Astronomy

Scientific Method, Metrics, and Scientific Notation

Practice Problems

1) Metrics:

Make the following conversions:

1) 35 cm to m	2) 145 m to km	3) 54.2 cm to km
4) 75 cm to km	5) 200 km to m	6) 1500 km to cm

2) Scientific Notation

Express the following numbers in Scientific Notation

1) 0.0153	2) 4.12	3) 52833
4) 1013	5) 0.00000180	6) 1960000000000

3) Scientific Method

List the six steps of the scientific method in sequence

1)	3)	5)
2)	4)	6)

4) Magnitude

Choose the smallest number by circling the appropriate letter.

(a) 1.000
(b) 1.0001
(c) 1.00001

Choose the largest number by circling the appropriate letter.

(a) 10^{-2}
(b) 10^{1}
(c) -10^{2}

6) Sequencing

Place the following numbers from smallest to largest. Place your sequence in a horizontal row, with the smallest number on the left and the largest number on the right:

0, -15, 10^{-5}, 10^{3}, 2.7×10^{3}, 0.003, 5×10^{-5}

English Conversions

1 foot = 12 inches
1 yard = 3 feet
1 mile = 5280 feet

Examples:
1) A football field is 100 yards, not including end zones. How many inches, feet, and miles is that?

2) My commute to work is about 3.7 miles. How many inches, feet, and yards is that?

3) A sheet of binder paper is 11 inches long. How many feet, yards, and miles is that?

Astronomy

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab title: Metrics Lab

Purpose: To practice using the metric system.

Materials:

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Data:

Table 1:

Height

Object	mm	cm	m	km
Desk				
Lab Table				
Door				
Top of Whiteboard				
Base of Window				
Chair				
Yourself				

Metrics Lab

Data: (continued) -

Table 2:

Mass

Object	mg	cg	g	kg
Pen or pencil				
Paperclip				
Coin				
Calculator				

Table 3:

Classroom

Measure	Mm	Cm	M	Km
Length				
Width				
Height				

Table 4:

Volume of Classroom

mm^3	cm_3	m^3	km^3

Useful Information:

mm = millimeter 10 mm = 1 cm mg = milligram 10 mg = 1 cg

cm = centimeter 100 cm = 1 m cg = centigram 100 cg = 1 g

m = meter 1000 m = 1 km g = gram 1000 g = 1 kg

km = kilometer kg = kilogram

Volume = (Length) X (Width) X (Height)

Scientific Method and Metrics

Lab title: How big is the Sun?

Purpose: Practice using the scientific method and the metric system to determine the diameter of the sun.

Materials: meter stick, 2 index cards (12.7 cm X 20.32 cm and 7.62 cm X 12.7 cm), aluminum foil, scissors, tape, and a straight pin.

Hypothesis: The moon and the sun appear to be the same size in the sky. Are they the same size? Is one larger than the other, and if so, how much larger?

Procedure:

1) Make a window in the larger index card using the dimensions shown below in Figure 1.

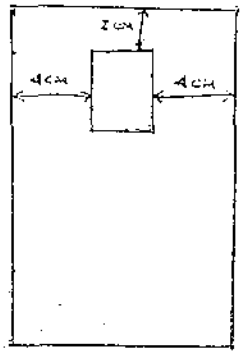


Fig. 1

2) Cover the window with a piece of aluminum foil. Attach the foil with tape. Make sure the foil completely covers the cut out window.

3) Using the straight pin, make a small hole in the center of the foil. **Important!** Make sure the hole you make is small!

4) Center the large card on the meter stick as shown below in Figure 2B. Tape it so that it is on the 98 cm mark of the meter stick.

5) Draw 2 parallel lines on the smaller card as shown below in Figure 2A. Attach the smaller index card to the meter stick as shown below in Figure 2B. Do not tape this card, it should be free to slide.

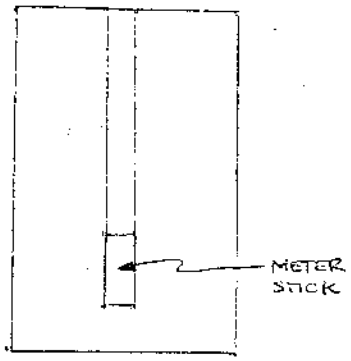


Fig. 2A

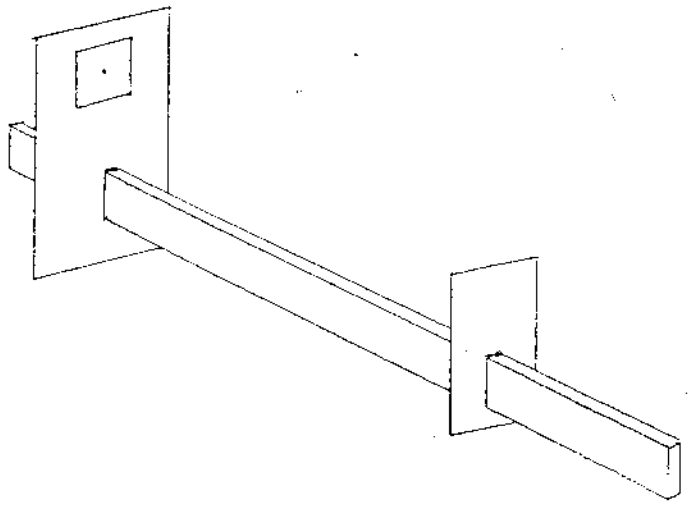


Fig. 2B

6) Aim the apparatus at the sun with the large card closest to the sun, making sure that the large card bathes the smaller card in shadow.

7) Sunlight traveling through the pinhole will create a small image of the sun that projects onto the smaller card.

8) Slide the smaller card so that the image of the sun fills in the two parallel lines that you drew on it.

9) Record the separation distance between the large card and the smaller card in the data table under D_c.

Data:

D_s		D_c		Dia_{si}		Dia_s	
km	m	m	cm	m	cm	km	m

D_s= Distance to sun=1.5 X 10^8 km D_c = Distance between index cards

Dia_{si} = Diameter of sun's image Dia_s = Diameter of sun

Results:

Using the equation shown below, solve for the diameter of the sun. Before making your calculation, make sure that all of your units are the same for the three known variables. Show all of your work in the space below the equation.

$D_s / D_c = Dia_s / Dia_{si}$

Conclusions:

1) Obtain the actual diameter of the sun from your teacher. Using the equation below, calculate your percent error for the diameter of the sun:

%error = (Actual) – (Experimental)/(Actual) X 100%

2) List any sources of error that may have influenced the accuracy of your results.

3) Obtain the actual diameter of the moon from your teacher and compare it with the diameter of the sun that you calculated with your experimental data. How does the two values compare?

4) How did your hypothesis compare to your experimental outcome?

SCIENCE IN THE NEWS

1) Find an article from any newspaper, magazine, or internet source that involves science in the news.
2) Write a 1/2 page summary.
3) On the back of your paper, include 5 bullet notes to help you present your article.
4) Attach a copy of the article to your paper or list the website.

Presentation:

Using your 5 bullet notes as a guide, simply tell the class about your story. Be sure to mention the date of the news article.

Grading:

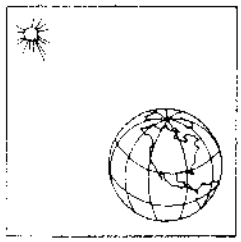
20 points total (2 points extra credit for an astronomy topic)
-2 points if article is not attached or website is not listed
-2 points if summary is less than 1/2 page
-2 points if more or less than 5 bullet notes on the back
-2 points if less than 50% eye contact

Name_____ Date_____

WHAT ARE YOUR IDEAS ABOUT THE EARTH?

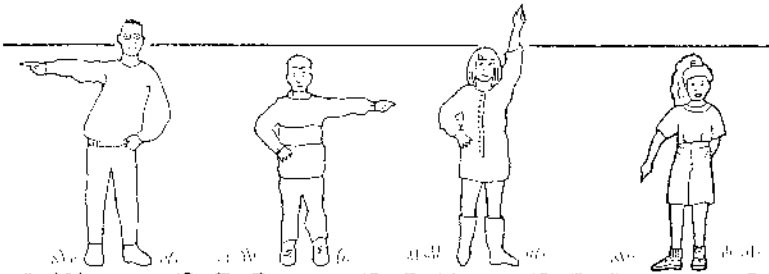
QUESTION 1: Why is the Earth flat in picture #1 and round in picture #2?
(Circle the letter in front of the best answer.)


1


2

A. They are different Earths.
B. The Earth is round like a ball, but people live on the flat part in the middle.
C. The Earth is round like a ball, but it has flat spots on it.
D. The Earth is round like a ball but looks flat because we see only a small part of the ball.
E. The Earth is round like a plate or record, so it seems round when you're over it and flat when you're on it.

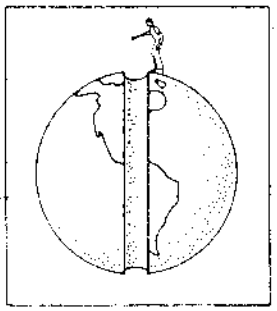
QUESTION 2: Pretend that the Earth is glass and you can look through it. **Which way would you look, in a straight line, to see people in far-off countries like China or India?**



A. Westward? **B.** Eastward? **C.** Upward? **D.** Downward?

QUESTION 3: This drawing shows some enlarged people dropping rocks at various places around the Earth. **Show what happens to each rock by drawing a line showing the complete path of the rock, from the person's hand to where it finally stops.**

QUESTION 4: Pretend that a tunnel was dug all the way through the Earth, from pole to pole. Imagine that a person holds a rock above the opening at the North Pole. **Draw a line from the person's hand showing the entire path of the rock.**



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Astronomy

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Show Me The Money

Purpose: To learn the concept of gravity and freefall.

Materials:

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Part 1 - Dollar Bill

Part 2 - Reaction Time

Data Table 1: Dollar Bill

Trial Number	Caught (Y/N)
1	
2	
3	

Astronomy

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Gravity is Fantastic!

Purpose: To explore the effects of gravity for falling objects.

Materials:

Background Information:

Consider the following situation: A long piece of string has 6 metal hexagonal nuts taped at equal 20 cm intervals. The string is held vertically and allowed to fall into a metal pie pan. The nuts will make a distinct sound as they hit the pan.

Question: Will the nuts hit at equally space time intervals?

Answer: No, because the nuts pickup speed due to acceleration of gravity and therefore, the time interval between each successive impact with the pie pan will be less.

The objective of this lab is to determine how far apart the metal hexagonal nuts should be taped to a long piece of string so that when the string is held vertically, the nuts will strike the pie pan at equal time intervals.

To simplify the lab we will use the elapsed time between nuts hitting the pie pan. This elapsed time will be referred to as a "beat" because the sense of rhythm is used to judge whether or not the nuts hit the pan in equally-spaced time intervals.

Hints to Help You Achieve Success:

Hint #1: The falling nuts speed up (accelerate) as they fall due to gravity. Therefore, as time goes by, each nut will fall a greater distance in the same amount of time than the previous one. How can you compensate for this so that each nut strikes the pan in the same time interval?

Hint #2: The distance d that an object falls in time t is $1/2gt^2$. The distance iks equal to a constant $1/2$ g multiplied by t^2. The constant is the first distance between the first two nuts. The time it takes the first nut above the pie pan (the second nut) to hit the pan is one "beat."

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Analysis:

Describe your spacing pattern that resulted in the nuts striking the pie pan at equal time intervals.

Phases of the Moon

Activity 1: In class

Title: Predicting Phases and Features of the Moon.

Purpose: 1) To draw your mental model of the moon; 2) To infer the sequence of the moon's phases bases on observations of lunar photos.

Materials: Lunar photographs, scissors, pencil, tape or glue, and sheets of blank paper.

Procedure:

Work alone:

1) Close your eyes and create a mental picture that depicts your image of how the moon looks.

2) On a blank, unruled, piece of paper (supplied in class) draw your mental picture of how the moon looks.

3) With no emphasis placed on whether your mental picture is accurate or correct, compare your picture with your classmates.

4) Be prepared to share with the entire class and participate in a group discussion on why the pictures vary.

Work in small group (2-3 students)

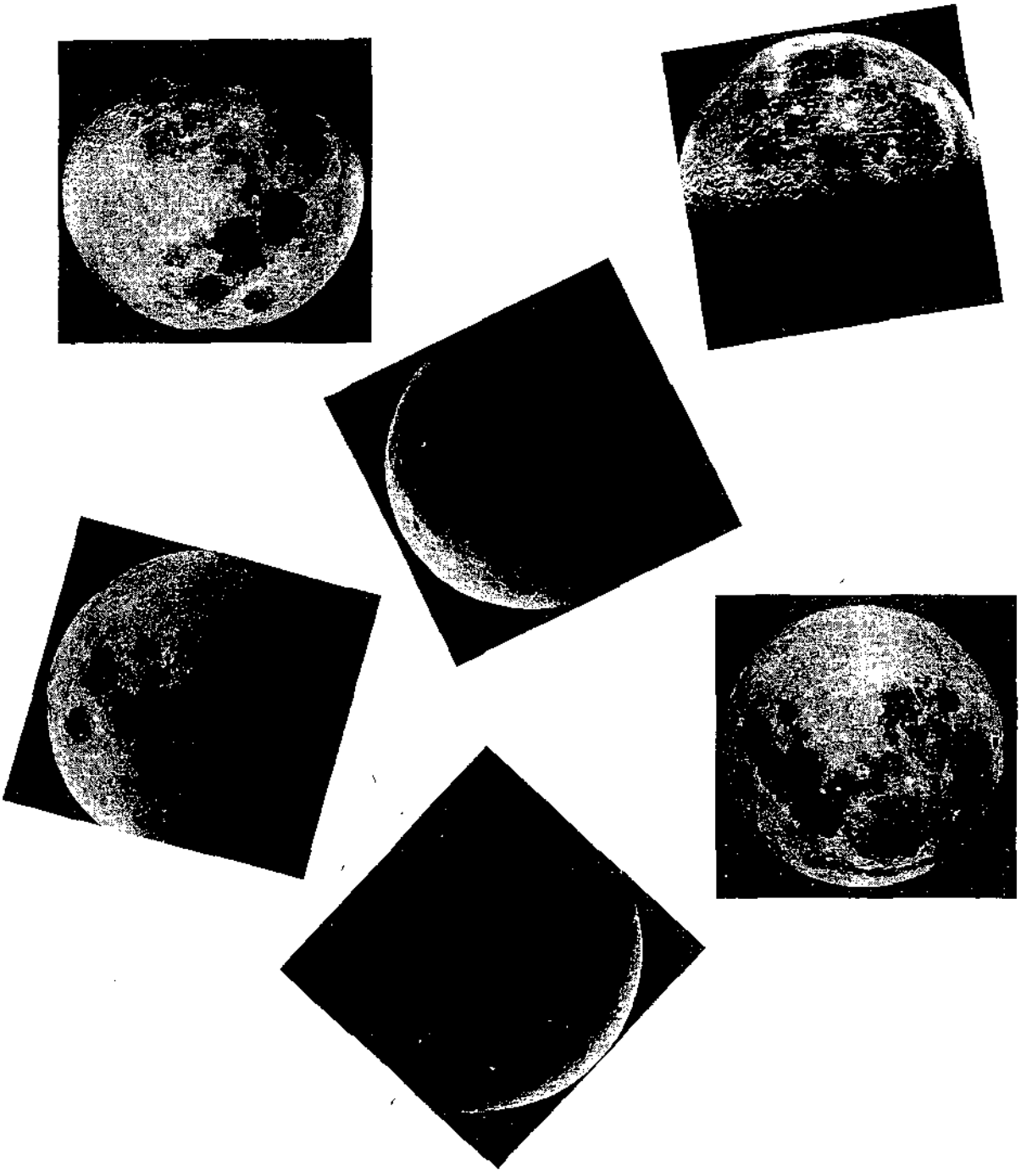
1) Obtain the following: lunar photographs, tape or glue, scissors, and blank paper.

2) Cut out the photos.

3) Place the photos in the sequence that your group thinks they would see them in if they were to observe the moon over a period of several weeks.

Lunar Photographs

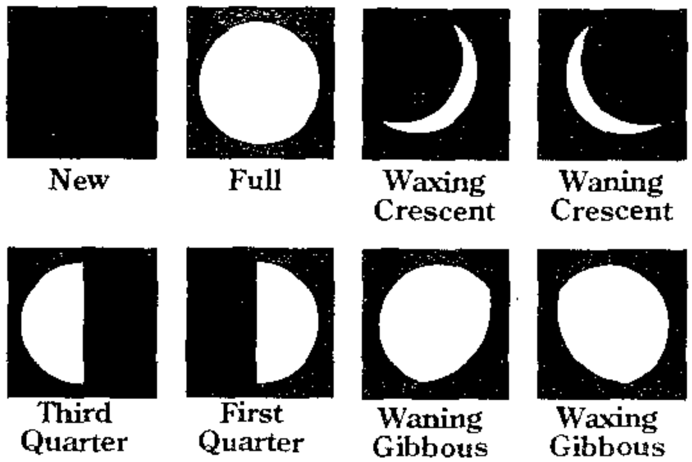
Cut out each picture. Arrange them in the order you would expect to see the moon during the next several weeks.



4) Once your group is satisfied with the arrangement of the photos, tape or glue them to the blank paper.
5) Place your lunar photo sequence on a designated wall in the classroom. The accuracy of your arrangement will not be addressed until the next activity. The photo arrangement predictions will be use as a reference for the next activity.

Activity 2: At home
Title: Observing Phases and Features of the Moon.
Purpose: 1) Make a daily record of moon observations, 2) Use your observations to refine your predictions and to determine the proper sequence of the moon's phases.
Materials: Lunar Observing Record Chart, pencil, binoculars (optional), clipboard or other firm writing surface.
Procedure:
Work Alone
1) Begin this activity when the first quarter moon is visible in the sky. The moon is often visible during the day as well as the night. Use the pictures at the top of the Lunar Observing Record Chart to see what the first quarter moon looks like.
2) Go outside and locate the moon.
3) Record the date, time of the observation and draw in the shape of the moon.
4) Repeat step 3 every day over a four week period.
5) Use your completed product to determine the correct sequence for the lunar photos in Activity 1.

LUNAR OBSERVING RECORD CHART



Directions: Find the moon in the sky. Record the date and time in the box corresponding to the date. Shade the circle to show the moon's appearance.

SUN	MON	TUE	WED	THUR	FRI	SAT
Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____
Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____
Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____
Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____

NAME DATE CLASS

Chapter 22

REINFORCEMENT

Text Pages 623–631

• Earth's Moon #1

Identify each phase of the moon in Figure 1 by writing its name on the line beneath the phase shown. Then answer the questions that follow on the lines provided.

FIGURE 1

1. _____ _____ _____ _____

_____ 2. What phase occurs between the full moon and the third quarter?

_____ 3. What phase occurs between the third quarter and the new moon?

_____ 4. What phase occurs between the new moon and the first quarter?

_____ 5. What phase occurs between the first quarter and the full moon?

Identify Figures 2 and 3 as lunar or solar eclipses. Then explain why each type of eclipse happens and who would be able to see the eclipse.

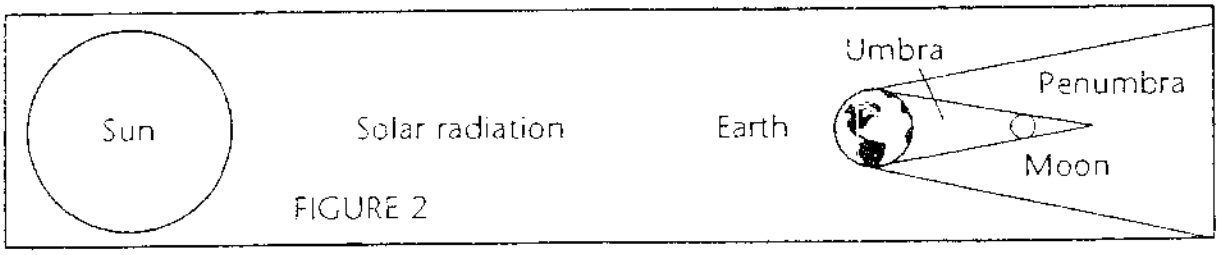


FIGURE 2

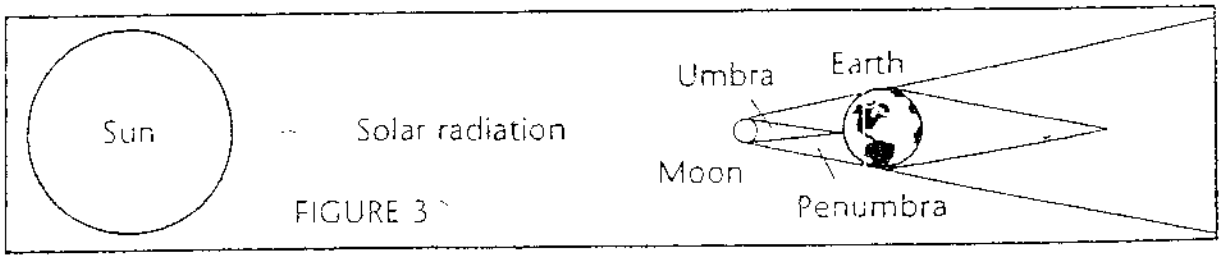


FIGURE 3

6. Figure 2: _____

_____

_____

7. Figure 3: _____

_____

_____

_____

NAME DATE CLASS

Chapter 22

ENRICHMENT

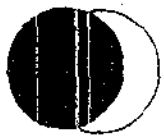
Text Pages 623–631

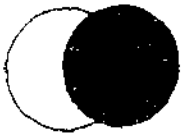
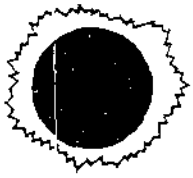
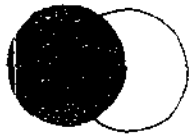
• Earth's Moon #2

Comparing Eclipses

The following observations were made during two eclipses. Beneath each sketch, write a number (1 for first and 5 for last) that shows the order of that observation during the eclipse. Then answer the questions. Note that the moon revolves eastward in its orbit and goes eastward across the sky during an eclipse.

Total solar eclipse



_____ _____ _____ _____ _____

Total lunar eclipse





_____ _____ _____ _____ _____

1. What makes the shadow during a solar eclipse? _____ during a lunar eclipse? _____

2. How are the shapes of the moon during partial stages of the above eclipse different from phase shapes? _____

3. Is the east side or the west side of the sun covered first during a solar eclipse? _____

4. Is the east side or the west side of the moon covered first in a lunar eclipse? _____

5. Which of the above eclipses helps show that Earth is a sphere? Why? _____

6. Why does a lunar eclipse last longer than a solar eclipse? _____

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Astronomy Lab

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Getting Pushy!

Purpose: To determine the relationships among Force, Mass, and Acceleration.

Materials:

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Data:

Table 1

Trial #	Distance (m)	Time (s)	Force
	3		
1	6		
	9		
	3		
2	6		
	9		
	3		
3	6		
	9		

Table 2

Trial #	Distance (m)	Time (s)	Force
	3		
	6		
	9		
	3		
	6		
	9		
	3		
	6		
	9		

Getting Pushy (continued) -

Analysis:

1) Until the time of Galileo, people believed that a constant force is required to produce a constant speed. Do your observations confirm or reject this notion? Explain!

2) What happens to the speed as the students riding the cart as they proceeded farther and farther along the measured distances?

3) What happens to the rate of increase in speed, the acceleration, as the riders proceed farther and farther along the measured distances?

4) When the force is the same, how does the acceleration depend upon the mass? (hint: compare the results for each of the individual riders in Table 1)

5) When the mass of the skater is the same, how does the acceleration depend upon the force? (hint: choose one of the riders and compare their results between Table 1 and Table 2)

6) How does this lab verify Newton's 2nd Law?

Astronomy

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Balloon-Powered Rockets

Purpose: To explore Newton's 3rd law and the concept of action-reaction.

Materials:

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Analysis:

1) Describe how a balloon is able to travel once the air inside it is released.

2) Identify the action and reaction forces for an inflated balloon that loses its air.

3) Would the balloon rocket action take place if there was no surrounding air? Why or why not?

4) Since there is no surrounding air on the moon, it would be impossible to send astronauts to the moon and back to the earth. Discuss why this statement is false using what you have learned from this activity about Newton's 3rd law of motion.

Astronomy Lab

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Goin' Orbital

Purpose: To explore the concept of circular motion and how it applies to celestial orbits.

Materials:

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Data:

Table 1

# of Washers	Mass of Washers (kg)	Weight of Washers (N)	Trial #	T_{10} (s)	T_1 (s)	f (Hz)	r (m)
			1				0.25
			2				0.50
15			3				0.75
			4				1.00
			5				1.25
			6				1.50

Note: T_{10} = The time for 10 complete revolutions. T_1 = The time for 1 complete revolution. T_1 is found by dividing T_{10} by 10.

Goin' Orbital (continued) –

Data: (continued)

Table 2

Trial #	# of Washers	Mass of Washers (kg)	Weight of Washers (N)	T_{10} (s)	T_1 (s)	f (Hz)	r (m)
1	9						
2	12						0.9
3	15						
4	18						
5	21						
6	24						

Analysis:

1) From the data in Table 1, what is the relationship between the Period (T_1) and the radius (r)?

2) From the data in Table 2, what is the relationship between the Period (T_1) and the weight of the washers?

3) How could you use your findings for Analysis questions 1 and 2 towards understanding the orbits of planets around stars?

Astronomy

Directions: Use these pages as a template only. Do not write on these pages. Do not turn in these pages when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

Lab Title: Kepler's Third

Purpose: To verify Kepler's 3rd Law by graphing Solar System data.

Materials:

Background Information:

For this lab you will be graphing planet Period's (T) versus their average radii (R) from the sun in Astronomical Units. T, the planet's Period's will be placed on the y-axis of your graph and R, the planet's radii from the sun will be placed on the x-axis.

The name of the graph game is to get a straight line. That is because a straight line tells you that whatever you are plotting on the y-axis is proportional to whatever you are plotting on the x-axis. If one thing is proportional to the other thing, that means you have discovered an important relationship between those two things, which leads to the development of a law; in this case, it will lead you to Keplers 3rd Law.

Start out by graphing T vs. R from the Data table. If this doesn't give you a straight line, then try raising T to the second power and leaving R alone. In that case you will be graphing T^2 vs. R. If this gives you a straight line then you have achieved your goal. If it doesn't give you a straight line, then you must try other combinations until you get a straight line. Be patient and Happy graphing!!!

Procedure: Write a step-by-step set of instructions for what you did for this lab. Make it clear enough that someone who was absent for the lab would be able to do it from your procedure. Number your steps down the left margin of this page.

Kepler's Third (continued) –

Data:

Planet	Period in Years (T)	Average Radius in A.U. (R)
Mercury	0.241	0.39
Venus	0.615	0.72
Earth	1.00	1.00
Mars	1.88	1.52
Jupiter	11.8	5.20
Saturn	29.5	9.54
Uranus	84.0	19.18
Neptune	165	30.06

Analysis:

1) What combination of powers result in a straight-line graph?

2) How are T and R related?

3) Explain what the relationship between T and R actually means.

Notes: If you find the relationship between T and R during this lab period, feel really good. It took Johannes Kepler (1561 – 1630) ten years of painstaking effort to discover the relationship!!!

NAME DATE CLASS

Chapter 23

STUDY GUIDE

Text Pages 646–651

The Inner Planets

In the blank at the left, write the letter of the term or phrase that correctly completes each statement.

_____ 1. Mars is the _____ planet outward from the sun.
a. third b. fourth

_____ 2. Because of similar size and mass, _____ is called Earth's twin.
a. Mars b. Venus

_____ 3. _____ has great extremes in temperature, –450°C during the day and –170°C at night.
a. Mercury b. Mars

_____ 4. Venus is the _____ planet outward from the sun.
a. fourth b. second

_____ 5. The _____ space probes made many discoveries about Mars.
a. *Viking* b. *Mariner*

_____ 6. The atmosphere of _____ is mostly carbon dioxide.
a. Mercury b. Venus

_____ 7. The largest volcano in the solar system is _____ on Mars.
a. *Valles Marineras* b. *Olympus Mons*

_____ 8. One astronomical unit (AU) is equal to the avenge distance between the sun and _____.
a. Earth b. Mercury

_____ 9. One astronomical until (AU) equals _____.
a. 150 million km b. 15 million km

_____ 10. Water exists as a solid, liquid, and gas on _____.
a. Mercury b. Earth

_____ 11. Polar ice caps are a visible feature of _____.
a. Mars b. Venus

_____ 12. Mars appears red because of _____ in its rocks.
a. sulfuric acid b. iron oxide

_____ 13. _____ is the third planet outward from the sun.
a. Venus b. Earth

_____ 14. _____ is the larger of Mars' two moons.
a. Phobos b. Deimos

_____ 15. The _____ space probe mapped the surface of Venus.
a. *Magellan* b. *Mariner*

NAME DATE CLASS

Chapter 23

STUDY GUIDE

Text Pages 654–661

The Outer Planets

Decide if a statement is true or false. If false, change the italicized word or words to make the statement correct and write your answer in the blank. If the statement is correct, write "true" in the blank.

_____ 1. Ganymede, the largest satellite in the solar system, is one of *Neptune*'s 16 moons.

_____ 2. All of the outer planets except Pluto are large and *gaseous*.

_____ 3. *Neptune* is the only planet that rotates on an axis parallel to its orbit.

_____ 4. The largest of Saturn's moons, *Charon*, is larger than Mercury.

_____ 5. *Io* is volcanically active because of Jupiter's gravitational force.

_____ 6. *Saturn* is the largest planet and the fifth planet outward from the sun.

_____ 7. Much of the information about the outer planets was discovered by the *Viking* space probes.

_____ 8. Unlike the other outer planets, *Pluto* has a solid, rocky surface.

_____ 9. Uranus is the *sixth* planet outward from the sun.

_____ 10. A large swirling storm on Jupiter is called the *Titan*.

_____ 11. Pluto is not always *closest to* the sun because its orbit crosses Neptune's orbit.

_____ 12. *Charon* and Pluto are sometimes called a double planet.

_____ 13. *Saturn* is known for its rings and its very low density.

_____ 14. The blue-green color of Uranus and Neptune is caused by *carbon dioxide* in their atmospheres.

_____ 15. *Neptune* is usually the eighth planet outward from the sun.

Assignment title: Planet Vacation Brochure

Purpose: To design a brochure using a blend of science fiction and science fact that will entice someone to visit a planet in our solar system (excluding the Earth).

Background Information: In this assignment you will assume the role of a Solar System Travel Agent. Take a standard size piece of paper (8.5 inches X 11 inches) and fold it across its width into thirds. This folding should give you six separate panels, three on the front and three on the back.

Each panel must contain a mixture of graphics and text. You can capture images from the internet or print media or draw them yourself. Your brochure must be based on actual planetary facts, however, feel free to use your imagination to extend what your planet has to offer to the potential traveler.

For the front panel consider using a combination of image(s) and text that will grab the attention of a prospective planetary tourist. The back panel should have the name of your travel agency along with contact information, website, and so on.

To get a better understanding of the power of advertising to attract interest in the travel industry, take a look at travel-related information on the internet. However, your brochure must be entirely original.

Make sure that the images and text that you use are of high quality. All panels must be done in color. Be creative and convince me and other readers to go to your planet!

Rubric

4	3	2	1
All 6 panels used	4-5 panels used	2-3 panels used	1 panel used
Images and text are high quality and relevant	Images and text are good quality and relevant	Images and text are of fair quality and mostly relevant	Images and text are poor and/or not relevant
All panels are in color	3-5 panels are in color	1-2 panels are in color	No color used
Excellent blend of facts and imagination.	Good blend of facts and imagination.	Fair blend of facts and imagination.	Poor blend of facts and imagination.
I really want to go there	I would like to go there	I might want to go there	Not going there

Moons of Jupiter

Activities

I. Tracking Jupiter's Moons

In this exercise you will be simulating Galileo's observations of Jupiter's most prominent moons made over 400 years ago.

(a) In the first part of the activity, you will be responsible for tracking only one of the four Galilean moons. Your teacher will devise a strategy for dividing up the moons among your classmates.

(b) You will be observing a series of slides that will show the configuration of the moons over a nine day period, each slide representing a single night. The moons have been colored so that you can tell them apart. Once you have been assigned a moon, write down its color at the top of the sheet entitled 'Tracking Jupiter's Moons.'

(c) Notice the numbers on the slide entitled 'Night 1.' They indicate the distance from Jupiter in millions of miles. The negative number means to the 'left' and the positive number means to the right of Jupiter.

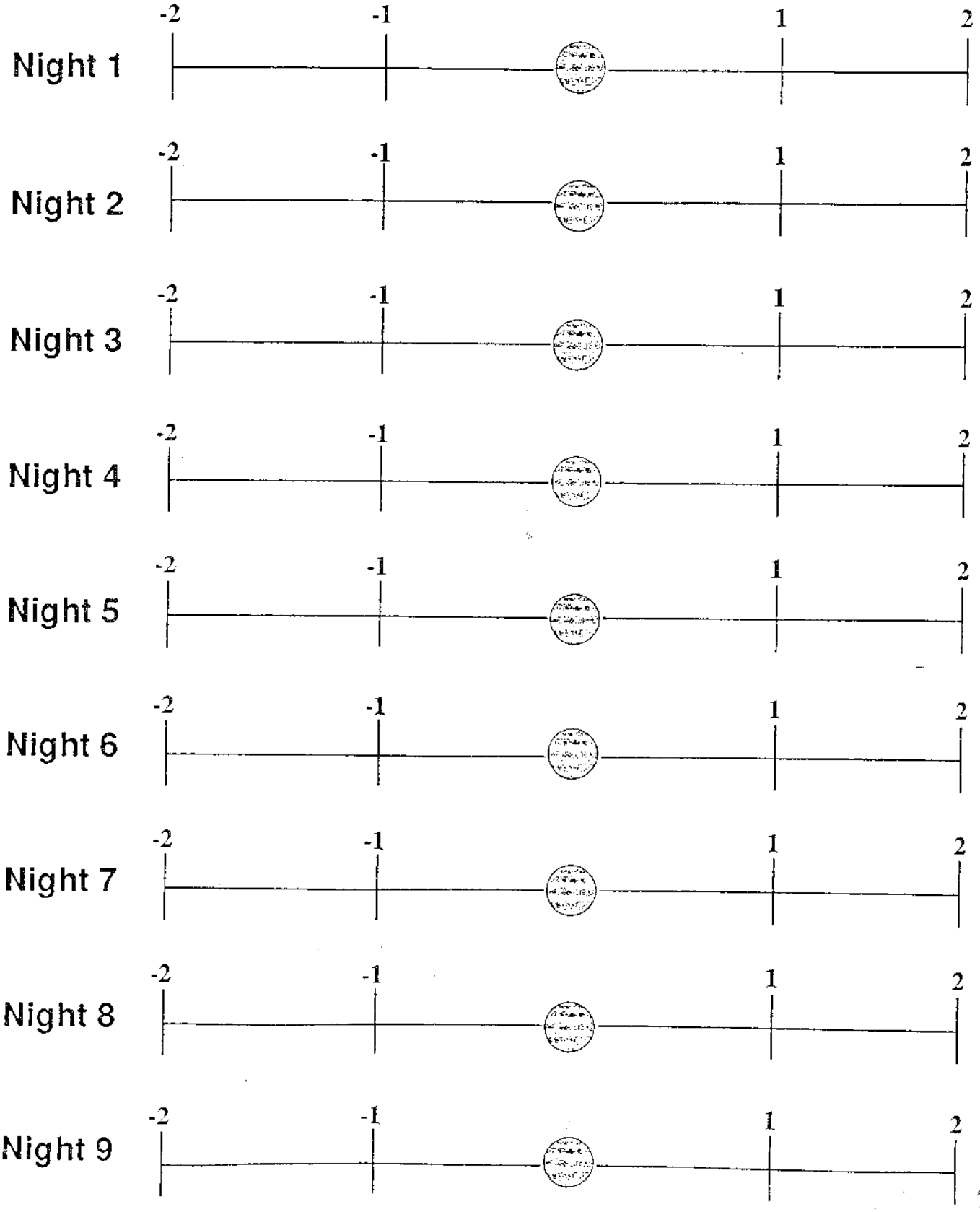
(d) Find your moon in relation to Jupiter in the slide for Night 1. Place an 'X' on the sheet on the 'Night 1' line to show the position of your moon as you see it in relation to Jupiter.

(e) Repeat this process for all nine nights. Connect the X's for each successive night with a straight diagonal line.

Name _____

Color code
of your moon: _____

TRACKING JUPITER'S MOONS



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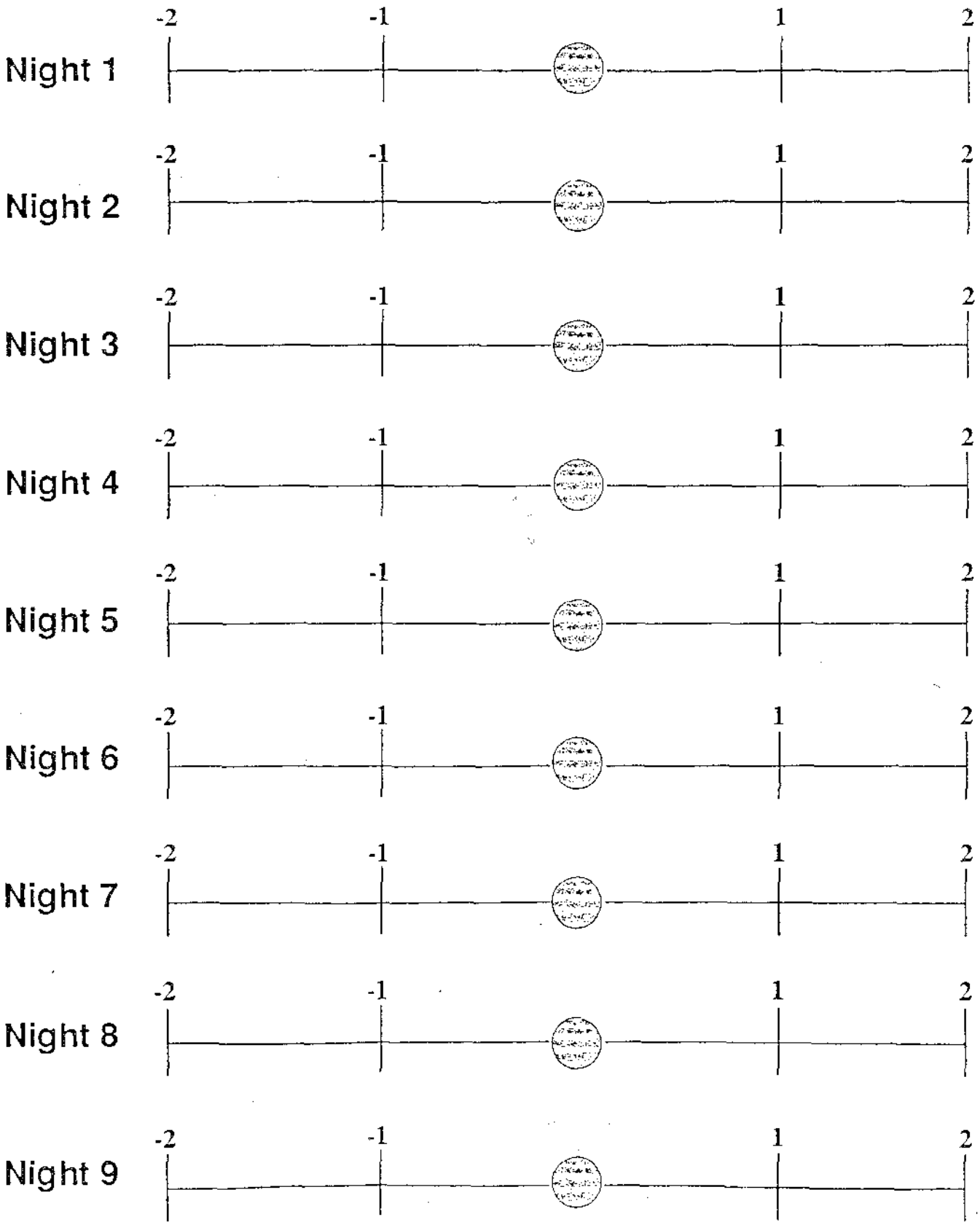
Name _____

Color code
of your moon: _____

TRACKING JUPITER'S MOONS



(f) Your teacher will now show the same series of slides again. This time track all 4 of the moons on the other sheet entitled 'Tracking Jupiter's Moons' included in this workbook. For each night you will make a mark for each moon. Make sure you make distinctions among them by either labeling or color coding.

(g) After viewing all nine nights for the second time and tracking all four moons, look at your data and determine how long each moon takes to revolve around Jupiter. Enter your results in the table below.

Color of Moon	Name of Moon	Number of days to revolve around Jupiter
Red	Io	
Yellow	Europa	
Blue	Ganymede	
White	Callisto	

Analysis:

1) Which moon is the furthest from Jupiter? The closest?
2) What is the relationship between distance and revolution?
3) Why is it that the moon that is the furthest out appears to be closer than Europa on Night 5?
4) Why do you think that Galileo's discovery of the moons of Jupiter, almost 400 years ago, was so important?

II. Grand Tour of the Jupiter System

In this activity you will continue your exploration of Jupiter's Galilean moons by studying close-up photos taken by the Voyager spacecraft.

(a) You will be viewing 10 slides of the Jupiter system. The first two slides are of Jupiter. The next eight images, 2 for each moon, details of the Galilean moons.

(b) When you view the two slides for each moon, write a brief description of what you observe on the data sheet entitled 'Grand Tour' for that moon.

(c) After you write your description of the moon, draw, as accurately as possible, the main features on the moon. In addition to the information provided on your data sheets, your teacher will supply some information that will be useful.

(d) Be sure that you make distinctions between **evidence** (what you actually observe) and **inference** (what you conclude from the evidence).

Unsolved Mysteries:

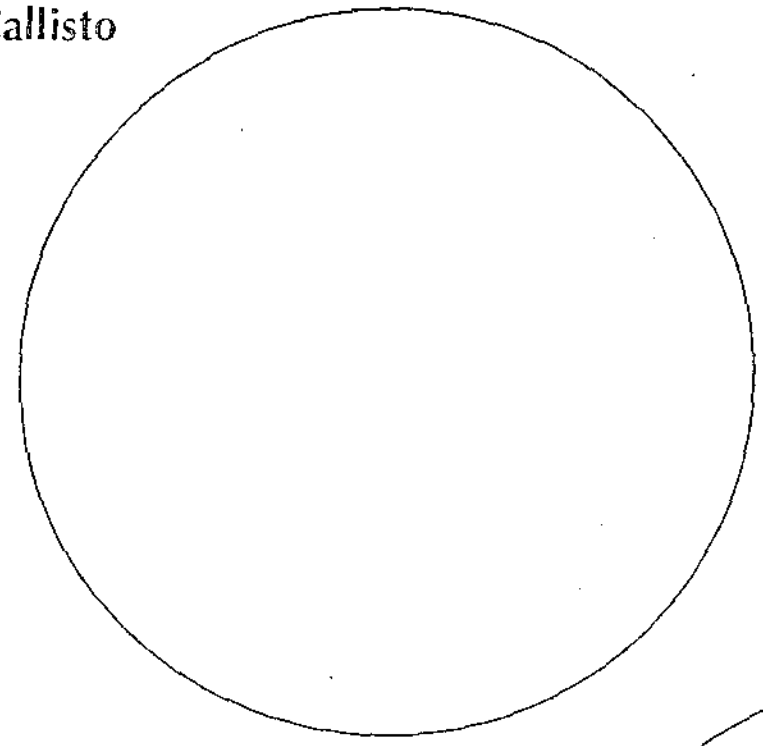
The answers to the questions below remain unanswered. With one or two classmates, develop an explanation for each, and also supply your reasoning for your ideas.

1) If Callisto's Valhalla is an impact crater, why does it have a multiple ring structure unlike other craters?
2) How did the grooved terrain on Ganymede originate?
3) Why is Europa so smooth?
4) Why does Io have so much sulfur?

Name_____ Date_____

Grand Tour

Callisto



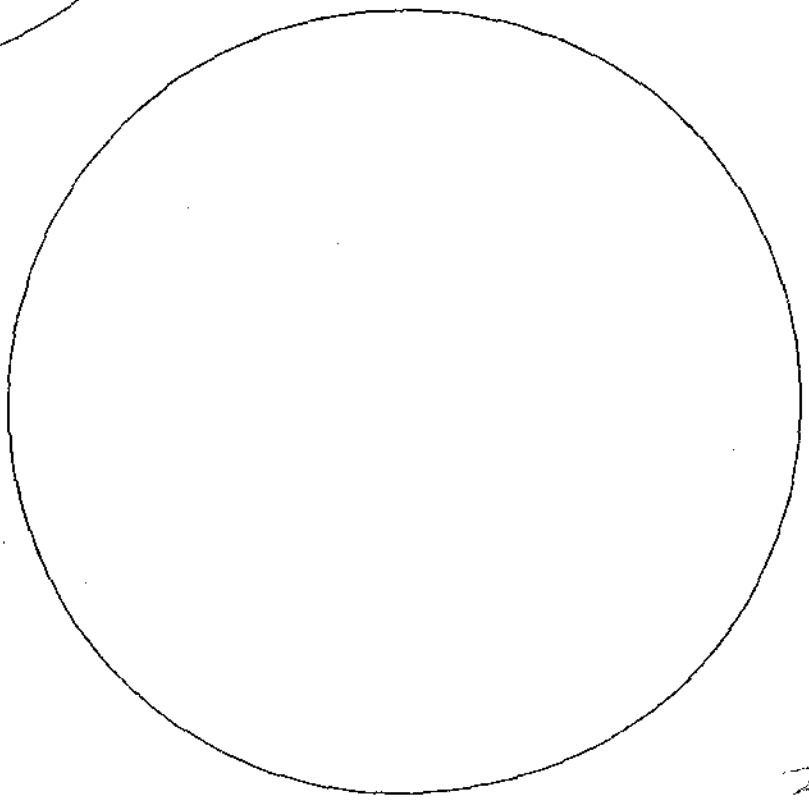
1. Impact craters cover much of the surface of Callisto.

2. The bright spots are probably ice exposed by the impact of large meteors.

3. The largest crater is called **Valhalla**. The bright area is 300 km in diameter, and the largest ring around Valhalla is 3,000 km in diameter.

4. There are no tall mountains and no volcanoes on Callisto.

Ganymede



1. **Galileo Regio** is a dark area, probably very old.

2. Bright impact craters probably reveal ice under the rock.

3. Light brown areas show long ridges of mountains and valleys in close-up views.

Note: Jupiter's moons are drawn to scale.
Scale: 1 cm = 500 km

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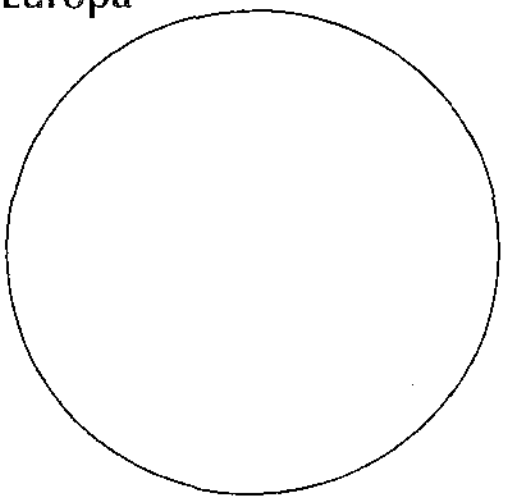
Name_____ Date_____

Grand Tour

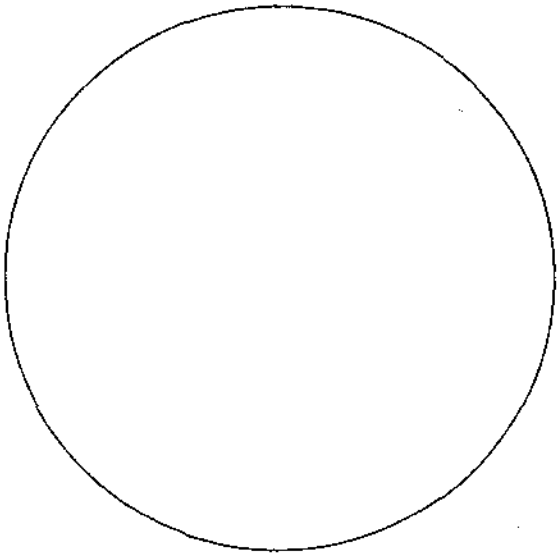
Europa



1. The slightly darker region may be a little rougher than the rest of Europa's surface.

2. Fine lines on the surface appear to be cracks, but are not very deep. No one knows for certain what they are.

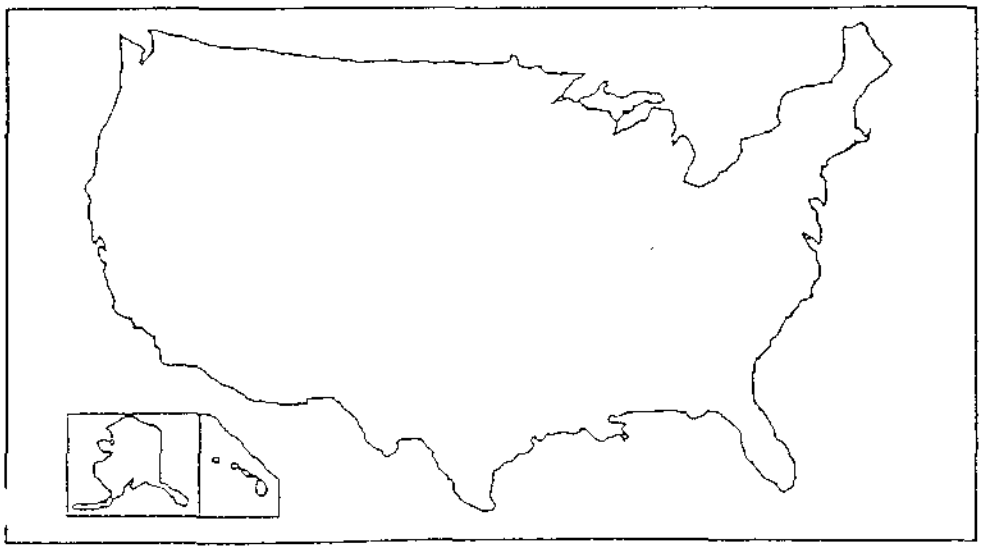
Io



1. **Pele** is an erupting volcano. The heart-shaped marking is the cloud of material being thrown out by the volcano.

2. **Loki Patera** is a volcano surrounded by a dark lake of liquid sulfur. **Babbar Patera** is another volcano that was erupting when the Voyager Spacecraft flew by.

4. **A close-up view** shows a volcano erupting on the horizon. The material from the volcano is ejecting in a cloud more than 200 kilometers high.



Compare the size of Jupiter's moons to the size of the United States.

All are drawn to scale.
1 cm = 500 km

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III. Creating Moon Settlements

In this activity you will work in teams, four students to a team, to design settlements where the first explorers of the Galilean moons might live and work. Each moon has its own settlement and scientific objective that will guide your thinking and design strategies.
Each student should have a piece of posterboard, cardboard, or piece of foamcore that measures about 24" X 36". This will provide the base upon which you will build your moon settlement.

(a) Materials for the settlements will be brought to class by you and your classmates (see the list of things to bring) and distributed by your teacher.

(b) Before building your team's settlement, examine the surface conditions and ask yourselves what would be necessary to live there. Also look at your settlement and scientific objectives to help you decide how to develop your moonbase.

(c) When you have completed your settlement, each member of your group will go before the class and give a presentation. The report should take the form of a tour of the facilities and should address the following:

- What is special about this moon?
- What were the settlement and scientific objectives that you had?
- How does your settlement take into account what you know about this moon?
- What types of functionality did you build into your moonbase.
- What do think it would be like to live in this settlement?

Scientific Mission to Io

Background:

Io is one of the strangest bodies in the solar system. Its volcanoes erupt various compounds of sulfur that have the striking colors of: red, orange, yellow, black, and white. There are about 200 volcanic craters with diameters greater than 20 kilometers. Nine eruptions were recorded by the two Voyager fly-by missions in 1979. Some of the plumes were hundreds of kilometers high. The sulfurous lava flows are hundreds of kilometers long.

There are two theories about why Io has so many volcanoes. One is that it is pushed and pulled by Jupiter's strong gravity, causing it to heat up as it orbits. (This is like the way a paper clip heats up when you bend it back and forth many times.) The other suggests that the heating is caused by Jupiter's strong magnetic field.

Your Scientific Objective: Use an all-terrain electric vehicle to explore volcanoes. Be careful! They are thought to be very hot and may erupt unpredictably.

Your Permanent Settlement Objective: Import water from Europa. Develop a system for using heat energy from the volcanoes to turn the ice into water for drinking, oxygen for breathing, and hydrogen for fuel.

Don't forget about conditions like:

- Low gravity (1/3rd to 1/6th the gravity of Earth)
- Bitter cold temperatures (-100°C to -200°C), except in lava lake and volcanoes, where temperatures can be well over 70°C (160°F)
- Exposure to cosmic rays and radiation
- No liquid water
- No air
- Little sunlight (1/25th as much as on Earth)

Good Luck!