in culture dishes. He noticed that a mold called Penicillium was also growing in some of the dishes. A clear area existed around the mold because all the bacteria that had grown in this area had died. In the culture dishes without the mold, no clear areas were present.

Fleming hypothesized that the mold must be producing a chemical that killed the bacteria. He decided to isolate this substance and test it to see if it would kill bacteria. Fleming transferred the mold to a nutrient broth solution. This solution contained all the materials the mold needed to grow. After the mold grew, he removed it from the nutrient broth. Fleming then added the nutrient broth in which the mold had grown to a culture of bacteria. He observed that the bacteria died which was later used to develop antibiotics used to treat a variety of diseases.

1. Identify the problem:____

2. What was Fleming's hypothesis?

____

____

____

3. How was the hypothesis tested?

____

____

____

____

4. What was the variable in Fleming’s experiment? _________________________________
5. What was the control? ____

6. What data/observations did he obtain?

7. What was his conclusion?

Famous Scientists and their Contribution to the Scientific Process Tissue Box Project



1. **Pick one of the following scientists:**
    a. Francesco Redi (Maggots experiment)
    b. Lazzaro Spallanzani (Microbes and broth)
    c. Louis Pasteur (Swan-necked flask)
    d. Maria Merian (Butterflies and spontaneous generation)
    e. Your Choice (Anyone but Fleming)
2. **From the point of view of the scientist, decorate a full tissue box that explains their experiment. (Must be typed, cut out and put on the sides of a tissue box. Be creative).**

    Side 1:
    - Name of Scientist
    - Title of Experiment
    - Date of Experiment

    Side 2:
    - Write the problem in the form of a question.

    Side 3:
    - List the procedure (steps) the scientist followed and identify the control and variable.

    Side 4:
    - What conclusion did they come to?

    Bottom of Tissue Box:

- Design an award that this scientist may have been given by his/her peers.
    - Be sure to include the scientist's name and what the award is for.

Famous Scientists and their Contribution to the Scientific Process
Tissue Box Project RUBRIC

Entry Topic	Points Possible	Points Earned
<u>Side 1:</u> ● Name of Scientist ● Title of Experiment ● Date of Experiment	5	
<u>Side 2:</u> ● Write the problem in the form of a question.	3	
<u>Side 3:</u> ● List the procedure (steps) the scientist followed (6 points) and identify the control (2 points) and variable. (2 points).	10	
<u>Side 4:</u> ● Identifies the scientists conclusion	3	
<u>Bottom of Tissue Box:</u> ● Design an award that this scientist may have been given by his/her peers. ○ Be sure to include scientist's name and what the award is for.	4	
TOTAL	25	

Famous Scientists and their Contribution to the Scientific Process
<u>Tissue Box Project Research Outline</u>

Side 1:

NAME OF SCIENTIST____
(choose from the list above or your choice - not Fleming)

TITLE OF EXPERIMENT ____

DATE OF EXPERIMENT
____

Side 2:

PROBLEM (WRITE IN FORM OF A QUESTION): ___________________________
____
_
____
_
____
_

Side 3:

LIST THE PROCEDURE (STEPS) THE SCIENTIST FOLLOWED:

1. ____
_
2. ____
_
3. ____
_
4. ____
_

5. ____
_
6. ____
_
7. ____
_

IDENTIFY THE CONTROL (WHAT STAYS THE SAME)

____

_

IDENTIFY THE VARIABLE (WHAT YOU CAN CHANGE)

____

_

Side 4:

IDENTIFY THE SCIENTISTS CONCLUSION ______________________________

____

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____

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Bottom of Tissue Box:

- DESIGN AN AWARD THAT THIS SCIENTIST MAY HAVE BEEN GIVEN BY HIS/HER PEERS.
  - BE SURE TO INCLUDE THE SCIENTIST'S NAME AND WHAT THE AWARD IS FOR.

____

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My Ideas About Day, Year, Seasons, and Moon Phases

Day	**Year**
What changes happen in the sky every 24 hours?	What is a year? What changes happen in the Sun's position in the sky over the course of a year?

What causes these changes?	What causes these changes?
<u>Seasons</u> What changes happen in the seasons every year? What causes these changes?	**<u>Moon Phases</u>** What changes takes place in the visible shape of the moon every day? How long does it take for these changes to take place? What causes these changes?

<u>Atmosphere:</u>

Name	Characteristic	Order	Altitude	Temperature	Image
Exosphere					
Thermosphere					
Mesosphere					
Stratosphere					
Troposphere					

Activity 1 - Exploring Space

Guiding Question: *What have we learned from missions to space?*

PROCEDURE

Use Student Sheet 1.1, "Anticipation Guide: Space Exploration," to prepare for the following activity.

1. Each person in your group of four will read about one of the four missions to space. As you read, record information on Student Sheet 1.2, "Four Space Missions," about:
    - what was learned from that space mission.
    - the challenges faced during that space mission.
2. Share what you learned about your space mission with your group. Tell your group members about the mission, what was learned, and what challenges were faced.
3. Make sure each person in your group has a chance to share. As you listen to others share, write down information about the other three space missions on Student Sheet 1.2.
4. Discuss the similarities and differences between the four missions your group read about.

STUDENT SHEET 1.1

ANTICIPATION GUIDE: SPACE EXPLORATION

Before starting the activity, mark whether you agree (+) or disagree (—) with each statement below.

After completing the activity, mark whether you agree (+) or disagree (—) with each statement below. Under each statement, explain how the activity gave evidence to support or change your ideas.

BEFORE AFTER

______ ______ 1. People have walked on the Moon.

______ ______ 2. All spacecraft return to Earth.

______ ______ 3. A spacecraft landed on one of Saturn's moons.

______ ______ 4. Telescopes are used only on Earth.

______ ______ 5. There has never been liquid water on the surface of Mars.

______ ______ 6. Space exploration is cheap and easy.

STUDENT SHEET 1.2

FOUR SPACE MISSIONS

Mission	What was learned?	What were the challenges?
Apollo Program		
Cassini Mission		
Hubble Space Telescope		
Mars Science Laboratory		

<u>Activity 1 - Exploring Space</u>
<u>Analysis Questions</u>

1. Return to Student Sheet 1.1, and complete the "After" column by marking whether you agree (+) or disagree (–) with each statement. Under each statement, explain how the activity gave evidence to support or change your ideas. **Evidence is information that supports or refutes a claim.**

2. Governments sometimes fund space missions instead of using that money for other scientific research on Earth. Would you fund a future space mission? Explain why, and provide an example of a trade-off between funding a space mission and funding other types of scientific research. A trade-off is a desirable outcome given up to gain another desirable outcome.

3. Reflection: If you had to choose a place in space to explore, where would it be? Explain why you chose this place and what new things you would want to learn.

Activity 2 - The Predictable Moon

Guiding Question: ***How can we predict changes in the Moon's appearance?***

MATERIALS
For each pair of students:
1 set of 8 Moon Phase Cards

For each student:
1 Student Sheet 2.1, "Moon Observations"

PROCEDURE
Part A: Moon Phase Cards

1. With your partner, look at all of your Moon Phase Cards.
    a. Discuss if you have ever seen the Moon appear as it does on each card.
2. Place your cards in an order, from left to right, that you think shows how the Moon's appearance changes over time.
    a. Why did you choose to put the cards in this way?

3. Compare the order of your cards with the order created by the other pair in your group.
    a. Identify any similarities and differences between the two orders.

4. A **cycle** is a sequence of events that repeats. As a group, combine and order the two sets of Moon Phase Cards, from left to right, to show how the changes in the Moon's appearance are part of a cycle.

5. Answer Analysis Question #1

Part B: Moon Observations

6. Student Sheet 2.1, “Moon Observations,” has a calendar where observations of the Moon’s phases have been filled in on certain dates. Using the observations on the calendar, answer the following:
    a. How many days does a complete cycle of the Moon’s phases take?

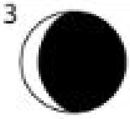
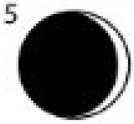
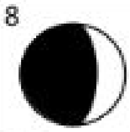
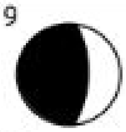
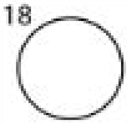
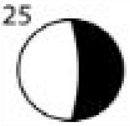
7. In the circles on Student Sheet 2.1 for May 11, 22, and 28, draw what you think the Moon will look like on those days.

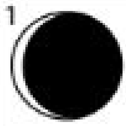
8. Predict the date for the next full moon for the June calendar on Student Sheet 2.1. Draw a full moon on the date you predicted.

9. On Student Sheet 2.1, write the word “new moon” on the days you predict the new moon will occur.

STUDENT SHEET 2.1

MOON OBSERVATIONS

May		1	2	3 	4	5 
6	7	8 	9 	10	11 	12
13	14 	15	16 	17	18 	19
20	21	22 	23	24	25 	26
27	28 	29	30	31		

June					1 	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Activity 2 - The Predictable Moon
Analysis Questions

1. In Step 4, if you had moved your first card to the end of your order, would the order still be correct? Explain your answer using the word pattern in your explanation. A **pattern** is something that happens in a repeated and predictable way.

2. Explain how you made your predictions for Steps 7 through 9.

3. Predict the date of the next first quarter moon for the June calendar on Student Sheet 2.1. Explain how you made your prediction.

4. Reflection: Why do you think the Moon's appearance changes?

<u>Activity 3 - Explaining the Moon's Phases</u>

<u>Guiding Question:</u> ***<u>What causes the cycle of the Moon's phases that we observe from Earth?</u>***

<u>PROCEDURE</u>

1. Watch closely as your teacher demonstrates how you and your partner will model the Moon's orbit around Earth.

> To create your model, you will use a light to represent the Sun (because the Sun produces light), a ball to represent the Moon, and your head to represent Earth. You will observe the appearance of the Moon in its orbit around the Earth. The curved path that a space object takes around another star, planet, or moon is called its **orbit**.

2. Position yourself as instructed by your teacher, and model one complete orbit of the Moon around Earth. Observe the Moon's appearance throughout the modeled orbit. Your partner should then repeat this step.

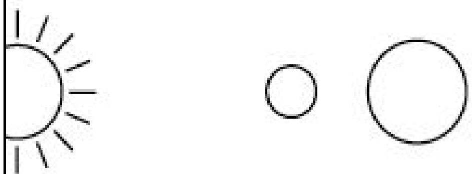
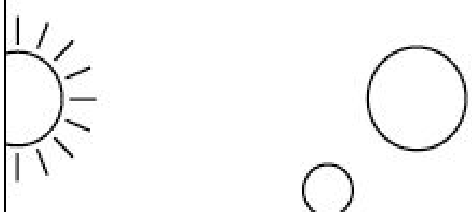
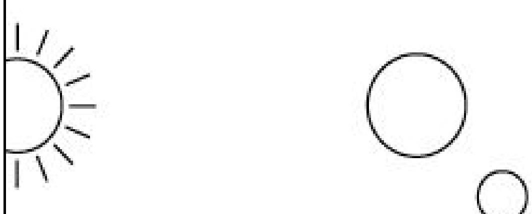
3. Repeat Step 2, except make sure to stop at each of the positions shown on Student Sheet 3.1, "Observations of Moon Model." For each position, observe the Moon model, and draw your observations of the Moon model on your Student Sheet. Your partner should then repeat this step.

4. On Student Sheet 3.1, complete the final diagram by drawing the Moon so that it shows where you think the Sun, Moon, and Earth are located during a first quarter moon. Explain why you would see a first quarter moon.

    Hint: If you are having trouble figuring this out, have your partner use the model to find the first quarter moon phase, and then draw where the Sun, Earth, and Moon are positioned.

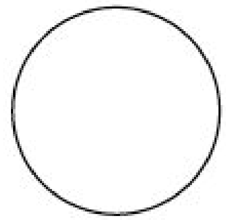
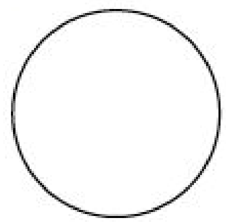
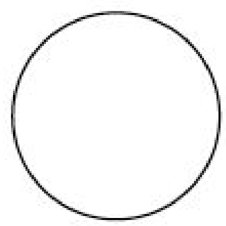
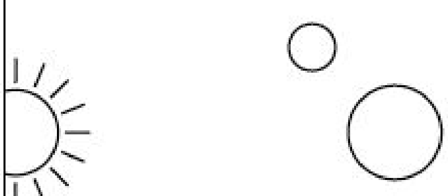
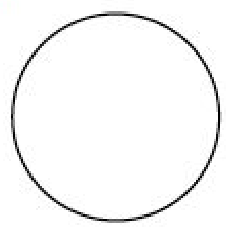
STUDENT SHEET 3.1

OBSERVATIONS OF MOON MODEL

Position	Diagram of where the Sun, the Moon, and Earth are located (as viewed from above)	Moon's phase (Shade in only the part of the Moon that isn't lit up by the Sun.)
1		Phase:
2		Phase:
3		Phase:
4		Phase:

STUDENT SHEET 3.1 (continued)

OBSERVATIONS OF MOON MODEL

Position	Diagram of where the Sun, the Moon, and Earth are located (as viewed from above)	Moon's phase (Shade in only the part of the Moon that isn't lit up by the Sun.)
5		Phase: 
6		Phase: 
7		Phase: 
8		Phase: 

STUDENT SHEET 3.1 (continued)

OBSERVATIONS OF MOON MODEL

Draw the Moon so that it is a first quarter moon.

Explain why your drawing results in a first quarter moon.

Activity 3 - Explaining the Moon's Phases
Analysis Questions

1. What fraction of the Moon model was always lit up by the light in your model?

2. What fraction of the Moon is always lit up by the Sun?

3. Why can't you see a new moon?

4. Although we call it moonlight, where does the light that we see coming from the Moon actually come from?

5. Your friend claims that the Moon's repeated orbit around Earth causes the cycle of the Moon's phases.

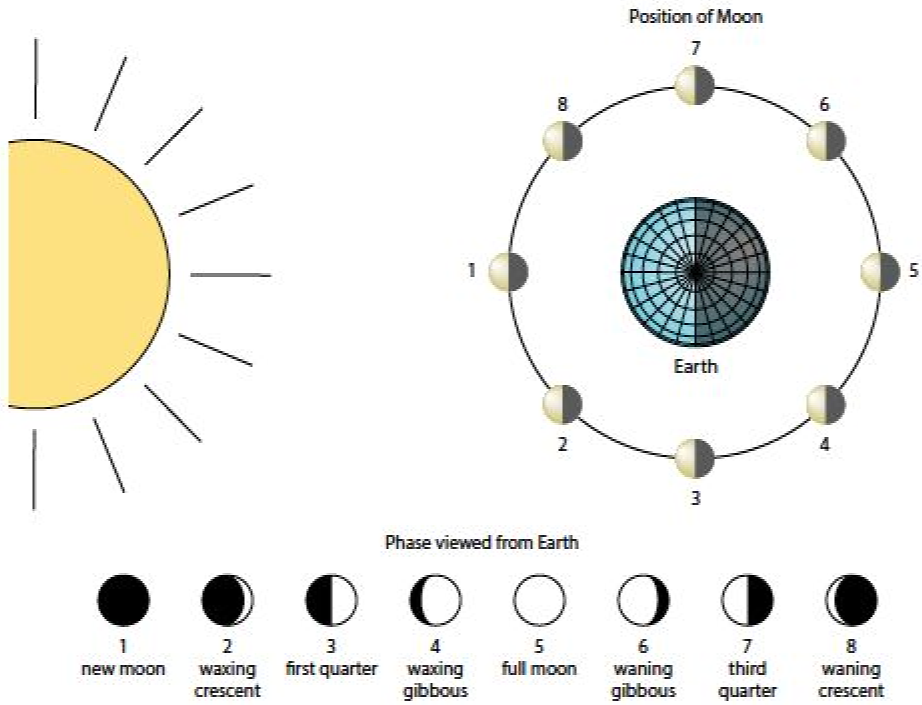
    a. Do you agree or disagree with your friend? Use your observations from this activity to support your answer.

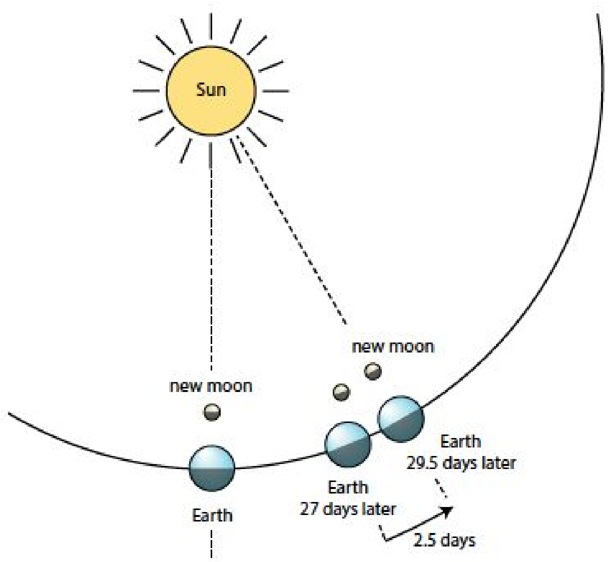
    b. Does your friend's claim make sense with the predictable cycle of the Moon's phases that you observed in the previous activity? Explain.

6. In this activity, you modeled the Sun–Earth–Moon system. If you removed one object from this system model, would the model still explain the changes to the Moon's appearance? Explain your ideas.

A **system** is a group of interacting objects or processes. Every system includes

- components: the substances, materials, and processes that make up the system.
- interactions: the relationships between the substances, materials, and processes in the system.
- boundaries: the extent of the system, separating those component and processes that are part of the system from those that are not.





Note: The distance moved by the Earth in 2.5 days is exaggerated in this diagram so that you can see the alignment of the Earth and Moon.

Activity 4 - Moon Phase Simulation

Guiding Question: ***How does the Moon's orbit around Earth cause the Moon's phases to repeat around every 29 days?***

MATERIALS

For each pair of students:

1 computer with Internet access

PROCEDURE

Part A: Exploring the Simulation

1. Open the Moon Phase Simulation on your computer.
2. Identify the sunlight, Earth, and Moon.
    a. Note: The view in the model is from above Earth's North Pole.
3. Discuss with your partner what the large circle around Earth represents.
4. Press "Play," and observe what the Moon does and what Earth does.
5. Discuss your observations with your partner. Make sure to discuss what Earth's rotation is modeling.

Part B: Observing the Phases

6. After watching the Moon orbit Earth one time, press "Pause."
7. Select "new moon" in the drop-down menu under Select Moon Phase.
8. Look carefully at where the Moon is in relation to Earth and sunlight, and what its phase looks like. Make a labeled sketch below of your observations. Title your sketch with the name of the moon phase.

PROCEDURE, cont.

9. Press "Play," and watch the simulation until the Moon is in the first quarter phase, and then press "Pause."
10. Below, make a sketch similar to the one you made in Step 8.

11. With your partner, make predictions of where you think the Moon will be in its orbit during the: full moon, third quarter moon, and waning crescent moon. Sketch your predictions below.

12. Select the phases described in Step 11 in the drop-down menu under Select Moon Phase, and observe whether your predictions in Step 11 were correct. Correct your sketches as needed.
13. Press "Play" and then press "Fast Forward" to make the simulation go more quickly. Observe the pattern between how the Moon's position changes and how the Moon's phase changes.

Activity 4 - Moon Phase Simulation
Analysis Questions

1. In the simulation, what do the dark and light halves of the Moon and Earth represent?

2. Why are the light halves of the Moon and Earth always shown facing the incoming sunlight?

3. A simulation can be thought of as another type of model. Compare this computer simulation to the physical model your teacher showed you in "Explaining the Moon's Phases" activity.
    a. What are the advantages and disadvantages of using the ball and light to represent the Moon and the Sun?

    b. What are the advantages and disadvantages of the computer simulation?

    c. Why do we use models to understand how the Moon orbits Earth instead of traveling into space to observe the phenomenon?

4. Draw a model, and use it to explain the reason we see the cycle of the Moon's phases.

5. NASA scientists often use simulations to prepare for space missions. During the Apollo program, NASA scientists and engineers built a simulator called Project LOLA. Using the simulator, astronauts could practice flying over the surface of the Moon to find their landing spot. Why do you think NASA engineers and scientists developed Project LOLA?

Activity 5 - The Moon's Orbit

Guiding Question: ***Why don't we see lunar and solar eclipses more often?***

MATERIALS

For each pair of students:

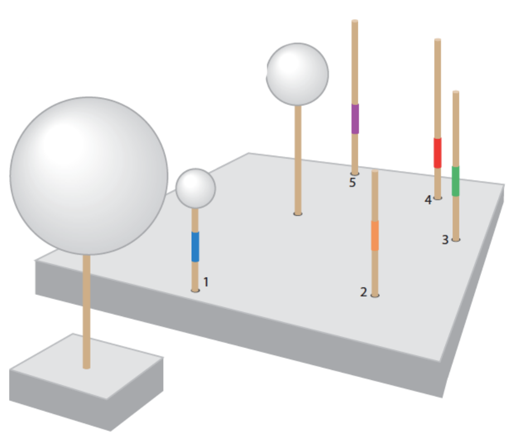
- 1 Earth model: a medium white foam ball attached to a stick
- 1 Sun model: a large white foam ball attached to a stick
- 1 Moon model: a small white foam ball with a hole in it
- 1 blue stick
- 2 orange sticks
- 2 green sticks
- 2 red sticks
- 1 purple stick
- 1 foam board with labeled holes
- 1 piece of foam
- 1 blank sheet of paper
- 1 marker

PROCEDURE:

Part A: Completing One Orbit

1. Set up Earth and the Sun as instructed by your teacher.
2. Place the blue stick in position #1, and add the Moon to the top of the stick. Discuss with your group which moon phase you would see from Earth. Record your ideas below:

3. Place an orange stick in position #2, a green stick in position #3, a red stick in position #4, and a purple stick in position #5. Look at the other sticks you have remaining, and see if you can determine the pattern that the sticks are following.

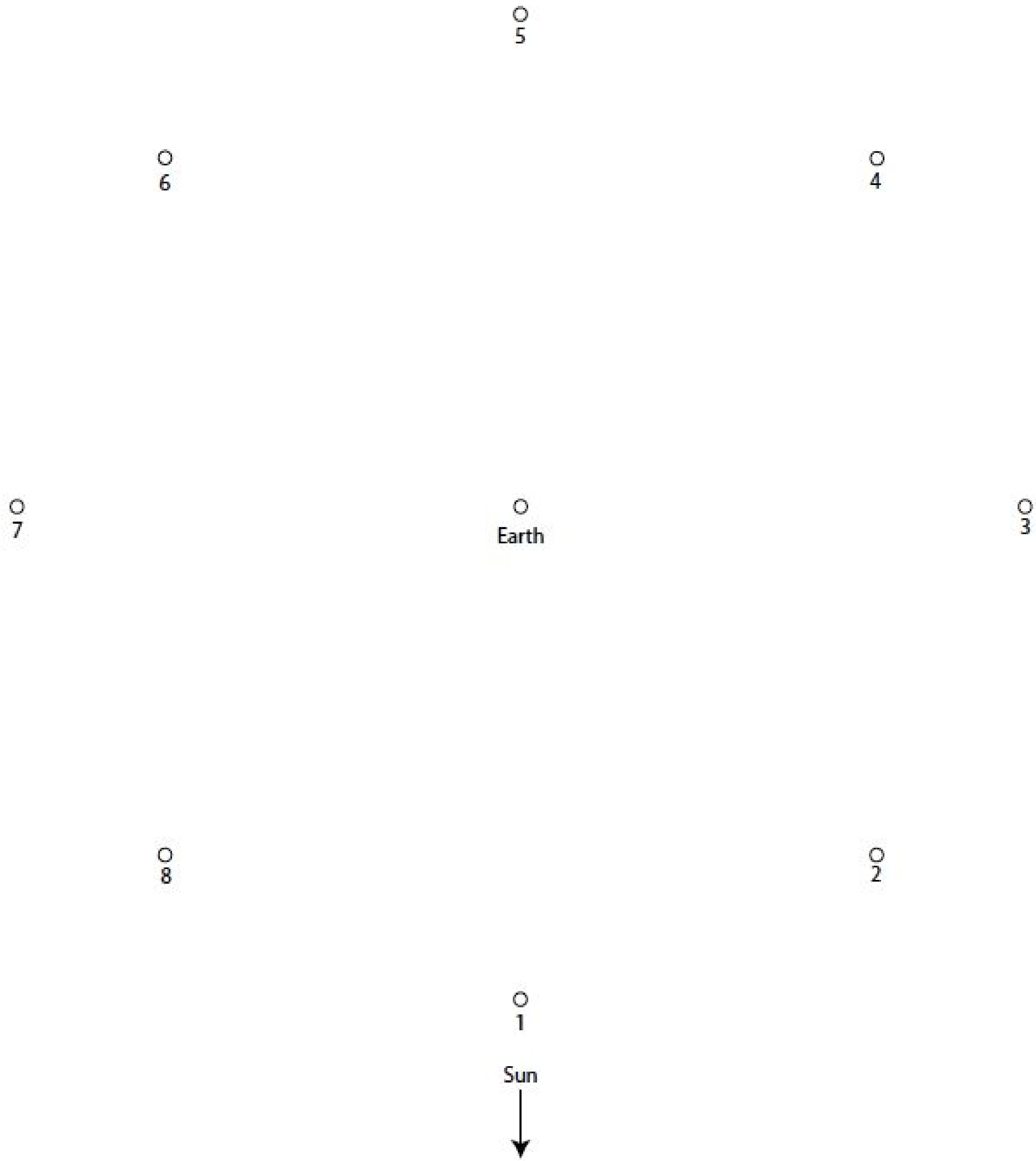


4. Decide with your group which stick should go in which position. Place the sticks in those positions.
5. Move the Moon ball from stick to stick, making sure to observe the height of the Moon compared with Earth and the Sun. Discuss with your group what the Moon's phase is at each position. Record your observations below.

Part B: The Orbital Plane

6. Move the Moon ball to the stick in the position it needs to be in for there to be a full moon, and discuss whether there would be a lunar eclipse.
    a. Note: Lunar eclipses can only happen during a full moon.
7. Remove Earth, the Moon, and the Sun from your model, but leave the sticks in their positions.
8. Have one member of your group hold a piece of paper so that it touches the top of each of the sticks. This piece of paper is a model of the Moon's orbital plane, the flat two-dimensional plane where the Moon is at any point in its orbit. Notice how the Moon's orbital plane is tilted relative to the line between Earth and the Sun.
9. Have a different member of your group use a marker to put a dot where each of the sticks touches the modeled orbital plane.
10. Add a dot in the center of your drawing and label it "Earth."
11. At one end of your paper, add arrows that represent light coming from the Sun toward Earth and the Moon.
12. Looking at where you added the sunlight and where Earth is located, discuss where the different phases of the Moon would occur.
13. As a group, label each dot with which phase of the Moon it represents.
14. Keep your model set up as you work on the Analysis.

MOON ORBIT TEMPLATE



Activity 5 - The Moon's Orbit
Analysis Questions

1. The Moon takes about 29 days to orbit Earth. In this activity, there were eight positions the Moon could be in.
    a. How many days would it take for the Moon to get from position #2 to position #4 in its orbit?
    b. What phases would the Moon go through as it traveled from position #2 to position #4?
2. In Step 9, you created a two-dimensional drawing of the Moon's orbit. What information about the Moon's orbit is missing from the two-dimensional drawing?
3. There are two points during the Moon's orbit around Earth when the Moon, Earth, and Sun are all in the same plane. In your model, this is represented when the Moon is on the green stick such that the Moon, Earth, and Sun are all at the same height.
    a. If the Moon is on the green stick in position #6, in what phase is the Moon? Draw what that phase looks like, and explain why it looks that way.
    b. If the Moon is on the green stick in position #1, in what phase is the Moon? Explain what people on Earth would observe.
    c. And when the green stick is in position #1, what color stick should be in position #5? Explain.
4. Reflection: How have your ideas about the reason for the phases of the Moon changed since you began this unit?

SECTION **2.3** POSITIONS OF THE SUN AND MOON AFFECT EARTH.

Reading Study Guide A

BIG IDEA Earth and the Moon move in predictable ways as they orbit the Sun.

KEY CONCEPT Positions of the Sun and Moon affect Earth.

Vocabulary

eclipse occurs when a shadow makes the Sun or the Moon seem to grow dark

umbra the darkest part of the shadow

penumbra a spreading cone of lighter shadow around the umbra

Review

1. Circle the term that best completes the sentence.

(The Moon/The Sun) orbits Earth.

Sunlight shines on Earth (and/and not) the Moon.

Take Notes

I. Phases are different views of the Moon's sunlit half. (p. 59)

2. Fill in the main-idea outline for the main idea shown.

I. Phases are different views of the Moon's sunlit half.

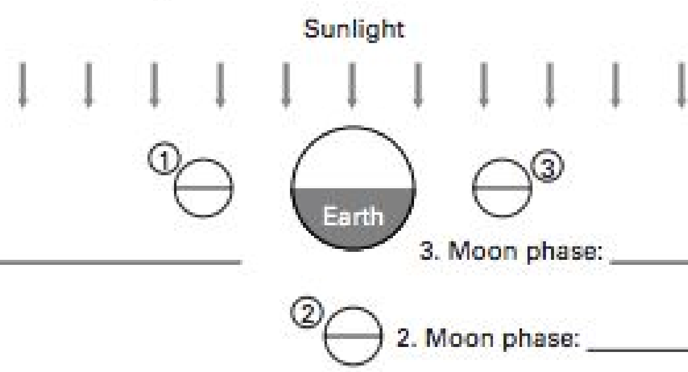
A. At any time, sunlight is shining on just ____________ the Moon's surface.

B. When you look at the Moon, you see the lit part of the

________________________.

A–B. Waxing Moon, Waning Moon, and Crescent and Gibbous Moons (pp. 60–62)

3. For each position of the Moon below, shade in the part of the Moon that is unlit by sunlight. Label each phase.



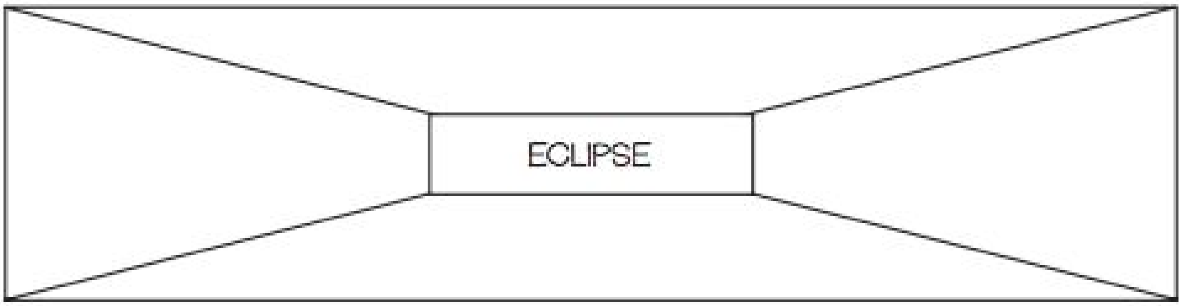
1. Moon phase: ____________________

3. Moon phase: ____________________

2. Moon phase: ____________________

II. Shadows in space cause eclipses. (p. 63)

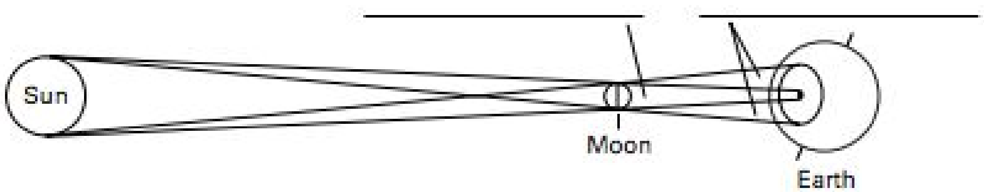
4. Fill in the frame game diagram for *eclipse*.



A–B. Lunar Eclipses and Solar Eclipses (pp. 63–64)

5. Label the *umbra* and *penumbra* on the diagram of the eclipse below. What type of eclipse is this?

____



III. The Moon's gravity causes tides on Earth. (p. 65)

6. Fill in the combination notes for the main idea shown.

Notes	Sketch
Tides occur because the Moon's gravity changes the shape of Earth's oceans. • A pattern of ______________ high tides and two low tides takes a little more than 24 hours. • The Moon's pull produces ______________ bulges of water. • A location moves past different thicknessess of water as Earth ______________.	

Measuring Shadows and Measuring Time Investigation

Problem: What happens to the Sun's shadow over the course of a day?

Hypothesis: ____

____

____

____

____

____

____

Materials:

Procedure:

1. Place a piece of paper or poster on the ground outside.
2. Use the compass and a marker to label the directions of North, West, East, and South on the edges of the paper. Check this with the compass.
3. Place the disc with the sun stick in the center of the poster/paper on the circle that is drawn on the paper.
4. Observe the Sun's shadow on the paper.
5. Trace the Sun's shadow on the paper with the marker and the meter stick.
6. Label the line with your period number, time, and length of shadow.
7. Complete data sheet.
8. Draw a LINE graph of your data.

Observations:

Data Table # 1: Measuring Shadows and Measuring Time

TIME	DIRECTION OF SUN	HEIGHT OF SUN	DIRECTION OF SHADOW	AVERAGE LENGTH OF SHADOW (cm)

<u>Patterns:</u> Draw a diagram of the Sun and the Sun's shadow direction throughout the day using the data above.

Conclusion:

1. What changes did you observe in the shadow at several different times on the same day?

____

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2. Why do you think the shadow moved during the day?

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3. What observations did you make that support your answer to question 2?

____

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4. Why do you think the length of the shadow changed during the day?

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5. What observations did you make that support your answer to question 4?

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6. Explain how you could use your sun stick to tell time.

–

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7. Was your hypothesis correct? Restate Hypothesis and then explain using at least 2 observations/pieces of evidence that helped you come to this conclusion.

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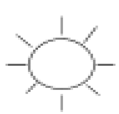
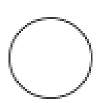
Talking Drawing: A Day on Earth

Draw a:  for the sun and a  for Earth.
Place a dot on the Earth to show the location of the U.S.

Draw a picture that shows the Sun and Earth during the day in the U.S.

Draw a picture that shows the Sun and Earth during the night in the U.S.

On Earth, day and night are caused by____

It is day when____

It is night when____

Jupiter's day-night cycle is 10 hours long. What does this tell you about Jupiter's rotation around its axis?

Mercury's day-night cycle is over 1400 hours long. What does this tell you about Mercury's rotation around its axis.

Activity 6 - Changing Sunlight

Guiding Question: ***What do you observe about the length of daylight and the position of the Sun in the sky over the course of a year?***

MATERIALS

For each pair of students

- 1 protractor

- 1 pair of scissors
- 2 black pens or pencils
- 2 colored pens or pencils (both the same color)
- transparent tape

For each student

- 1 Student Sheet 6.1, "Anticipation Guide: Sunlight and Seasons"

Daylight Hours and Sun Angle: Year 1

MONTH*	TIME OF SUNRISE (A.M.)	TIME OF SUNSET (P.M.)	DAYLIGHT (HOURS)	SUN'S HIGHEST ANGLE (DEGREES)
January	8:12	5:52	9.7	28.4
February	7:37	6:31	10.9	37.8
March	6:51	7:04	12.2	48.6
April	6:00	7:38	13.6	60.2
May	5:24	8:10	14.8	68.4
June	5:15	8:29	15.2	71.6
July	5:34	8:19	14.8	68.4
August	6:05	7:41	13.6	60.0
September	6:37	6:48	12.2	48.6
October	7:10	5:59	10.8	37.2
November	7:47	5:24	9.6	28.1
December	8:14	5:22	9.1	24.7

**Data were collected on the 21st day of each month.*

Daylight Hours and Sun Angle: Year 2

MONTH*	TIME OF SUNRISE (A.M.)	TIME OF SUNSET (P.M.)	DAYLIGHT (HOURS)	SUN'S HIGHEST ANGLE (DEGREES)
January	8:12	5:51	9.7	28.4
February	7:37	6:31	10.9	37.8
March	6:52	7:03	12.2	48.6
April	6:00	7:38	13.6	60.1
May	5:24	8:09	14.8	68.4
June	5:15	8:29	15.2	71.6
July	5:33	8:19	14.8	68.5
August	6:04	7:41	13.6	60.1
September	6:36	6:49	12.2	48.7
October	7:09	5:59	10.8	37.3
November	7:47	5:25	9.6	28.1
December	8:14	5:22	9.1	24.7

**Data were collected on the 21st day of each month.*

STUDENT SHEET 6.1

ANTICIPATION GUIDE: SUNLIGHT AND SEASONS

Before starting the activity, mark whether you agree (+) or disagree (—) with each statement below.

After completing the activity, mark whether you agree (+) or disagree (—) with each statement below. Under each statement, explain how the activity gave evidence to support or change your ideas.

BEFORE AFTER

______ ______ 1. The Sun is higher in the sky in summer than in winter.

______ ______ 2. Earth orbits the Sun every 24 hours.

______ ______ 3. The Northern and Southern Hemispheres experience the same seasons at the same time.

______ ______ 4. Earth has a tilt relative to its orbital plane around the Sun.

______ ______ 5. Earth is farther away from the Sun in the winter season than at any other time of the year.

______ ______ 6. Other planets besides Earth have seasons.

PROCEDURE

Use Student Sheet 6.1, “Anticipation Guide: Sunlight and Seasons,” to prepare for the activities that follow.

1. Review the data in the previous tables: “Daylight Hours and Sun Angle: Year 1” and “Daylight Hours and Sun Angle: Year 2.” These data are typical of would be collected over the course of a year in the United States.
    a. Note: The United States is in Earth’s Northern Hemisphere.
2. Describe what you observe for the:
    a. time of sunrise

    b. time of sunset

    c. length of daylight

    d. highest angle of the Sun in the sky

3. Compare the patterns you described in Step 2 to see if any of the patterns are similar to one another. Record your observations below.

4. Working as partners, one person should use Student Sheet 6.2a, “Graph of Daylight Length and Sun Angle vs. Month: Year 1,” to prepare a scatterplot graph of daylight length and the Sun’s highest angle vs. month based on the data in the table “Daylight Hours and Sun Angle: Year 1.” The other partner should use Student Sheet 6.2b, “Graph of Daylight Length and Sun Angle vs. Month: Year 2,” to prepare a similar scatterplot graph based on the data in the table “Daylight Hours and Sun Angle: Year 2.” Agree on which color to use to plot daylight length and which color to use to plot the Sun’s highest angle.

5. After completing your graph, cut it on the line indicated on your Student Sheet and tape your graph to your partner’s graph.

6. Draw a curve to smoothly connect the points on your combined graph.

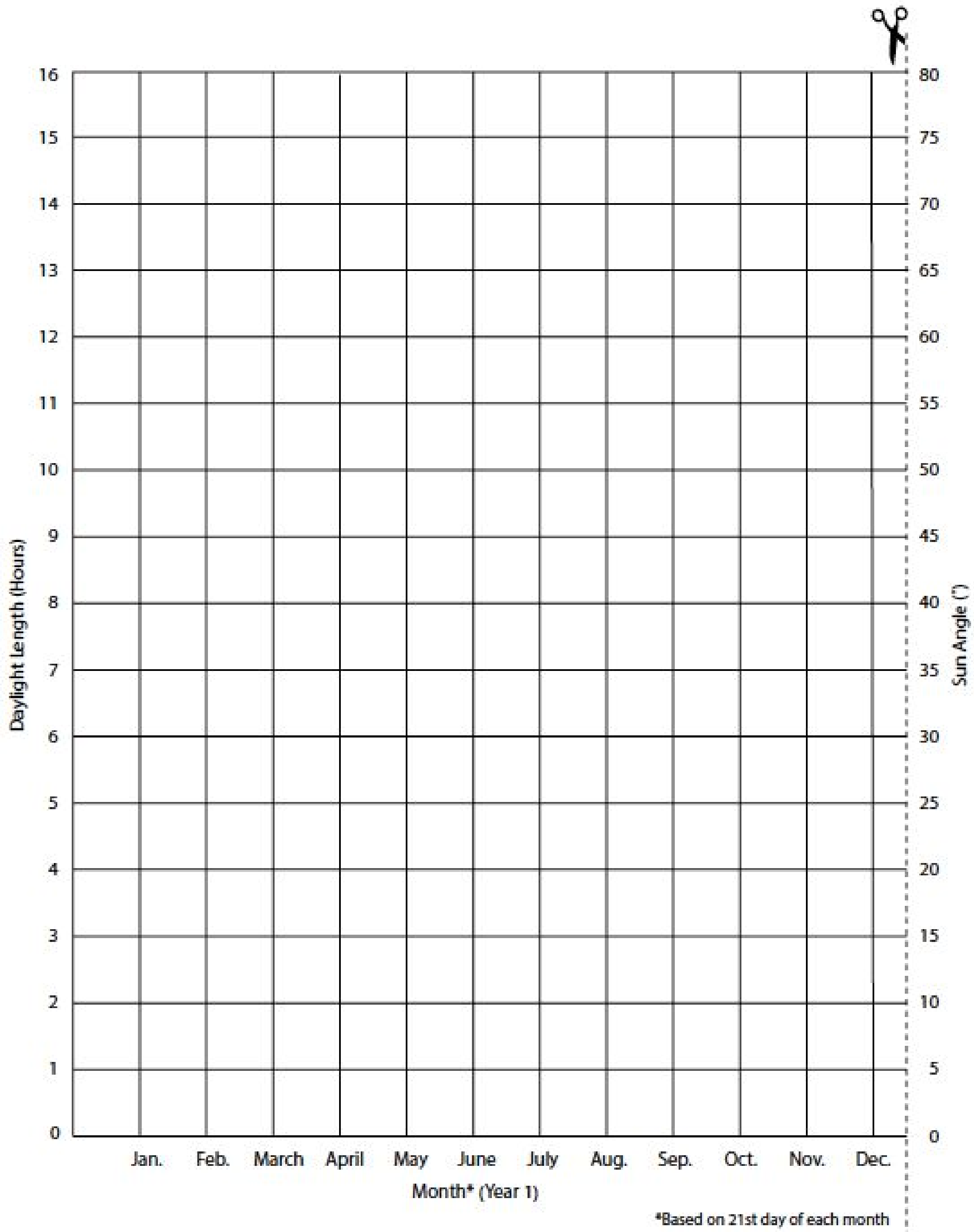
7. Create a key for the curves in your graph (noting which curve is which color).

8. What pattern do you see now that you have graphed the data?

9. Discuss with your partner what the graph might look like if you added data for Year 3.

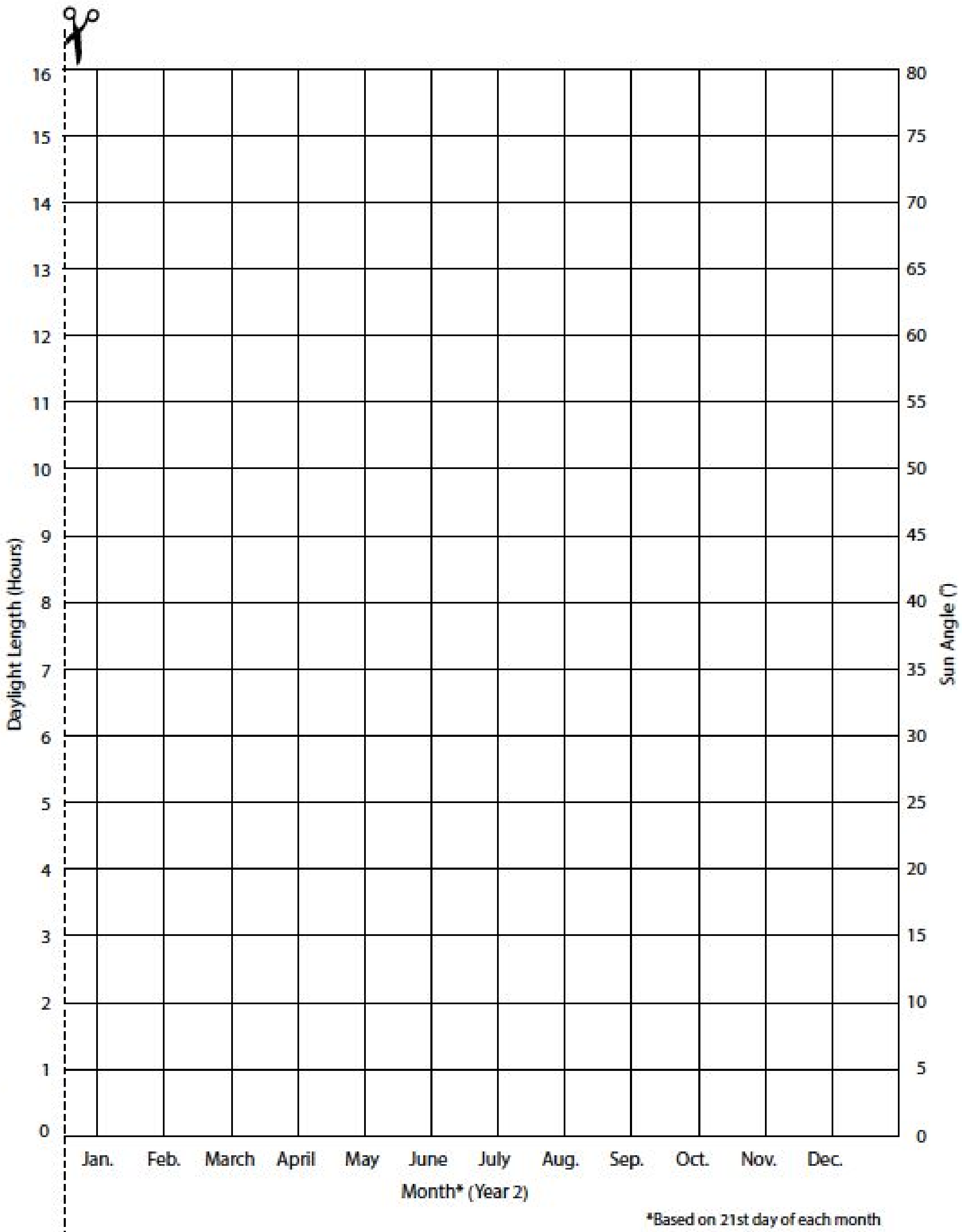
STUDENT SHEET 6.2a

GRAPH OF DAYLIGHT LENGTH AND SUN ANGLE VS. MONTH: YEAR 1



STUDENT SHEET 6.2b

GRAPH OF DAYLIGHT LENGTH AND SUN ANGLE VS. MONTH: YEAR 2



Activity 6 - Changing Sunlight
Analysis Questions

1. Based on your graph, what do you think was the length of daylight for each of the following days?
   a. March 6

   b. July 6

   c. November 6

2. When are the daylight hours
   a. Shortest?

   b. Longest?

   c. about equal to the length of the nighttime hours (12 hours)?

3. When is the Sun
   a. lowest in the sky?

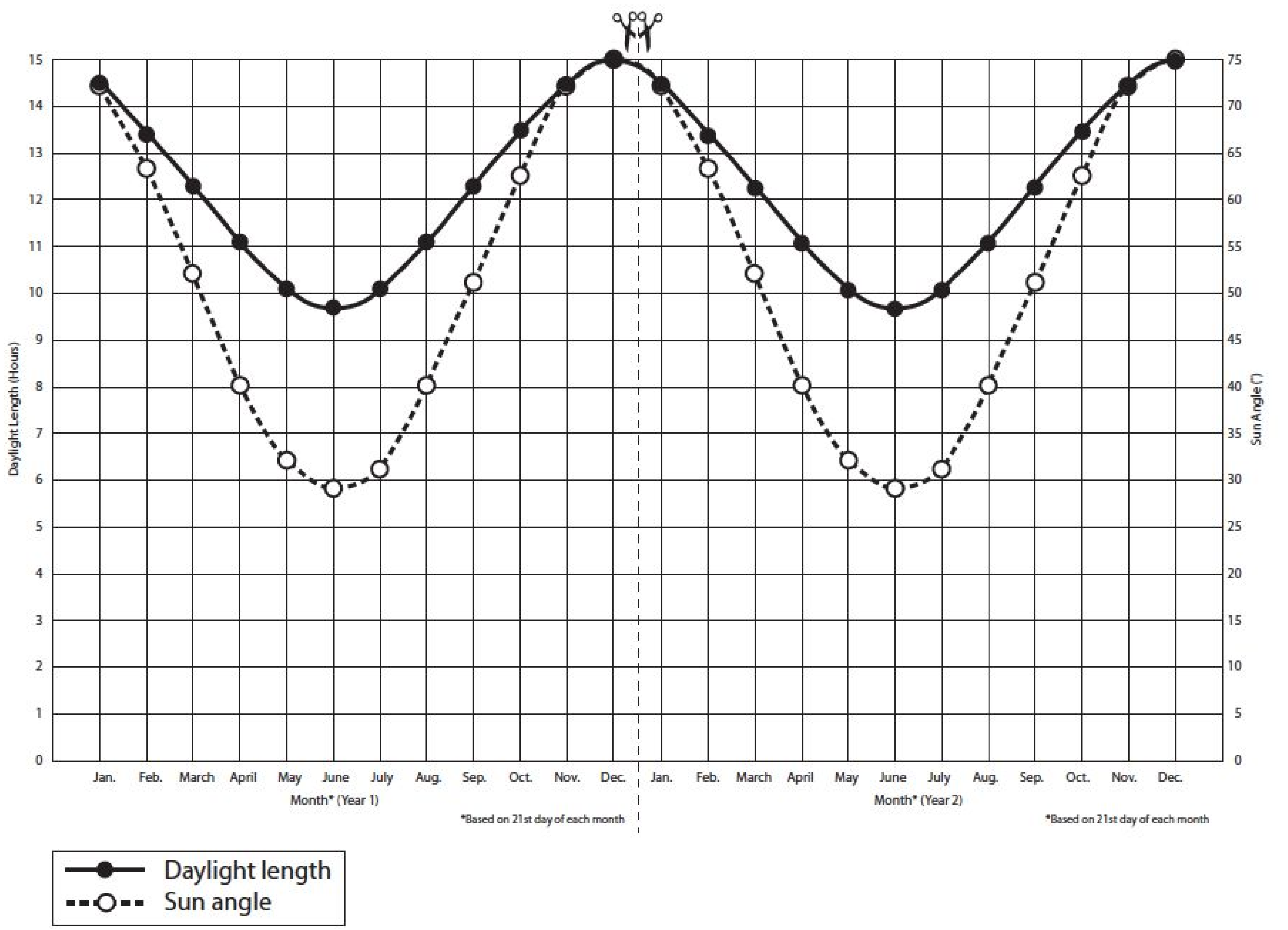
   b. highest in the sky?

4. What is the relationship between the length of daylight and the Sun's angle?

5. How do the Sun's position in the sky and the length of daylight relate to the seasons of the year?
   a. Hint: Look at your graphs and compare the curves at March (beginning of spring), June (beginning of summer), September (beginning of fall), and December (beginning of winter).

6. In the following graph, data from the Southern Hemisphere were collected and graphed as you did in this activity for the Northern Hemisphere.
   a. What differences do you notice between your graphs and this graph?

   b. Are there any dates where the amount of daylight is the same in both the Northern and Southern Hemispheres?



Activity 7 - A Year Viewed From Space

Guiding Question: ***What does Earth's orbit around the Sun have to do with seasons?***

MATERIALS

For each pair of students

- 1 computer with Internet access

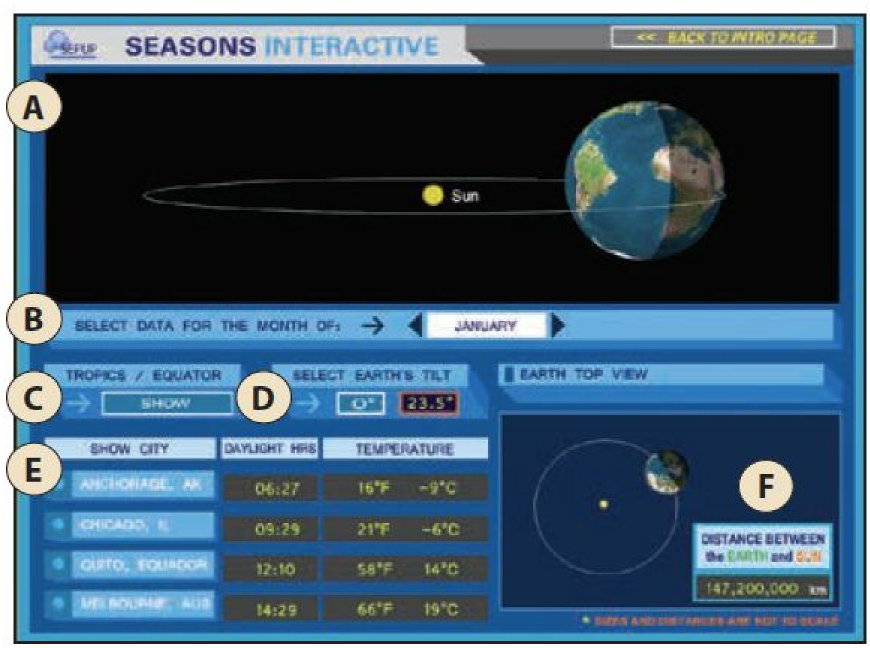
For each student

- 1 Student Sheet 7.1, "Earth's Year Viewed from Space: Side View"
- 1 Student Sheet 7.2, "Earth's Year Viewed from Space: Top View"

PROCEDURE

Part A: Analyzing Data on Earth's Tilt and the Seasons

1. Open the Seasons Interactive Simulation, and review the introduction. Find each of the following on the screen:
    a. North America and the United States
    b. the Northern Hemisphere
    c. the equator
    d. the Southern Hemisphere
2. Begin the simulation by clicking in the "Continue to Interactive" box on the upper right of the screen. Find Earth and the Sun.
    a. Note: The size of Earth and the Sun, and the distance between Earth and the Sun, are not to scale.
3. Use the following diagram to find and set the six noted items on the screen:



(A) **EARTH SIDE VIEW** shows Earth and its orbit.

(B) **MONTH SETTING:** Use the arrows to move from month to month.

(C) **TROPICS/EQUATOR SETTING:** Make sure this is set to show.

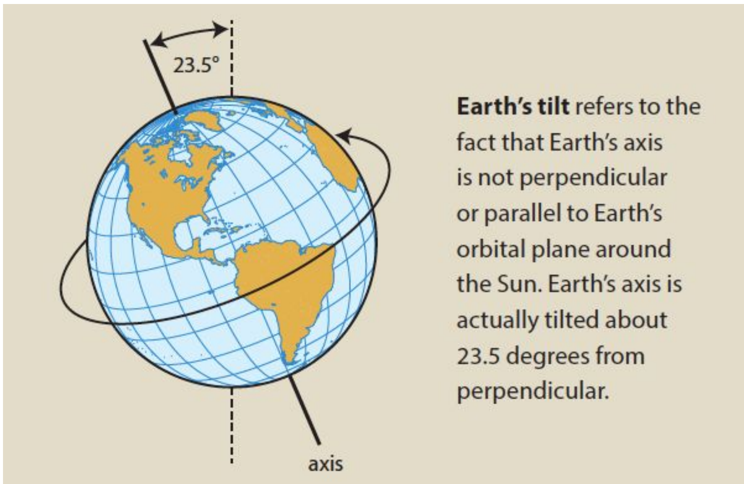
(D) **EARTH'S TILT SETTING:** Make sure this is set to 23.5°, the actual tilt of Earth.

(E) **SHOW CITY BUTTONS:** Try clicking on each of these to see what happens. Then turn them all off.

(F) **EARTH TOP VIEW** shows Earth from above the North Pole in its orbit around the Sun.

4. Compare Student Sheet 7.1, "Earth's Year Viewed from Space: Side View," with the side view of the Sun and Earth at the top of your computer screen.
5. On the simulation, set the month for December, and click on the "Chicago, IL" button under "Show City."
6. Look at the top view and side view of Earth, and record each of the following on Student Sheet 7.1 for December in Chicago:
   - the position of Earth and direction of its tilt

   - the number of daylight hours



7. Repeat Step 6 three more times: once for March, once for June, and once for September.

8. What do you think the number of daylight hours for Chicago would be in December, March, June, and September if Earth had 0 degrees (°) of tilt? Record your ideas below:

9. Change the tilt to 0 degrees, and then describe what happens to daylight hours and temperature in Chicago as you change the months of the year and as Earth orbits around the Sun.
10. Return the tilt to 23.5 degrees. Now click on "Melbourne, Aus." Notice that Melbourne is in the Southern Hemisphere. Explore its daylight hours as you change the months. Record the following:
    a. Melbourne's average daylight length in December and June

    b. Melbourne's average temperature in December and June

Part B: Analyzing Data on the Earth-Sun Distance

11. In the simulation, look at the "Earth Top View." Notice how the distance from Earth to the Sun is displayed in kilometers at the bottom right corner.

12. Many people claim that Earth's seasons are caused by changes in Earth's distance from the Sun during different times of year.
    a. Write down whether you agree or disagree with this claim. Discuss why you agree or disagree with your partner.

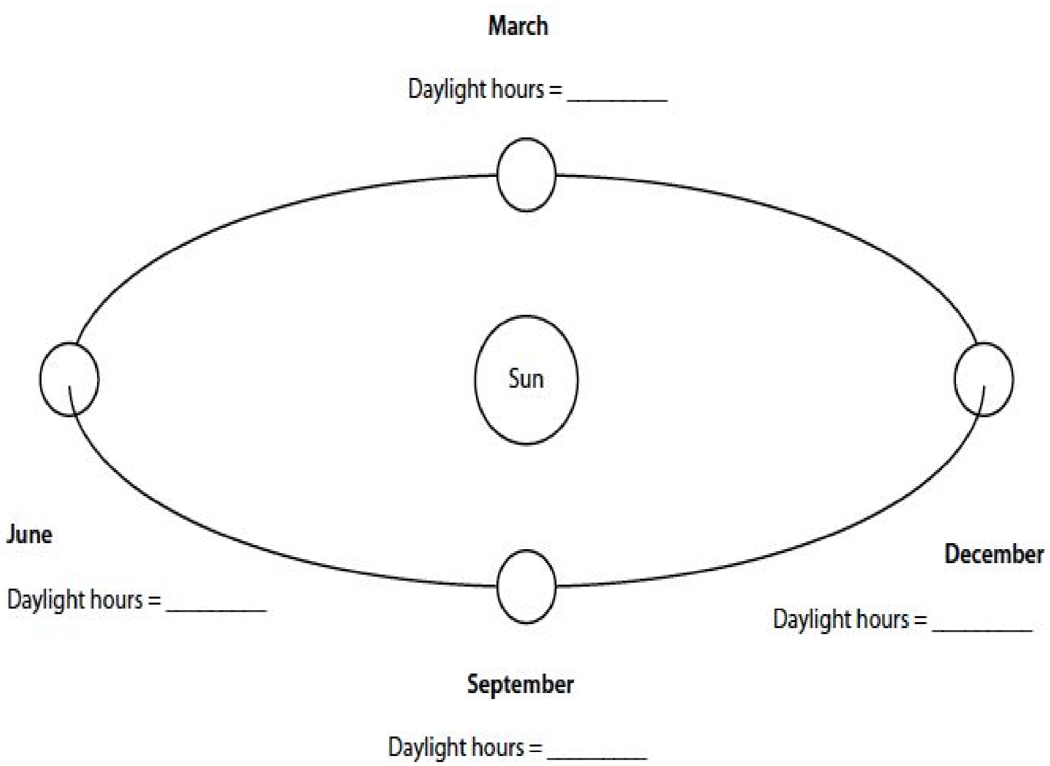
13. Set the month to December, the beginning of winter in the Northern Hemisphere. Record the distance from Earth to the Sun and the average temperature in the appropriate spaces on Student Sheet 7.2, "Earth's Year Viewed from Space: Top View."

14. What do you think the distance from Earth to the Sun will be at the start of spring (March)? of summer (June)? of fall (September)? Discuss your predictions with your partner.

15. Repeat Step 13 for March, June, and September. Did the data support or go against your predictions?

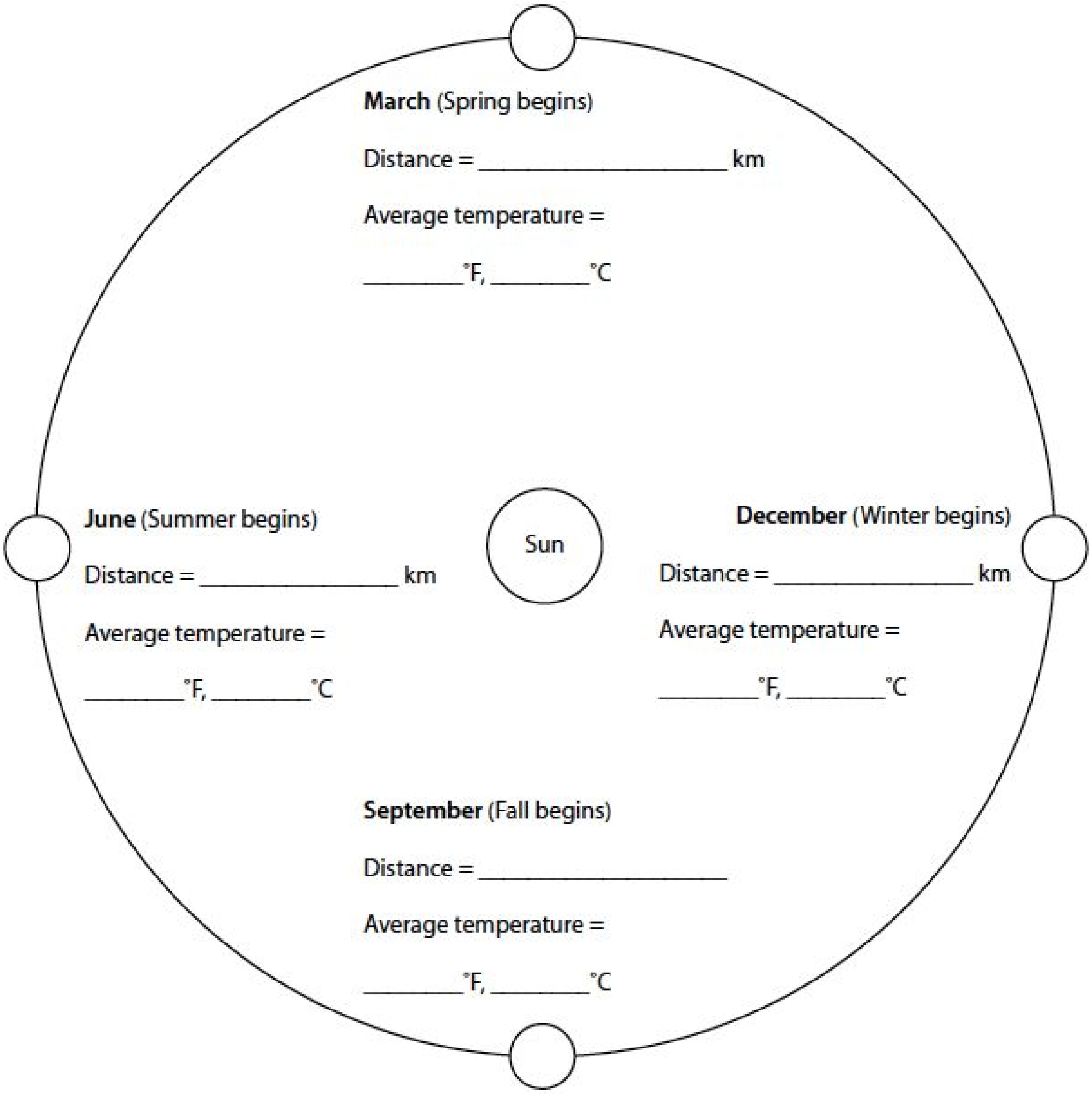
STUDENT SHEET 7.1

EARTH'S YEAR VIEWED FROM SPACE: SIDE VIEW



STUDENT SHEET 7.2

EARTH'S YEAR VIEWED FROM SPACE: TOP VIEW



Activity 7 - A Year Viewed From Space
Analysis Questions

1. In what month is the Northern Hemisphere most tilted toward the Sun?

2. In what month is the Northern Hemisphere most tilted away from the Sun?

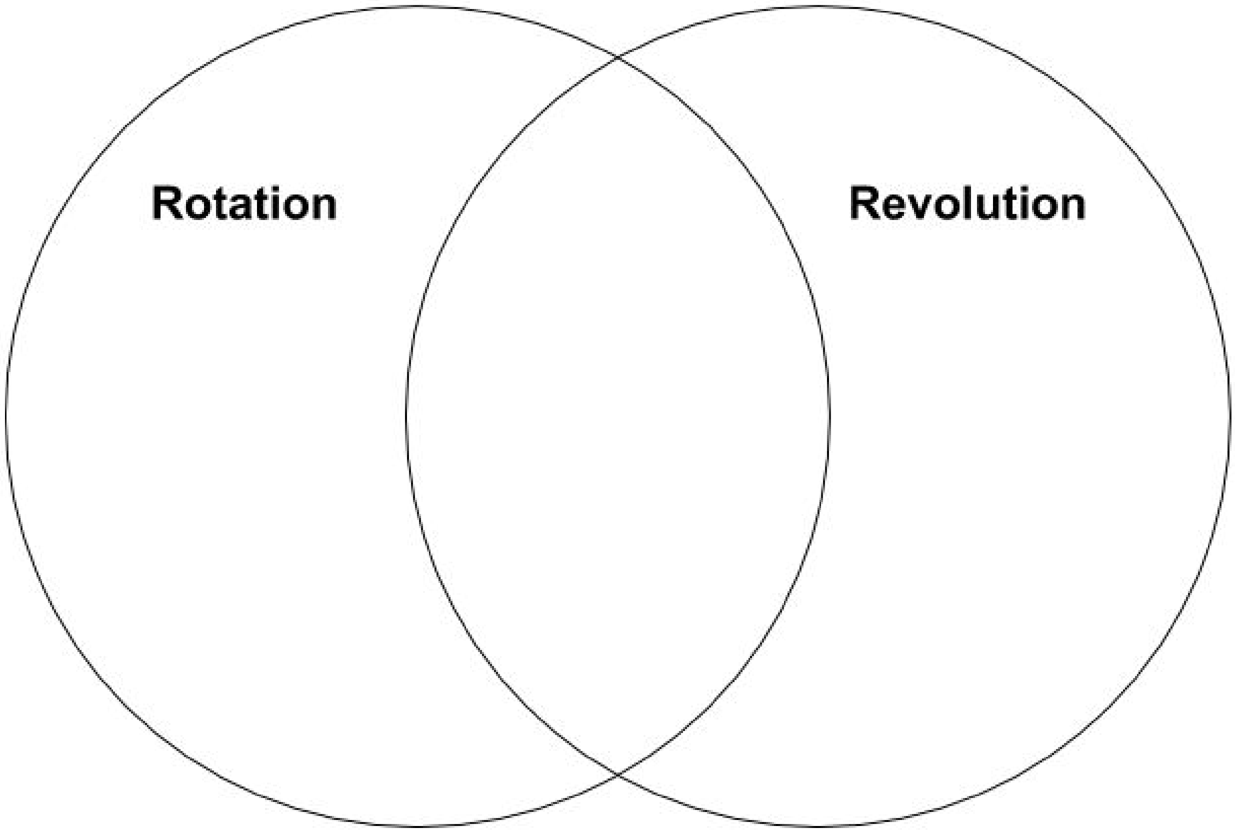
3. Using what you learned from the computer simulation, explain how Earth's tilt affects the seasons and daylight length.

4. Does Earth's tilt change over the course of a year? Explain.

5. In which month(s) is Earth
    a. closest to the Sun?

    b. farthest from the Sun?

6. Based on what you have observed about the distance from Earth to the Sun, does the distance from Earth to the Sun determine the seasons? Explain using evidence from this activity.


Rotation
Revolution

<u>Activity 8 - Earth's Tilt</u>

<u>Guiding Question:</u> ***<u>Why does Earth's tilt cause different places on Earth to receive different amounts of energy from the Sun?</u>***

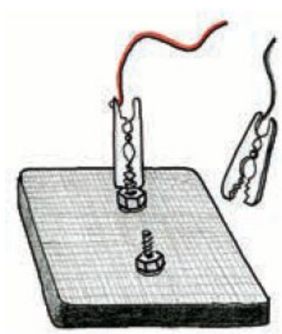
<u>MATERIALS</u>

For each group of four students

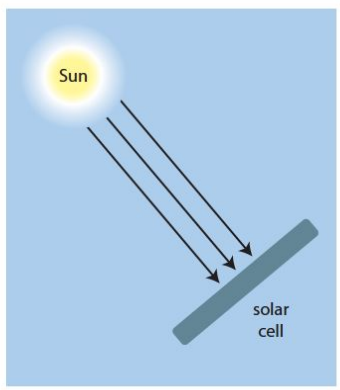
- 1 solar cell
- 1 electric motor with flag on axle
- 2 wire leads with alligator clips (1 red wire and 1 black wire)

For each student

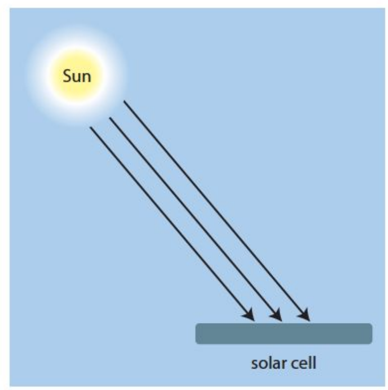
1 Science Skills Student Sheet 7, "Analyzing Models"



Back of solar cell



Position A



Position B

PROCEDURE

1. Complete the following table. Make sure to explain all parts of the model: the solar cell, sunlight, and the motor.

<u>Part of the Model</u>	***<u>Represents which part of the Real World</u>***
Solar Cell	
Sunlight	
Motor	

2. Work with your group to connect the solar cell to the electric motor with the wires.

3. Hold the solar cell so it directly faces the Sun, as shown in Position A above. Observe what happens to the motor and record it below.

4. Gradually tilt the solar cell so that it still gets sunlight but does not directly face the Sun, as shown in Position B above.

5. What happens to the speed of the motor?

Activity 8 - Earth's Tilt
Analysis Questions

1. When you tilted the solar cell from Position A to Position B, what effect did it have on the speed of the motor attached to the solar cell?

2. What does your answer to Analysis item 1 tell you about the amount of the Sun's energy transferred to the solar cell in the two different positions? Be sure to give a complete explanation.

3. Why is the Northern Hemisphere warmer when it is tilted toward the Sun?

4. Why is it summer in December and winter in July in the Southern Hemisphere? Explain using evidence from this activity.

5. **Reflection:** How did each of the following system models help you understand how Earth's tilt causes the seasons?
   - the computer simulation
   - the globe and flashlight model
   - the solar cell and motor model

Activity 9 - Earth on the Move

Guiding Question: ***Why does Earth have seasons?***

STUDENT SHEET 9.1

THREE-LEVEL READING GUIDE: EARTH ON THE MOVE

1. Put an X next to the statements below that you believe agree with what the reading says. Sometimes the exact words found in the reading are used. At other times, other words may be used to communicate the same meaning.

_______ a. Earth is closer to the Sun in December than it is in June.

_______ b. In the United States, sunlight is less direct in December than in June.

_______ c. Only the Northern Hemisphere has seasons.

2. Put an X next to the statements below that you believe represent the intended meaning of the reading.

_______ a. Sunlight that hits Earth more directly heats Earth's surface more than less-direct sunlight does.

_______ b. The effects of Earth's tilt are far more significant than the effects of changes in distance from the Sun in determining the seasons.

_______ c. If Earth were tilted even more, it would always be winter.

_______ d. The orbit of Earth around the Sun is almost circular.

_______ e. When it is spring in the Northern Hemisphere, it is fall in the Southern Hemisphere.

3. Put an X next to the statements below that you agree with, and be ready to support your choices with ideas from the reading and from your own knowledge and beliefs.

_______ a. If Earth were not tilted, the northern United States would be just as warm as the southern United States.

_______ b. If the Sun was out for more than 12 hours in the Northern Hemisphere, then it was out for less than 12 hours in the Southern Hemisphere.

<u>Activity 9 - Earth on the Move</u>
<u>Analysis Questions</u>

1. Prepare a labeled diagram that includes a caption to explain how Earth's tilt and its orbit around the Sun cause each of the following:
   a. changes in the angle of sunlight hitting Earth's surface.
   b. the seasons in the Southern Hemisphere to be opposite the seasons in the Northern Hemisphere.

2. In the Northern Hemisphere, the four seasons in a calendar year are in the order of winter, spring, summer, fall. The seasonal cycle then begins to repeat with winter near the end of the calendar year.
   a. What order are the seasons in the Southern Hemisphere during a calendar year?

   b. Explain how your answer to 2a provides evidence against the claim that seasonal changes are due to Earth's distance from the Sun.

3. The Cassini mission sent a spacecraft to Saturn. One of the goals of the mission was to learn more about the seasonal changes observed on Saturn. Even though Saturn receives about 1% of the amount of sunlight on its surface as Earth receives, it still has seasons. Why do you think Saturn has seasons?

4. **<u>Reflection:</u>** Review your initial ideas about the seasons that you recorded on Student Sheet 6.1, "Anticipation Guide: Sunlight and Seasons (p. 47)" How have your ideas about the cause of seasons changed since you began this unit? Complete p. 47 with your new understanding.

SECTION **2.1** | EARTH ROTATES ON A TILTED AXIS AND ORBITS THE SUN.

Reading Study Guide A

BIG IDEA Earth and the Moon move in predictable ways as they orbit the Sun.

KEY CONCEPT Earth rotates on a tilted axis and orbits the Sun.

Vocabulary

axis of rotation an imaginary line about which Earth turns
revolution the motion of one object around another
season patterns of temperature changes and weather trends over the course of a year
equinox occurs when sunlight shines equally on the northern and southern hemispheres
solstice occurs when the amount of sunlight is greatest in one hemisphere and least in the other

Review

1. If the sentence is true, write *true*. If the sentence is false, change the underlined word or words to make the sentence true.

Earth orbits Saturn. ____________________

The Sun is very far from Earth. ____________________

Because the Sun turns, stars seem to rise and set. ____________________

Take Notes

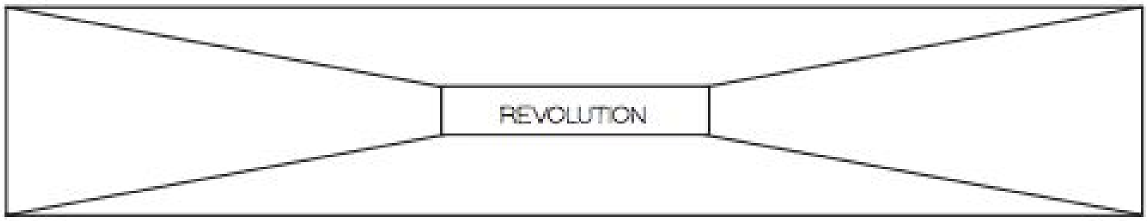
I. Earth's rotation causes day and night. (p. 43)

2. Fill in the combination notes for the main idea shown.

Notes	Sketch
As Earth turns, so do you. • You keep the same position on Earth. • Earth rotates around its axis of rotation. • The ends of the axis are ____________. At any one time, half of Earth's surface is in sunlight. • The amount of time it takes Earth to turn once on its axis is ____________. • When a location is in sunlight, it is ____________.	

II. Earth's tilted axis and orbit cause seasons. (p. 45)

3. Fill in the frame game diagram for *revolution*.



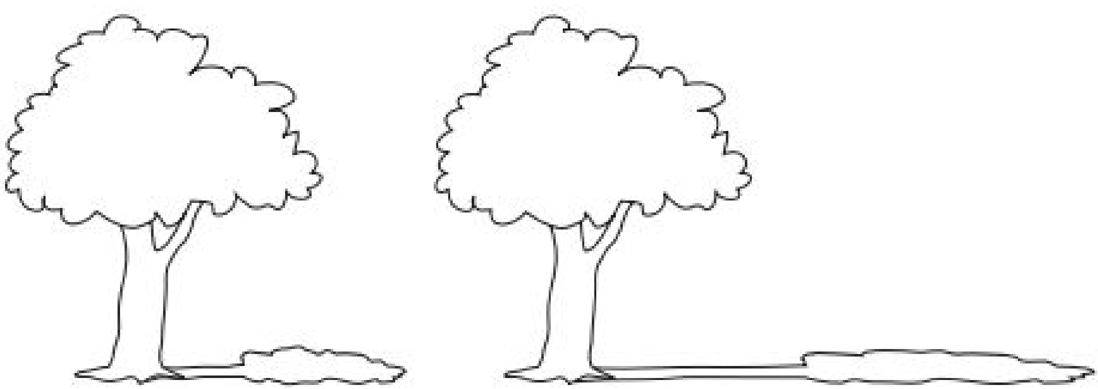
A–B. Seasonal Patterns, Angles of Sunlight, and Lengths of Days (p. 46)

4. Fill in the combination notes for the main idea shown. Decide what to sketch to help you see the angle of sunlight.

Notes	Sketch
Seasons are patterns of • temperature changes • other weather trends Temperature changes occur because • the amount of sunlight at ________________ ________________________ • changes in the amount of sunlight are due to ________________________	

5. One picture below was taken in winter, the other in summer. Both pictures were taken at 2:00 P.M. Which has a longer shadow? Which was taken in winter?

____



MISSION TO MARS (Rocket Team)

Although NASA's manned mission to Mars is not scheduled until 2030, preparations and testing to achieve this historic goal are now underway. In fact, robotic devices and rovers have been sending back data that will help future human explorers for almost 40 years. Astronauts aboard the International Space Station, ISS, are testing new technologies and communications equipment needed for deep space missions to Mars. Also, the effects on the human body continue to be monitored. By 2020, NASA will be testing the most powerful rocket ever, the Space Launch System.

Next, NASA plans on directing an asteroid towards the moon. In the next ten years, these astronauts will travel on the Orion Spacecraft and will send back samples from the asteroid back to Earth. In addition, Solar Electric Propulsion systems will send cargo as part of human missions. Finally, our next step in human exploration will take place, living and working on MARS!

Your mission will be to successfully launch a rocket with a payload and retrieve the payload without injury.

To help with your design and your understanding of how such vehicles work, you will research bottle rockets (try the NASA website) and Newton's Three Laws of Motion. You will also relate Newton's laws as to how they will affect the motion of the rocket and the lander.

ROCKET PROPULSION ENGINEERS

____ (Task Manager: Procedure)
____ (Technical Director: Research)
____ (Safety Director: Drawing/Design)
____ (Materials Manager: Build)

ENTRY, DESCENT, and LANDING ENGINEERS

____ (Task Manager: Procedure)
____ (Technical Director: Research)
____ (Safety Director: Drawing/Design)
____ (Materials Manager: Build)

STATEMENT OF NEWTON'S THREE LAWS OF MOTION:
(6 points)

1. ____

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2. ____

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3. ____

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Why are these considered laws and not theories? (4 points)

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FOR ROCKET DESIGN ENGINEERING TEAM:

ASK: What do you already know? What do you need to know to get started and where can you find the information that you need?
(3 points)

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HYPOTHESIS (If, Then, Because) (3 points):

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PLAN: Choose an idea. Draw a model below of what you will do and label it. Some models may need several diagrams. **(10 points)**

POSSIBLE MATERIALS: 2- liter soft drink bottle, poster board, cardboard, masking tape, clay, safety goggles, your imagination

List material that you will use for the rocket. **(2 points)**

Procedure: What are your steps? List the steps in number order that you used to build your rocket. Use your drawing to guide your plan.
(10 points)

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RESULTS:

Data Table # 1 (3 points)

Distance to Launchpad	Angle of Rocket	Height of Rocket (m)

How far did your rocket go? Did your payload land successfully? Explain **(2 points)**

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CONCLUSION:

1. Was your hypothesis correct?
   - Restate Hypothesis **(2 points)**
   - Discuss if Hypothesis is correct or not using at least 2 observations and or data **(4 points)**

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2. How could you improve your model? Did you need to start over or redo a part of your model? If it works, can it work even better? **(5 points)**

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3. How do Newton's Laws of motion relate to this lab? **(6 points)**
Law #1:____

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Law #2:____

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Law #3:____

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MISSION TO MARS (Lander Team)

Although NASA's manned mission to Mars is not scheduled until 2030, preparations and testing to achieve this historic goal are now underway. In fact, robotic devices and rovers have been sending back data that will help future human explorers for almost 40 years. Astronauts aboard the International Space Station, ISS, are testing new technologies and communications equipment needed for deep space missions to Mars. Also, the effects on the human body continue to be monitored. By 2020, NASA will be testing the most powerful rocket ever, the Space Launch System.

Next, NASA plans on directing an asteroid towards the moon. In the next decade, these astronauts will travel on the Orion Spacecraft and will send back samples from the asteroid back to Earth. In addition, Solar Electric Propulsion systems will send cargo as part of human missions. Finally, our next step in human exploration will take place, living and working on MARS!

Your mission will be to successfully launch a rocket with a payload and retrieve the payload without injury.

To help with your design and your understanding of how such vehicles work, you will research bottle rockets (try the NASA website) and Newton's Three Laws of Motion. You will also relate Newton's laws as to how they will affect the motion of the rocket and the lander.

ROCKET PROPULSION ENGINEERS

____ (Task Manager: Procedure)
____ (Technical Director: Research)
____ (Safety Director: Drawing/Design)
____ (Materials Manager: Build)

ENTRY, DESCENT, and LANDING ENGINEERS

____ (Task Manager: Procedure)
____ (Technical Director: Research)
____ (Safety Director: Drawing/Design)
____ (Materials Manager: Build)

STATEMENT OF NEWTON'S THREE LAWS OF MOTION: (6 points)

1. ____

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2. ___

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3. ___

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Why are these considered laws and not theories? (4 points)

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FOR ENTRY, DESCENT and LANDING ENGINEERS:

ASK: What do you already know? What do you need to know to get started and where can you find the information that you need?
(3 points)

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HYPOTHESIS (If, Then, Because) (3 points):

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PLAN: Choose an idea. Draw a model below of what you will do and label it. Some models may need several diagrams. **(10 points)**

POSSIBLE MATERIALS: 2- liter soft drink bottle, poster board, cardboard, masking tape, clay, safety goggles, your imagination

List material that you will use for the lander. **(2 points)**

Procedure: What are your steps? List the steps in number order that you used to build your lander. Use your drawing to guide your plan.
(10 points)

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RESULTS:

Data Table # 1 (3 points)

Distance to Launchpad	Angle of Rocket	Height of Rocket (m)

How far did your rocket go? Did your payload land successfully? Explain **(2 points)**

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CONCLUSION:

1. Was your hypothesis correct?
    - Restate Hypothesis **(2 points)**
    - Discuss if Hypothesis is correct or not using at least 2 observations and or data **(4 points)**

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2. How could you improve your model? Did you need to start over or redo a part of your model? If it works, can it work even better? **(5 points)**

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3. How do Newton's Laws of motion relate to this lab? **(6 points)**

Law #1:

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Law #2:

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Law #3:

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Mission to Mars Design Rubric

Team Members: ____ Rocket Team or Lander Team

Mission to Mars Scientific Method Design	Points	Earned Points
Research: Newton's Three Laws Statements	6	
Theories vs. Laws	4	
Ask: What do I need to get started? What do I already know about rocket design? Where can I find the information I need?	3	
Hypothesis ● Clear Hypothesis, Complete: If, Then, Because, Explains Why	3	
Plan/Model Design: Labeled, Colored, Complete	10	
Materials List Complete	2	
Procedure: Numbered, Detailed	10	
Statement of Results: ● Data Table Complete (3) ● Answers Question (2)	5	
Conclusion: ● Restate Hypothesis (2) ● Discuss if Hypothesis is correct or not using at least 2 observations or data (4) ● How could you improve your model? Did you need to start over or redo a part of your model? If it works, can it work even better? (5)	11	
Conclusion: Relation to Newton's Laws	6	

Total Points for Design	60	
Success of Mission to Mars Rocket and Lander		
Payload detaches	5	
Egg Safe	5	
Final Grade	70	

NASA Project Manager Comments:

SECTION **1.2** | TELESCOPES ALLOW US TO STUDY SPACE FROM EARTH.

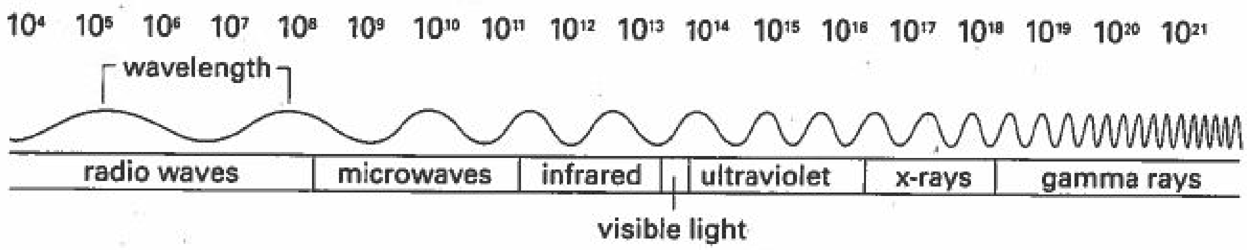
Challenge and Extension

BIG IDEA People develop and use technology to explore and study space.

KEY CONCEPTS Telescopes allow us to study space from Earth.

Wavelength and Frequency Electromagnetic waves differ in frequency as well as wavelength. The frequency of a wave is the number of wavelengths that pass a fixed point in a certain amount of time. If one peak of a wave passes a fixed point in one second, the wave has a frequency of one cycle per second, or one hertz (Hz). The higher the frequency of a wave, the higher its level of energy.

The diagram below shows the different forms of electromagnetic radiation and their ranges of frequency. Use the diagram to help you answer the questions.



1. Which forms of electromagnetic radiation have lower frequencies than visible light?

____

2. Which form of electromagnetic radiation has the highest level of energy? How can you tell?

____

3. What is the relationship between the wavelength of a wave and its frequency?

____

4. If an object in space mainly emits electromagnetic radiation with a frequency of 10^{13}, what type of telescope would be used to obtain images of the object? Explain.

____

A. Visible Light, Infrared, and Ultraviolet Telescopes (p. 17)

3. Describe why powerful telescopes are built on mountaintops in rural areas.

____

B. Radio Telescopes (p. 18)

4. What are the differences between a radio telescope and a visible light telescope?

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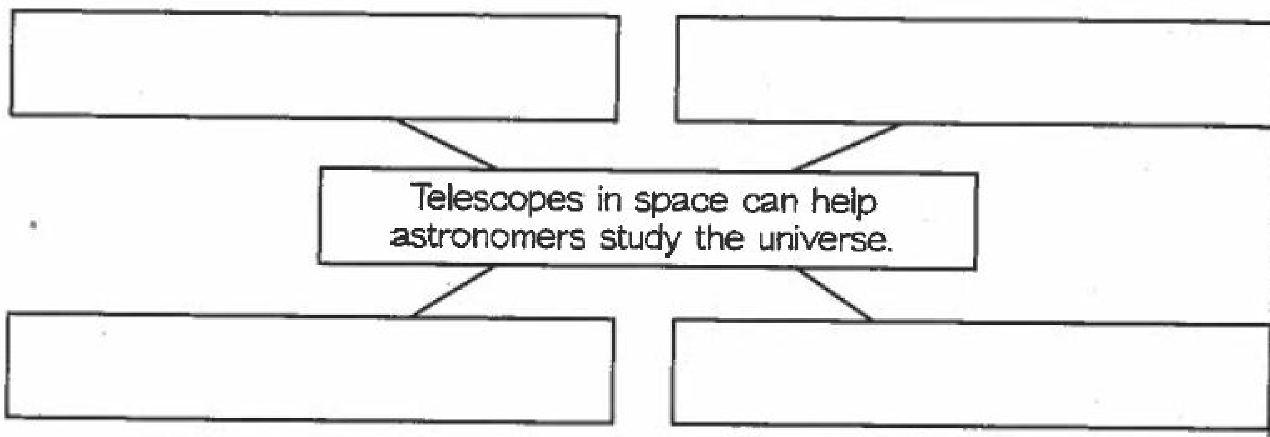
C. Telescopes in Space (p. 18)

5. Fill in the main-idea web for the main idea shown.



Activity 10 - Observing Objects in Space

Guiding Question: ***What types of objects are found in space?***

MATERIALS

For each group of four students

1 set of 6 Space Object Cards

PROCEDURE

1. Each photograph on page 51in the book shows a space object as seen through a camera from Earth.
2. Carefully examine each space object, and think about what it might be. For example, a space object could be a moon, a star, a planet, a galaxy, an asteroid, a comet, an artificial satellite, or something else.
3. Write down:
   a. what you think each object might be.

      1) 4)

      2) 5)

      3) 6)

   b. the order of the objects from smallest to largest.

   c. the order of the objects from closest to Earth to farthest from Earth.

4. In your group, take turns looking at the picture on each of the Space Object Cards. Each of the objects on the Space Object Cards was photographed by a spacecraft or through a powerful telescope. **Do not read the back of the cards at this time.**

5. In your group, match each card to one of the space objects shown on p. 51 in your book.

6. Read the descriptions on the back of each Space Object Card.
7. Add the information from your cards to what you wrote down in Step 3. Revise your ordered lists if you need to.

Activity 10 - Observing Objects in Space
Analysis Questions

1. Were you able to identify any of the space objects before seeing the Space Object Cards? If so, which ones?

2. Did seeing larger and clearer images on the Space Object Cards help you identify some of the space objects? Explain.

3. How did the Space Object Cards help you in Step 7?

4. Astronomy is the oldest science, dating back tens of thousands of years. However, astronomers didn't even know all of the planets in the Solar System until the 1800s. Why do you think that is?

5. How much farther away from the Sun is the farthest space object than the closest space object?
    - Hint: Divide the distance to the farthest object by the distance to the closest object.

6. What are some trade-offs between looking at an object from Earth and sending a spacecraft to investigate the object?

Field Study of the Night Sky

The objects described below are visible with the "naked eye" and can usually be seen on a dark, clear night away from city lights.

STARS are the most common object we see in the night sky. The light from a star comes from so far away that it appears to be a single point of light. Stars seem to "twinkle" because Earth's atmosphere refracts, or redirects, some of the light. Some stars can appear as different colors, such as red, white, or blue. Stars appear to move together across the sky at night.

PLANETS may be difficult to distinguish from stars. If an object in the sky looks like a star but doesn't twinkle as much, it is likely to be a planet. Planets can appear to be different colors. Planets appear as disks when magnified with binoculars or a telescope. Although much smaller than stars, they can appear larger because they are much closer to Earth.

EARTH'S MOON looks like the largest object in the night sky because it is the closest object to Earth. The phase of the Moon changes from night to night. Other planets have moons, but they are too small or too distant for us to see without a telescope.

SATELLITES move quickly across the night sky. Many satellites are seen only around sunrise or sunset. Most satellites take about 90 minutes to orbit Earth.

METEORS are small, bright objects that speed across the sky for a few seconds and appear to leave a trail. Meteors are often mistakenly called "shooting stars" or "falling stars," but they are not stars at all. Meteors are pieces of rock that are falling through the atmosphere and usually burn up before they hit the ground. Meteors that reach Earth's surface are called *meteorites*.

GALAXIES are collections of billions of stars. Only a few galaxies can be seen with the naked eye because most are too far away. To see what a galaxy looks like, look at the Andromeda Galaxy pictured in this activity.

STUDENT SHEET 10.1

NIGHT SKY OBSERVATIONS

Date and Time	Location (sketch or describe)	Size	Brightness	Other Characteristics	What do you think it is?

Activity 11 - Drawing the Solar System

Guiding Question: ***How can a scale model help us understand distances between objects in our Solar System?***

Planets' Distance from the Sun

PLANET	APPROXIMATE DISTANCE FROM THE SUN (km)
Mercury	58,000,000
Venus	108,000,000
Earth	150,000,000
Mars	227,000,000
Jupiter	778,000,000
Saturn	1,429,000,000
Uranus	2,869,000,000
Neptune	4,505,000,000

PROCEDURE

Part A: Distances in the Solar System

1. Using the data in the "Planets' Distance from the Sun" table above and a scale of 1 centimeter (cm) = 200,000,000 km, calculate the relative distances of the planets from the Sun.
   - Hint: To calculate the distance in centimeters, you will need to divide a planet's distance from the Sun in kilometers by the scale.

2. Record the results of your calculations in the table on Student Sheet 11.3, "Scaled Sun-to-Planet Distances." Round your answers to the nearest 0.1 cm.

3. Using the values you just calculated, draw a scale model of the distances on Student Sheet 11.3.
   a. Measuring from the center of the Sun, draw an X on the line where each planet is located.
   b. Record the name of each planet next to its location on the line.

Part B: Diameters of the Planets in the Solar System

4. Look at the diameters of the planets shown in the "Planets' Diameters" table below.

Planets' Diameters

PLANET	APPROXIMATE DIAMETER (km)
Mercury	5,000
Venus	12,000
Earth	13,000
Mars	7,000
Jupiter	143,000
Saturn	120,500
Uranus	51,000
Neptune	49,500

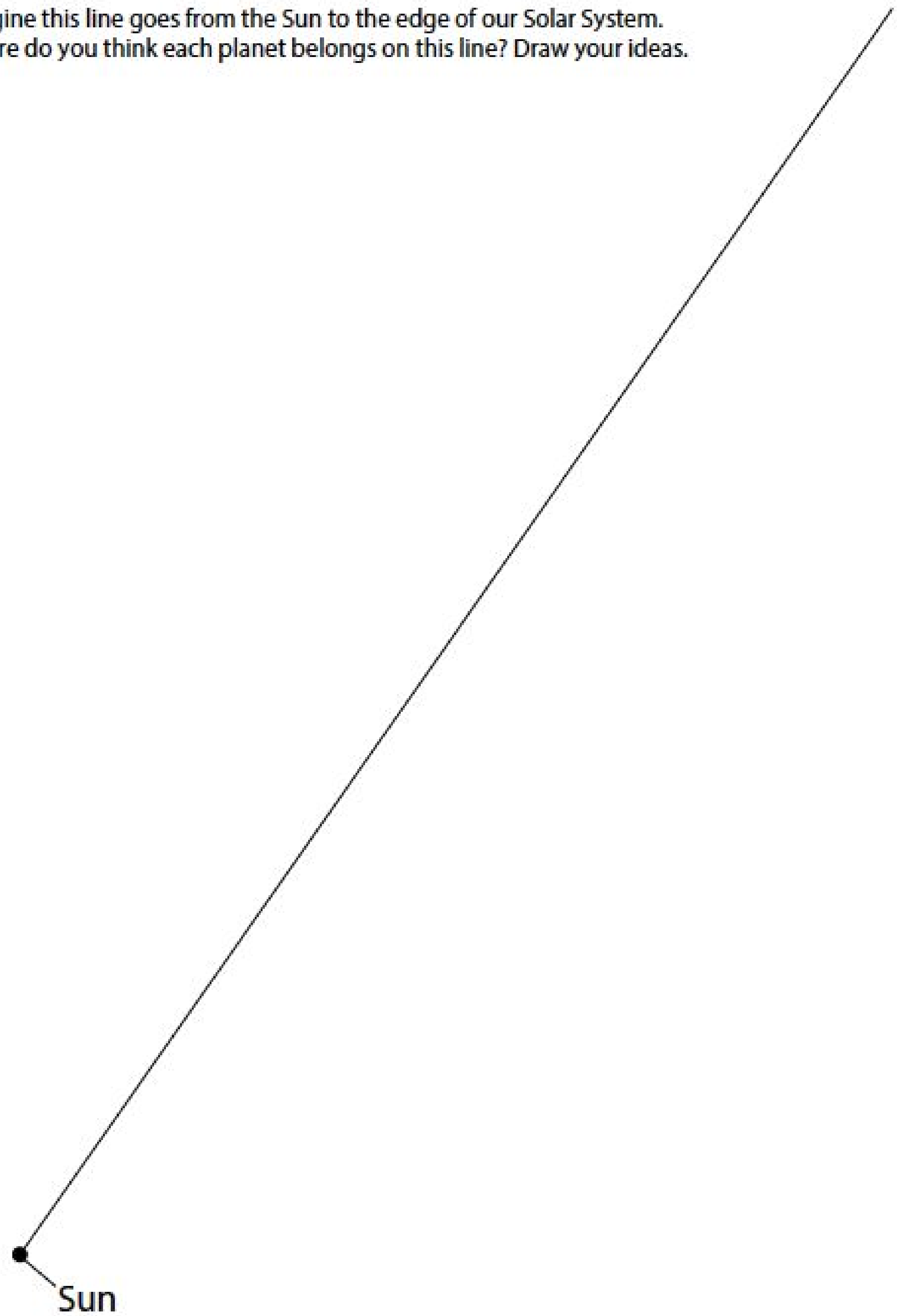
5. In your group, discuss whether the same scale used in Part A can be used to create a scaled drawing of each planet's diameter.
   - Hint: To calculate the diameter in centimeters, you will need to divide a planet's diameter in kilometers by the scale in kilometers (1 cm = 200,000,000 km). Round your answers to the nearest 0.1 cm.

6. With your group, discuss whether the following image of the Solar System is scaled properly. Use your group's response from Step 5 to inform your discussion. Record your ideas below.

STUDENT SHEET 11.1

THE SIZE OF THE SOLAR SYSTEM

Imagine this line goes from the Sun to the edge of our Solar System.
Where do you think each planet belongs on this line? Draw your ideas.



STUDENT SHEET 11.2

THE SIZES OF THE PLANETS

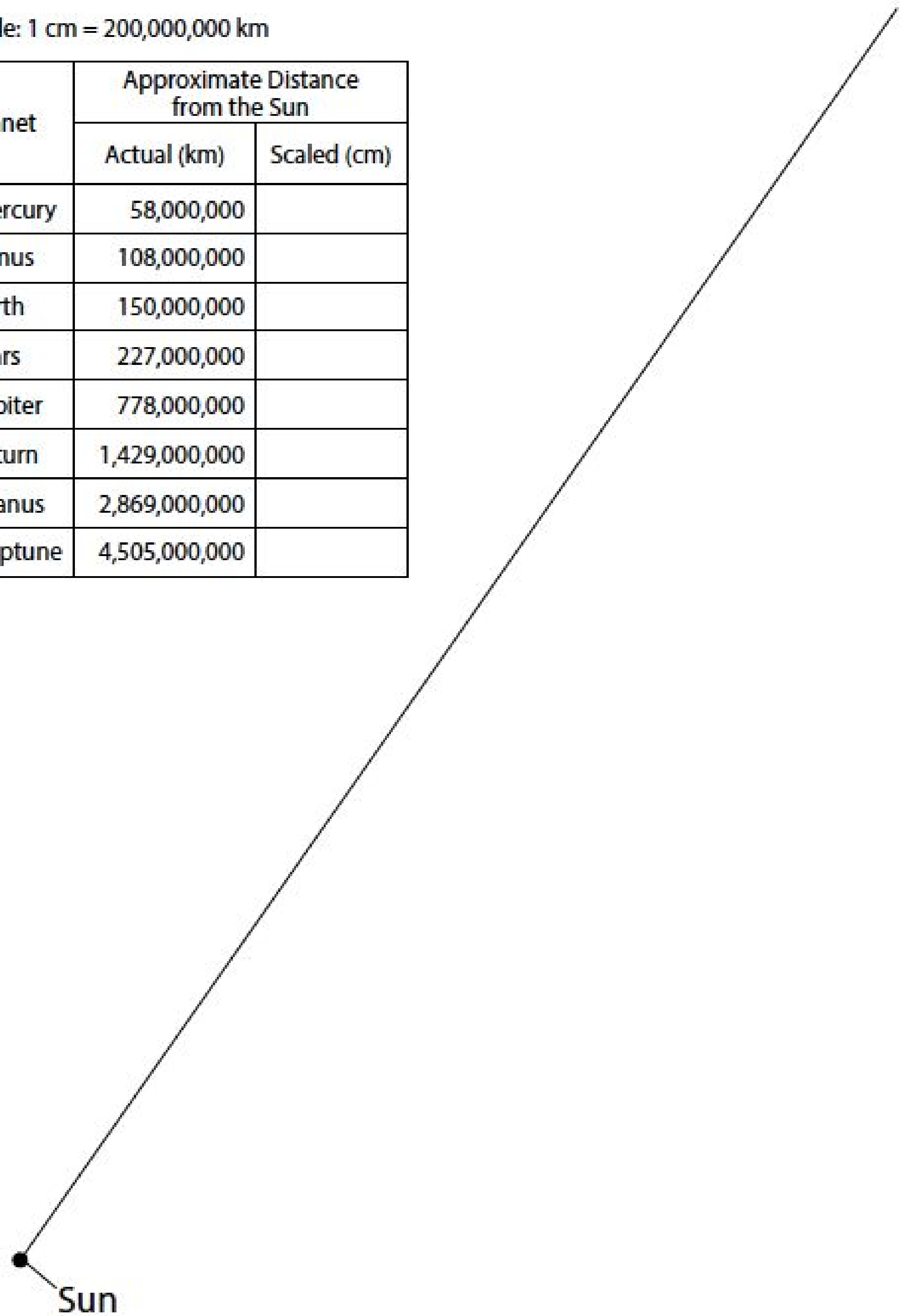
Imagine each planet were small enough to fit on this piece of paper. Draw each of planets. Remember, the planets have different sizes.

STUDENT SHEET 11.3

SCALED SUN-TO-PLANET DISTANCES

Scale: 1 cm = 200,000,000 km

Planet	Approximate Distance from the Sun	
	Actual (km)	Scaled (cm)
Mercury	58,000,000	
Venus	108,000,000	
Earth	150,000,000	
Mars	227,000,000	
Jupiter	778,000,000	
Saturn	1,429,000,000	
Uranus	2,869,000,000	
Neptune	4,505,000,000	



Activity 12 - Drawing the Solar System

Guiding Question: ***How can you make a scale model showing the sizes of all of the planets?***

MATERIALS

For each group of four students

- 9 or 10 spherical objects of varying sizes
- 1 meter stick
- 1 calculator
- 1 set of colored pencils

For each student

- 1 compass
- 1 Student Sheet 11.2, "The Sizes of the Planets" (completed from previous activity)
- 1 Student Sheet 12.1, "Scaled Sizes of the Planets"

PROCEDURE

Part A: Determining a Scale

1. Diameters of the Planets

Planet	Approximate diameter (km)	Scaled diameter (cm)	Diameter of model object (cm)	Calculated percent error
Mercury	5,000			
Venus	12,000			
Earth	13,000			
Mars	7,000			
Jupiter	143,000			
Saturn	120,500			
Uranus	51,000			
Neptune	49,500			

2. With your group, decide on a scale for the diameter of the planets. You will use this scale to find objects that represent the size of the planets in the model. Complete Steps 2a–e to make the scale.
    a. Decide how many kilometers a single centimeter will represent. This is the scale.
    b. Convert the diameters of the smallest and largest planets using the scale. Hint: Divide the diameter in kilometers by the scale in kilometers to get the diameter in centimeters. (How many kilometers will equal 1 cm in your scale?)
    c. If either of the scaled diameters is too big or too small for the ordinary spherical objects you have access to, try creating another scale.
    d. Repeat Steps 2a–c until the group agrees that the scale for the size of the smallest and largest planets is reasonable.
    e. Record the scale in your science notebook.

3. Using the scale you made and the data in the table, calculate the scaled diameters of all the planets. Record these in your table.

Part B: Making the Model

4. With your group, use your work from Part A to create accurate models of the planets using round objects you find at home and school. Gather objects with diameters that are similar to the scaled diameters you recorded in Step 3.

5. Measure the actual diameters of the objects, and record them in your table.

6. Using the following equation, determine the percent error between each model planet's measured diameter and that planets scaled diameter. This percentage will help you determine how precise your scale is in representing the actual diameter of the planets. A percentage closer to zero is more precise.

$$\%\ \text{error} = \frac{(\text{scaled diameter} - \text{diameter of model object})}{\text{scaled diameter}} \times 100\%$$

7. With your group, prepare a presentation of your model. Make sure your presentation explains
    a. the scale you used.
    b. which object models which planet.
    c. any inaccuracies in your model.

STUDENT SHEET 12.1

SCALED SIZES OF THE PLANETS

Scale: 1 cm = _______________ km

Planet	Planet diameter (smallest to largest)	
	Actual (km)	Scaled (cm)
Mercury	5,000	
Mars	7,000	
Venus	12,000	
Earth	13,000	
Neptune	49,500	
Uranus	51,000	
Saturn	120,500	
Jupiter	143,000	

● C

Activity 12 - Drawing the Solar System

Analysis Questions

1. Which planet in your model is most accurate to your scale? Which planet is least accurate? Explain your reasoning.

2. The diameter of the Sun is about 1,390,000 km.
    a. Convert the Sun's diameter to the scale of your model.
    b. Are there any objects that could be used in your model to represent the Sun? Give an example or explain why not.

3. Complete Student Sheet 12.1, "Scaled Sizes of the Planets," using a different-colored pencil for each planet.
    a. Find a scale that allows you to accurately draw the smallest and largest planets on the paper.
    b. Record the scale on Student Sheet 12.1.
    c. Convert all the diameters of the planets to the scale. Record them in the table.
    d. Use a compass to draw the scaled planets as circles inside circles with all planet centers being Point C. To draw each planet, adjust the compass to one half the planet's scaled diameter.
    e. Label each planet with its name.

4. Mercury, Venus, Earth, and Mars are all rocky planets. Jupiter, Saturn, Uranus, and Neptune are gaseous planets. Looking at Student Sheet 12.1, what similarities and differences do you notice between the two types of planets?

5. Reflection: How did your understanding of the relative sizes of planets change as you completed this activity? Refer to your drawings on Student Sheet 11.2, "The Sizes of Planets," and Student Sheet 12.1.

Activity 13 - Identifying Planets

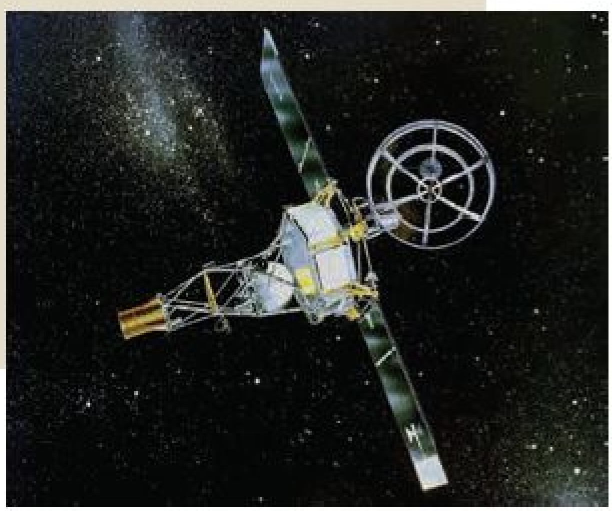
Guiding Question: ***What features make each planet in our Solar System unique?***

PROCEDURE

1. Read the following four transmissions of information from the different spacecraft.
2. Choose one of the transmissions, and carefully compare the descriptions in it with the information provided on Student Sheet 13.1, "Planet Information."
    a. Hint: It can be helpful to add marks to Student Sheet 13.1 to any planet that meets the description of the transmission.
3. With your partner, decide from which planet the transmission was sent.
4. Record the name of the spacecraft that sent the transmission and the name of the planet it was visiting.
5. List the evidence in the transmission that helped you decide which planet the transmission came from.
6. Repeat Steps 2–5 for the other three transmissions.

Transmission from Mariner 2

This planet's mass is very similar to Earth's mass. It takes over 7 Earth-months for this planet to complete an orbit around the Sun. The average temperature here is much hotter than Earth's average temperature.



Scientists measured the temperature of this planet's atmosphere for the first time during the Mariner 2 mission.

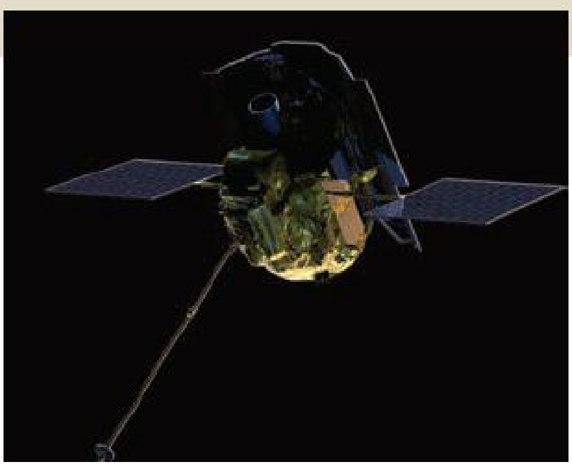
Transmission From Voyager 2

The diameter of this planet is about four times as large as Earth's diameter, and it takes over 50 Earth-years to orbit the Sun. The temperature of this planet is much lower than Earth's average temperature. More than 20 moons orbit this planet, and this planet has rings.

The Voyager 2 spacecraft was the first to visit this planet. While there, it discovered 10 new moons.

Transmission From MESSENGER

There are only two planets that ever get closer to Earth than this one. While its surface temperature is hot, it is not the hottest planet in the Solar System. This planet does not have any rings.



The MESSENGER mission discovered frozen water at the planet's north pole.

Transmission From Juno

This gaseous planet has rings and is colder than Mars but warmer than Uranus. Its diameter is about three times as large as the diameter of Neptune. This planet also has many moons.

On a close fly-by of this planet, the Juno spacecraft discovered that there are huge cyclone storms in the atmosphere at the poles. Some are 1,400 km wide!

Transmission from Mariner 2:

- Planet it is visiting:
- Evidence:

Transmission from Voyager 2:

- Planet it is visiting:
- Evidence:

Transmission from MESSENGER:

- Planet it is visiting:
- Evidence:

Transmission From Juno:

- Planet it is visiting:
- Evidence:

STUDENT SHEET 13.1

PLANET INFORMATION

Planet	Distance from Sun (AU)	Mass (10^{24} kg)	Orbital period (time it takes to orbit the Sun in years)	Diameter (km)	Average temperature (°C)	Number of moons	Has rings	Composition
Mercury	0.39	0.33	.24	4,879	167	0	No	Rocky
Venus	0.72	4.87	.62	12,104	462	0	No	Rocky
Earth	1	5.97	1.00	12,756	15	1	No	Rocky
Mars	1.52	0.64	1.88	6,792	–55	2	No	Rocky
Jupiter	5.20	1898	11.86	142,984	–148	69*	Yes	Gaseous
Saturn	9.58	568	29.46	120,536	–178	62*	Yes	Gaseous
Uranus	19.23	86.8	83.75	51,118	–216	27*	Yes	Gaseous
Neptune	30.10	102	163.73	49,528	–214	14*	Yes	Gaseous

*as of 2017

Activity 13 - Identifying Planets
Analysis Questions

1. Write a transmission from a planet in our Solar System other than those already used in this activity. In your transmission, describe several features that would help someone else identify the planet.

2. Look at the following "Pluto's Properties" table. It contains data related to the dwarf planet Pluto.

PLUTO'S PROPERTIES

Distance from Sun (au)	39.5
Mass (10^{24} kg)	0.0013
Time to complete one orbit (years)	248
Diameter (km)	2,374
Average temperature (°C)	−229
Number of moons	5
Has rings	Maybe
Composition	Rocky and icy

Analyze the data by comparing Pluto with the planets on Student Sheet 13.1, and then answer the following questions:

a. What are the similarities and differences between Pluto and the rocky planets in the Solar System?

b. What are the similarities and differences between Pluto and the gaseous planets in the Solar System?

c. Calculate the scaled sizes of Pluto, Earth, and Jupiter using a scale of 2,374 km = 1 cm.

d. Look at your answers for 2a–c. Why do you think Pluto is not considered a planet?

3. **Reflection:** The surface of Mars has a very rocky and uneven terrain. When designing the Mars Exploration Rovers, scientists and engineers at NASA created a large test area with rock, soil, and sand that matched images of Mars's surface. Engineers working on this mission used the area to test their designs for the wheel systems of the rovers. The rovers were only expected to drive around and collect data on the planet for about 90 days. But both remained operational for several years and drove much farther than expected! How do you think the work of the engineers supported this mission's scientific goals?

Activity 14 - Gravitational Force

Guiding Question: ***What determines the amount of gravitational force between objects?***

PROCEDURE

Part A: Gravitational Force on Different Masses

1. The "Mass and Gravitational Force Data" table shows the gravitational force between Saturn and some objects in Saturn's rings. All of the objects are the same distance (180,000 km) from Saturn's center.

Mass and Gravitational Force Data

MASS OF RING OBJECT (kg)	GRAVITATIONAL FORCE BETWEEN SATURN AND RING OBJECT (IN 10,000 N)
2	23
3	35
4	47
5	58
6	70
7	82
8	93
9	105

2. Use the data in the table to make a graph of the relationship between the ring object's mass in kilograms (kg) and gravitational force in newtons (N). Label your graph "Gravitational Force vs. Mass."

   Note: Put the data for mass on the horizontal axis and the data for gravitational force on the vertical axis.

SCATTERPLOT AND LINE GRAPHING CHECKLIST

Sample Graph

Follow the instructions below to make a sample line graph.

- ☐ Start with a table of data.

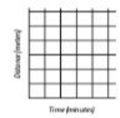
MOTION OF A BALL

Time (minutes)	Distance (meters)
0	0
1	5
2	9
3	16
4	20
5	27

- ☐ Determine whether a line graph or a scatterplot is the best way to represent the data.

LINE GRAPH

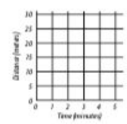
- ☐ Draw the axes. Label them with the names and units of the data.



- ☐ Decide on a scale for each axis. Be sure there is enough space for all the data, but that it's not too crowded.

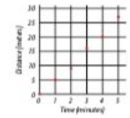
Time axis: 1 block = 1 minute
Distance axis: 1 block = 5 meters

- ☐ Draw intervals on the graph, and label them clearly.



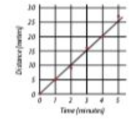
SCATTERPLOT AND LINE GRAPHING CHECKLIST (continued)

- ☐ Plot your data on the graph.

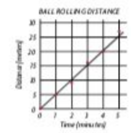


- ☐ For a scatterplot, leave the points unconnected.

  For a line graph, draw a smooth line or curve that follows the pattern indicated by the position of the points.



- ☐ Title your graph. The title should describe what the graph shows.



- ☐ If more than one data set has been plotted, include a key.

● = large ball
○ = small ball

3. Look at your graphed data, and record what relationships you notice.

Part B: Gravitational Force at Different Distances

4. The "Distance and Gravitational Force Data" table shows the gravitational force between Saturn and some ring objects that are at different distances from the planet. All of the objects in this table have a mass of 1 kg.
5.

Distance and Gravitational Force Data

DISTANCE OF RING OBJECT FROM CENTER OF SATURN (IN 1,000 km)	GRAVITATIONAL FORCE BETWEEN SATURN AND RING OBJECT (IN 10,000 N)
100	38
120	26
130	22
150	17
180	12
200	9
220	8
250	6
280	5

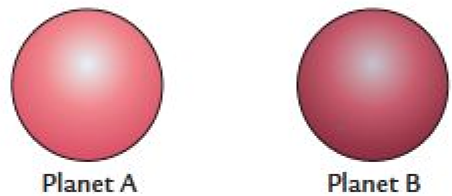
6. Use the data in the table to make a graph of the relationship between distance and gravitational force. Label your graph "Gravitational Force vs. Distance."
   a. Note: Put the data for distance on the horizontal axis and the data for gravitational force on the vertical axis.
7. Look at your graphed data, and record any relationships you notice. What do you see?

Activity 14 - Gravitational Force
Analysis Questions

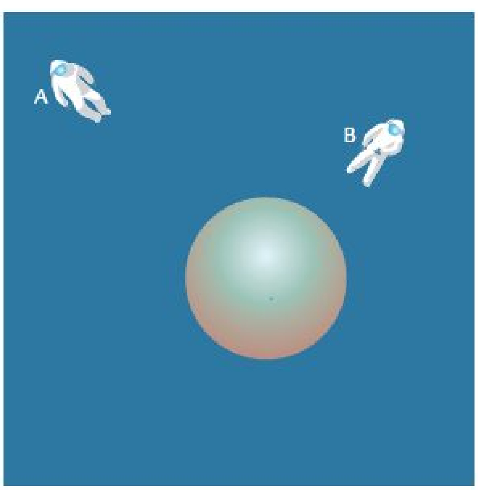
1. Compare your two graphs. Identify and explain any:
    a. Similarities.

    b. Differences.

2. Look at the pictures of the two planets below. Their diameters are the same, but Planet B has twice the mass of Planet A. Which one would you expect to have a stronger pull of gravity on its surface? Explain.



3. Look at the picture below of an astronaut at two different distances from a planet. In which position, A or B, would there be a stronger gravitational pull between the astronaut and the planet? Explain.



4. Your friend tells you that if you double the distance of a spacecraft from a planet, the gravitational force is one half as strong. Do you think this is correct? Cite evidence from this activity to support your position.

5. Jupiter is 5.2 times as far from the Sun as Earth is, but the gravitational force between Jupiter and the Sun is stronger than the gravitational force between Earth and the Sun. How can that be?

8. Look at your graphed data, and record in your science notebook any relationships you notice.

Activity 15 - The Effects of Gravity

Guiding Question: ***How does gravity affect the motions of objects in space?***

Stop to Think Questions

1. Argentina and Japan are on exactly opposite sides of the Earth. Is “down” in Japan the same direction as “down” in Argentina? Explain.

2. When astronauts who are used to gravity on Earth visit the Moon, they can jump much higher on the surface of the Moon. Why is that?

3. Outside our Solar System, is there any gravitational pull from the Sun?

4. a. What would happen if a satellite orbiting Earth started slowing down?

   b. Would our Solar System exist if gravity did not exist? Explain.

5. Why might astronomers want to use spacecraft to study asteroids?

Activity 15 - The Effects of Gravity
Analysis Questions

1. Your friend tells you that there is no gravity in space. Based on what you read, do you agree or disagree? Explain.

2. The Hubble Space Telescope pictured on the cover of the book had to be serviced a few times during its mission. After every servicing, the astronauts would push the Hubble Space Telescope a little bit farther away from Earth.
   a. What would change about the gravitational force between Earth and the Hubble Space Telescope after the servicing mission?

   b. The Hubble Space Telescope's orbit is designed so that eventually the telescope will fall into Earth's atmosphere and burn up. Why do you think the servicing missions pushed the spacecraft away from Earth?

3. Draw a picture of what you think the Solar System looked like when it was first forming. Explain how gravity was responsible for what is shown in your picture.

Activity 16 - Modeling Gravity

Guiding Question: How can models help us understand the role of gravity in the motion of space objects?

MATERIALS

For each pair of students
1 computer with Internet access
1 Student Sheet 13.1, "Planet Information"

For each student
1 Student Sheet 16.1, "Modeling Galactic Gravity"

PROCEDURE

Part A: The Mass of Our Sun

1. Open the Modeling Gravity simulation on your computer.
2. Your teacher will assign you and your partner one of the planets in our Solar System.
    a. Write your planet here ____________________________
3. Find your assigned planet on Student Sheet 13.1, "Planet Information." Identify the distance your assigned planet is from the Sun in astronomical units and how long it takes for your assigned planet to complete one orbit around the Sun—in years.
    a. Distance from Sun _________________________
    b. How long for one orbit around sun __________________________
4. On the computer screen, select your assigned planet.
5. In the upper left corner of the simulation is the simulated distance between your assigned planet and the Sun. Drag your assigned planet until this simulated distance matches the actual planet–Sun distance on Student Sheet 13.1.
6. Use the slider to change the mass of the Sun, and notice that in this simulation, the mass of the Sun changes without changing the distance you set in Step 5. Press "Run Simulation" and observe how long it takes for your assigned planet to complete one orbit.
7. Press "Stop Simulation" and repeat Step 6 until the time it takes for your assigned planet to complete one orbit is the same as what is on Student Sheet 13.1.

    Hint: If you need your planet to orbit faster, increase the gravitational force between the Sun and your planet.
8. Write down the mass of the Sun here __________________________ (from Step 7).
    - Discuss with your partner what you think other groups measured for the mass of the Sun even if they had a different planet.

9. Share your result from Step 8 with a pair who was assigned a different planet, and answer Analysis Question #1.

Part B: Galactic Gravity

10. Read the following information about the gravitational forces that determine the motions of objects within galaxies.

In the late 1900s, an astronomer named Vera Rubin was studying the motions of stars in the Andromeda Galaxy. She created a mathematical model based on gravity to predict how fast objects should be orbiting the center of the galaxy. She then observed how fast the objects were actually orbiting. Her data showed that her model's predictions were way off! Since gravity is due to distance and mass, either her mass or distance measurements were wrong. She figured out that there must be mass in the galaxy that cannot be seen. Astronomers call this source of mass dark matter. When Dr. Rubin added dark matter into her model, her new predictions matched her observations. Her model now explained the motion of stars around the center of the Andromeda Galaxy.

Because of Dr. Rubin's discovery, other astronomers have discovered that all galaxies have dark matter, even our own! The gravitational forces from normal matter and dark matter in the Milky Way cause our Solar System to orbit around the center of our Galaxy.

Activity 16 - Modeling Gravity
Analysis Questions

1. How many times more massive is the Sun than Jupiter? Use data from this activity and Student Sheet 13.1 to complete your calculation.

2. Follow the instructions on Student Sheet 16.1, "Modeling Galactic Gravity to model a portion of a galaxy. Keep in mind that galaxies usually have billions of stars, but this model only looks at three stars within a galaxy.

3. Think about all you needed to know to complete Student Sheet 16.1.
   a. Describe the role of gravity in determining the
      - orbits of the stars.

      - orbits of the planets around Star A.

      - orbit of the one moon you included in your model.

   b. Do the planets orbiting Star A orbit in the same direction? Explain.
      - Make sure your answer mentions solar system formation.

4. Would it be possible to create a scale model of a galaxy and a solar system on one piece of paper?
      - Hint: A typical solar system is about 100 AU from its center to its edge, and the average distance between stars in a galaxy is about 250,000 AU.

STUDENT SHEET 16.1

MODELING GALACTIC GRAVITY

Draw the orbits of Star A, Star B, and Star C around the galactic center. For Star A, draw a small solar system that includes three planets and one moon. Your solar system does not need to be drawn to scale.

Activity 17 - Choosing a Mission

Guiding Question: Which mission to Titan should we fund, and why?

PROCEDURE

1. Read the three proposed space missions to Titan in the “Solar System and Beyond” book.
    - On Student Sheet 17.1, “Comparing Three Space Mission Proposals,” record your answers to the following questions:
        - What can scientists learn on the mission?
        - What challenges might the mission face?
        - What are the similarities and differences between the missions?
2. Use the information you recorded on Student Sheet 17.1 and anything else you have learned in this unit to evaluate the mission proposals with your group of four students. Discuss how you think the money should be spent.
3. Compare the mission proposals by completing Student Sheet 17.1. In the last column of the table, rank on a scale of 1 to 3 how much you support each mission proposal, with 1 indicating the most support and 3 indicating the least support.
4. With your group, come to an agreement about which mission proposal should be funded. Support your ideas with evidence about the mission proposals. Be sure to discuss the trade-offs of choosing one mission proposal over another.
        - Remember to listen to and consider the ideas of other members of your group. If you disagree with others in your group, explain why you disagree.
5. Present your group’s recommendation to the class.

STUDENT SHEET 17.1

COMPARING THREE SPACE MISSION PROPOSALS

Mission	What can be learned?	What are the challenges?	Rank from 1 (most support) to 3 (least support)
Mission Proposal A			
Mission Proposal B			
Mission Proposal C			

Activity 17 - Choosing a Mission
Analysis Questions

1. What other information do you wish you had before making a final decision?

2. For the mission proposal you chose, what advancements in technology or engineering do you think this mission could offer?

3. Write a letter to NASA stating your recommendation for which of the three mission proposals to fund. Convince the agency with evidence you gathered in this activity and unit. Be sure to present the trade-offs of your recommendation.

The Universe: Total Eclipse Episode

Solar Eclipse: Occurs when the Moon passes in front of the Sun blocking out Sunlight to the Earth.

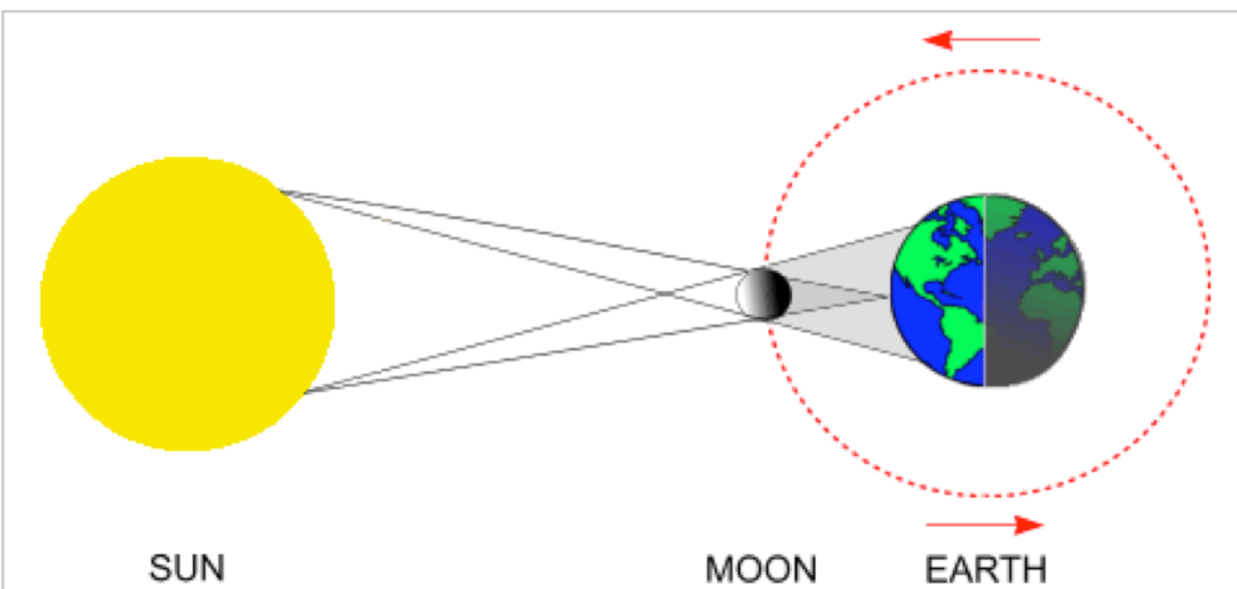
Lunar Eclipse: Occurs when the Earth is in between the Sun and the Moon (Full Moon) and the Moon is in the Earth's Shadow.

1. The Moon can sometimes block the Sun causing a ___________Eclipse.

2. What is the phase of the Moon during a Solar Eclipse?   _____________

3. A total eclipse occurs somewhere on Earth once every ____________months.

4. Why do the Sun and the Moon appear to be the same size in the sky from our view? (Use the diagram below to help you.)



5. Eclipses allow us to see the Sun's _______________________________.

6. The Sun sometimes undergoes: C_____________ M_______E____________ or CME's that can damage satellites and communications.

The Universe: The Moon Episodes

1. The Moon's Features/Characteristics

The Moon's Diameter is ________ of the Earth's Diameter.

The Moon's Revolution around the Earth is the same amount of time as its_____________.

The Moon also has no____________________ so you wouldn't be able to breathe on your own.

2.Time Keeping

Early timekeepers had 2 choices; they could monitor the Sun or monitor the Moon. Instead of keeping track of 365 days, most societies actually started out with a ______________calendar.

There are 365 days in a year and only _________ to __________days in a lunar cycle so it is very easy to count.

3. Tides and the Moon's Physical Effects

The Moon is responsible for the rise and fall of our ______________tides. The moon's gravity pulls the Earth's waters towards itself.

There are ______High Tides and ______Low Tides a day.

The Moon causes **2 tidal bulges** on the Earth.

One High tide is caused by the Earth's _____________ and the other is caused by the Moon's gravitational pull.

4. The Moon Effects the Seasons and Earth's Rotation

The Moon stabilizes the Earth's Tilt or locks it in place and keeps it the same throughout a year giving us the seasons.

7th Grade Science Quiz/Test Corrections Form

Directions:

For each incorrect answer:

- ❑ Write the question number in the blank
- ❑ Explain why your original answer was wrong
- ❑ Write the correct answer
- ❑ Explain why it is the correct answer
- ❑ Give an example to show how it is the correct answer

Partial credit will only be given for each correction that is **answered completely.**

________.

________.

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- ❏ Give an example to show how it is the correct answer

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________.

________.

7th Grade Scientific Method & Space Science Vocabulary

Scientific Method Vocabulary	**Page # in Packet**
Metric System or SI Units	
Qualitative Data	
Quantitative Data	
Hypothesis	
Procedure	
Variable	
Control	
Observation	
Conclusion	
Problem	
Astronomy Vocabulary	
Phenomenon	
Astronomy	
Day	
Rotation	
Revolution	
Axis	
Year	
Seasons	
Equinox	
Solstice	
Direct Sunlight	
Indirect Sunlight	
Universe	
Galaxy	
Solar System	
Moon Phases	
New Moon	
Waxing Crescent	
First Quarter	
Waxing Gibbous	
Full Moon	

Astronomy Vocabulary Continued	Page # in Packet
Waning Gibbous	
Last Quarter	
Waning Crescent	
Solar Eclipse	
Lunar Eclipse	
Electromagnetic Radiation	
Wavelength	
Gamma Rays	
X-rays	
UV Rays	
Visible Light	
Microwaves	
Radio waves	
Infrared waves	
Telescope	
Satellite	
Probe	
Lander	
Flyby	
Nuclear Fusion	