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.

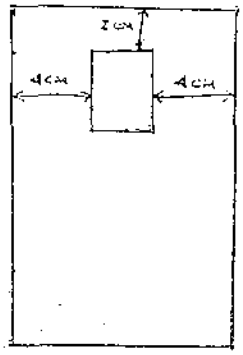


Fig. 1

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.

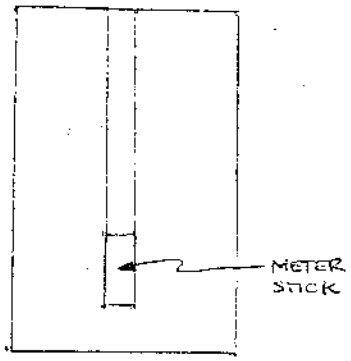


Fig. 2A

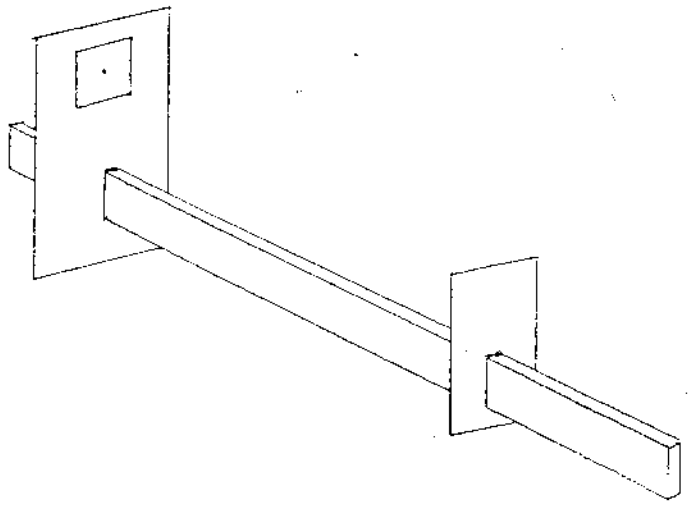


Fig. 2B

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:

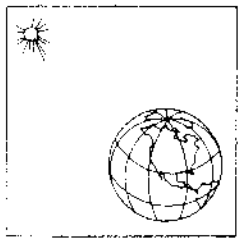
20 points total (2 points extra credit for an astronomy topic)
-2 points if article is not attached or website is not listed
-2 points if summary is less than 1/2 page
-2 points if more or less than 5 bullet notes on the back
-2 points if less than 50% eye contact

Name_____ Date_____

WHAT ARE YOUR IDEAS ABOUT THE EARTH?

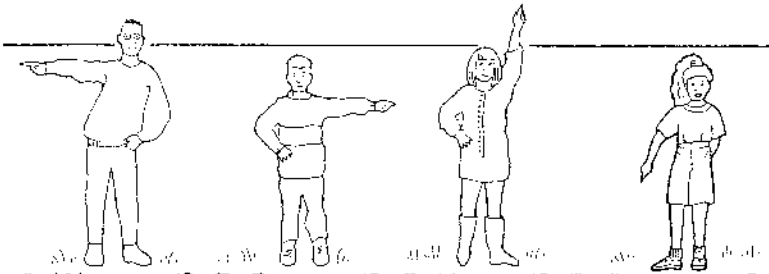
QUESTION 1: Why is the Earth flat in picture #1 and round in picture #2?
(Circle the letter in front of the best answer.)


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.

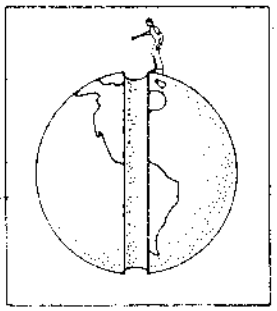
QUESTION 2: Pretend that the Earth is glass and you can look through it. **Which way would you look, in a straight line, to see people in far-off countries like China or India?**



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)

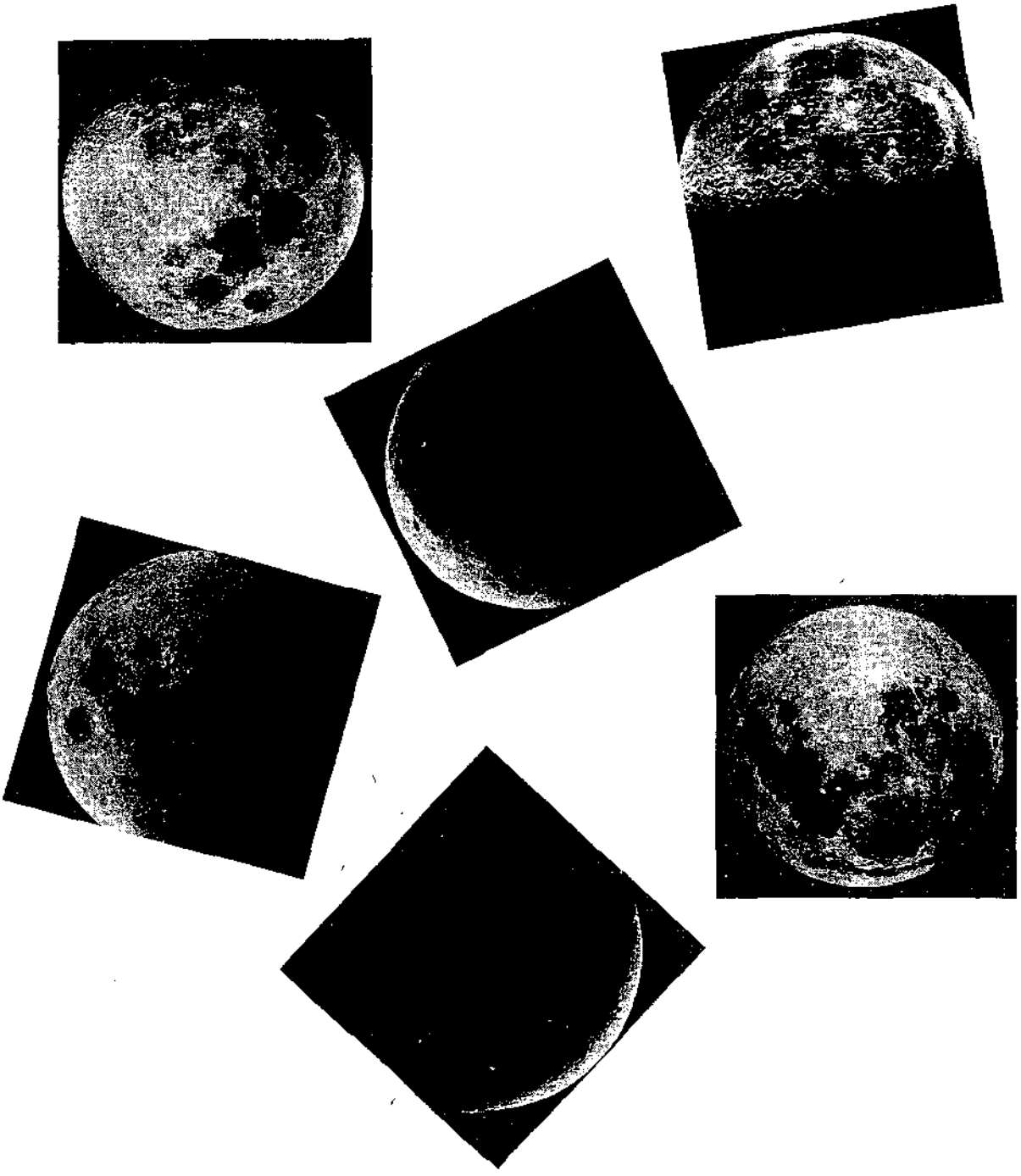
1) Obtain the following: lunar photographs, tape or glue, scissors, and blank paper.

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

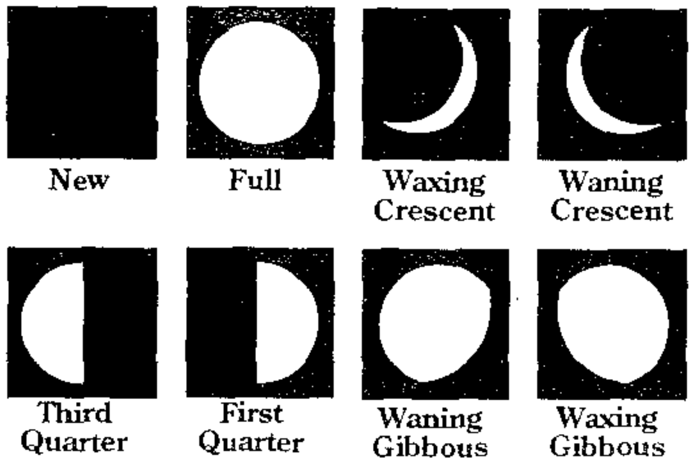
Cut out each picture. Arrange them in the order you would expect to see the moon during the next several weeks.



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.

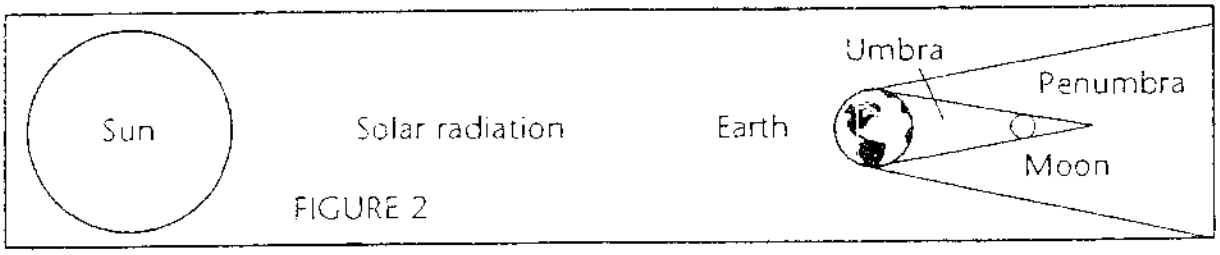


FIGURE 2

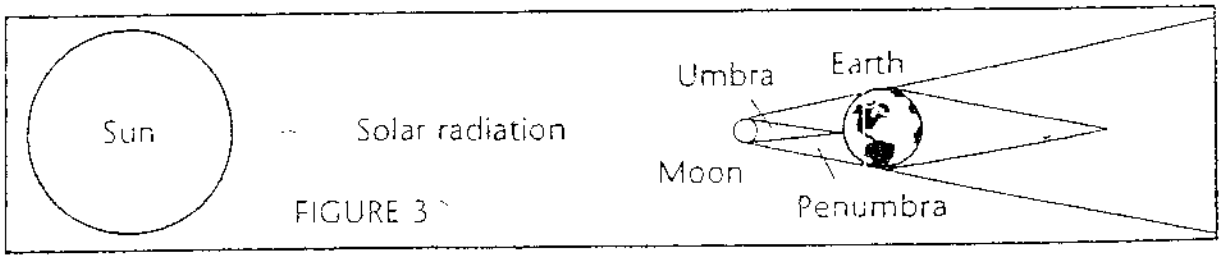


FIGURE 3

6. Figure 2: _____

_____

_____

7. Figure 3: _____

_____

_____

_____

NAME DATE CLASS

Chapter 22

ENRICHMENT

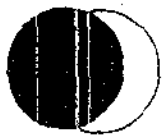
Text Pages 623–631

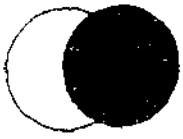
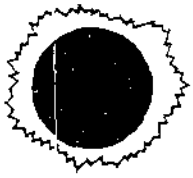
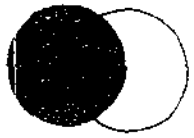
• Earth's Moon #2

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.

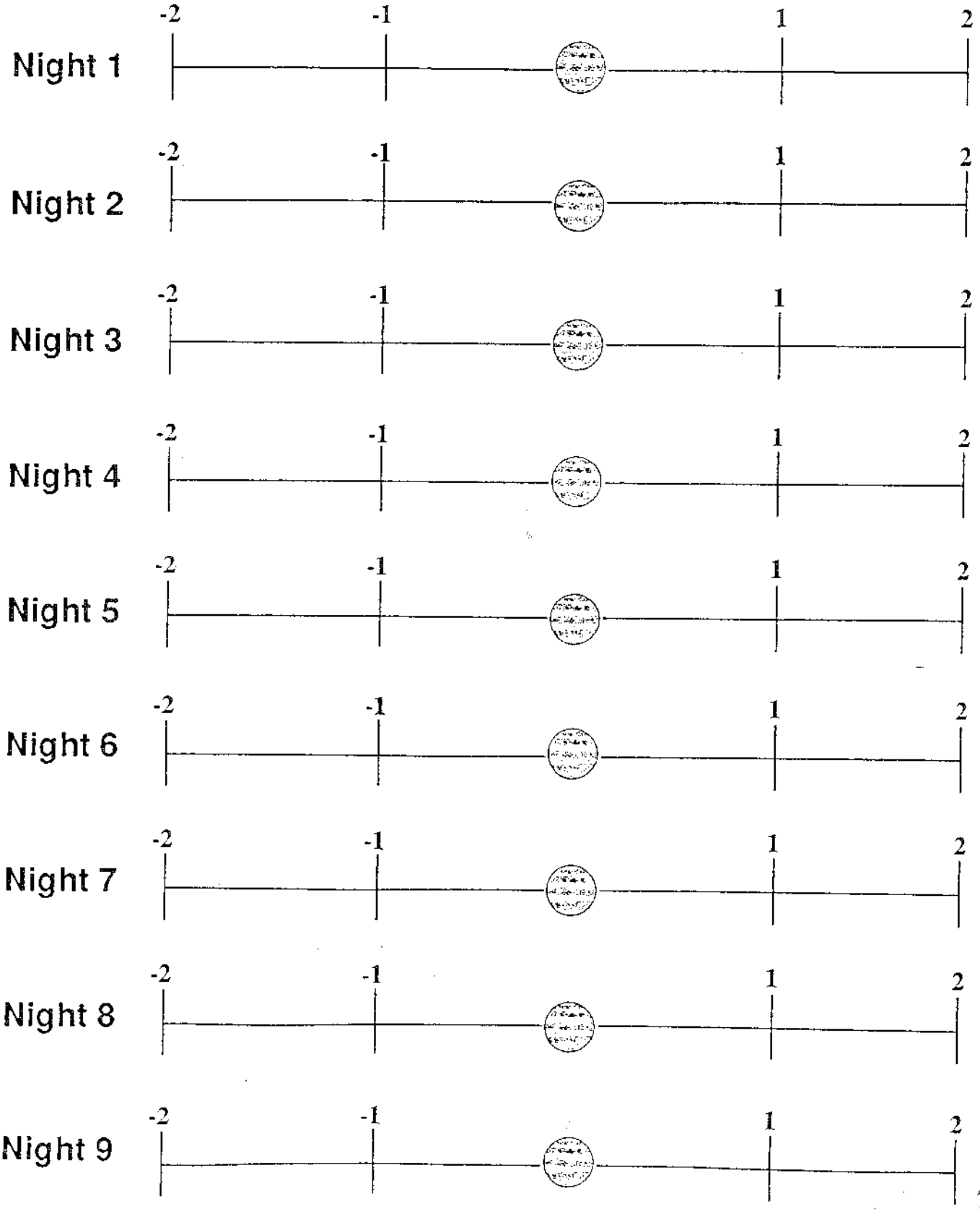
(d) Find your moon in relation to Jupiter in the slide for Night 1. Place an 'X' on the sheet on the 'Night 1' line to show the position of your moon as you see it in relation to Jupiter.

(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

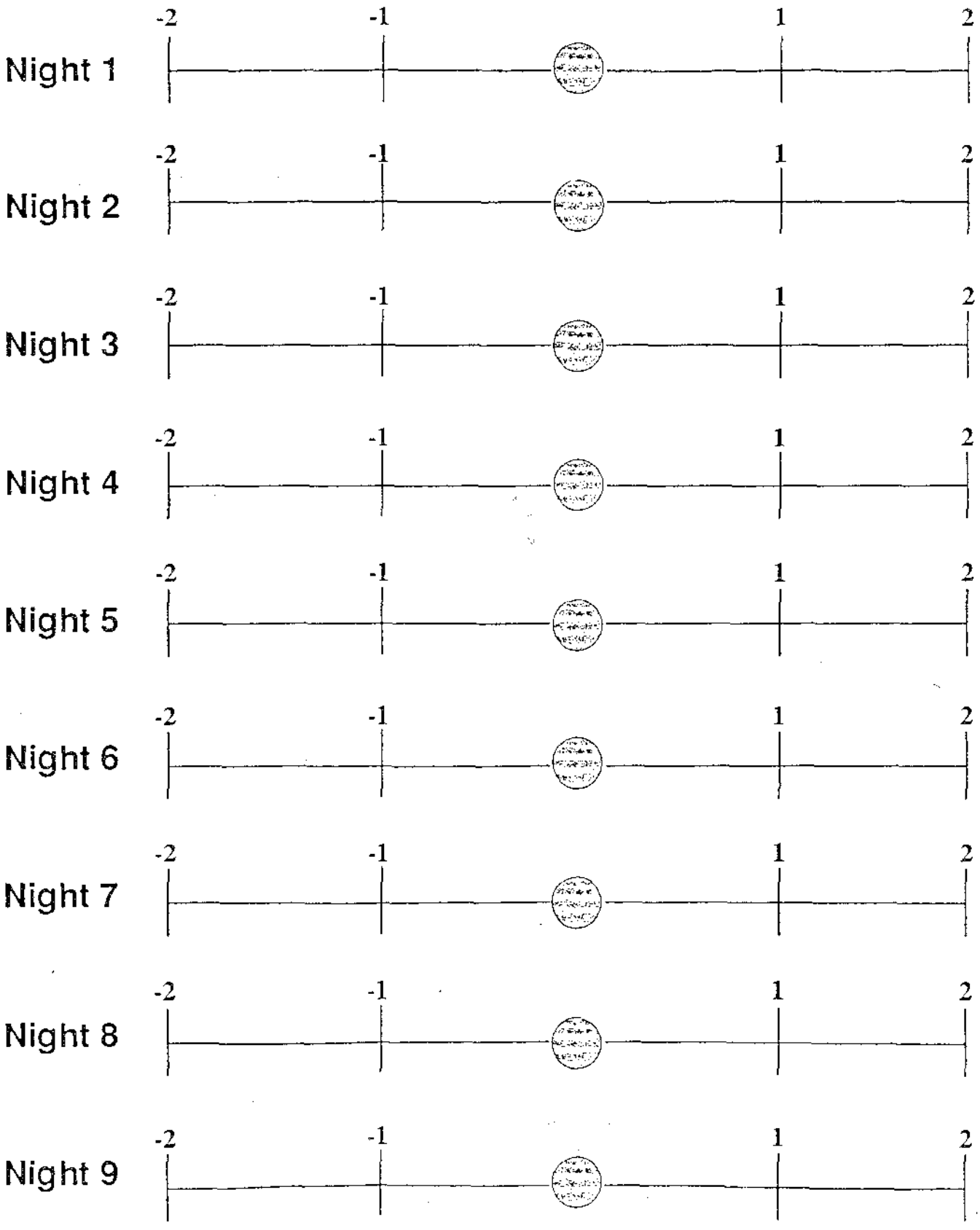


32

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:

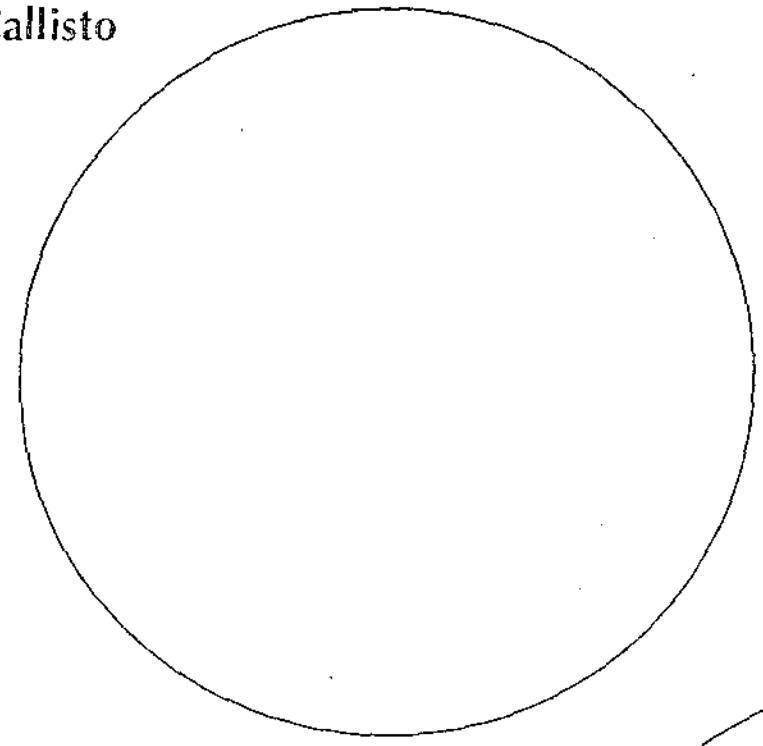
The answers to the questions below remain unanswered. With one or two classmates, develop an explanation for each, and also supply your reasoning for your ideas.

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



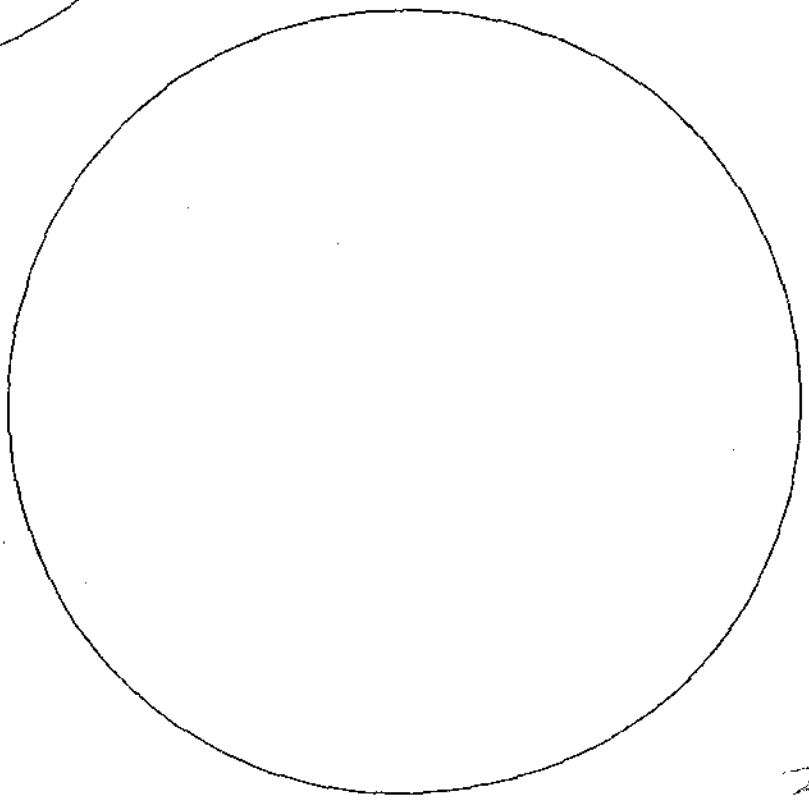
1. Impact craters cover much of the surface of Callisto.

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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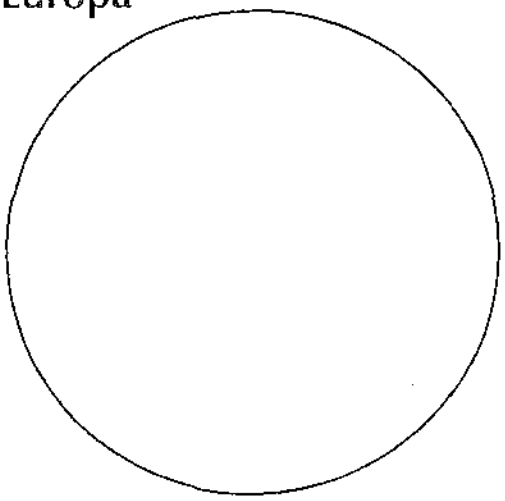
Name_____ Date_____

Grand Tour

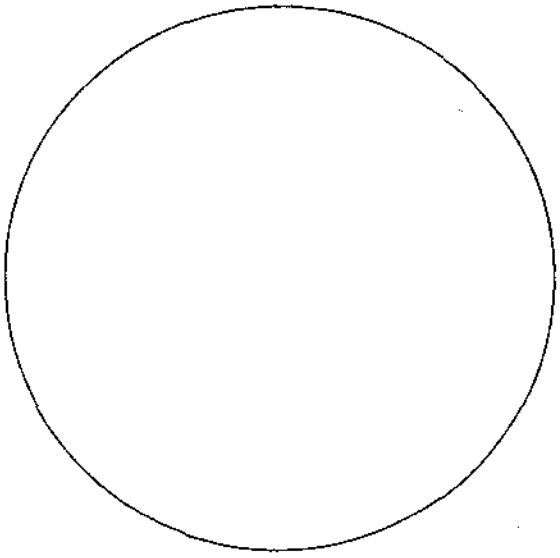
Europa



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.

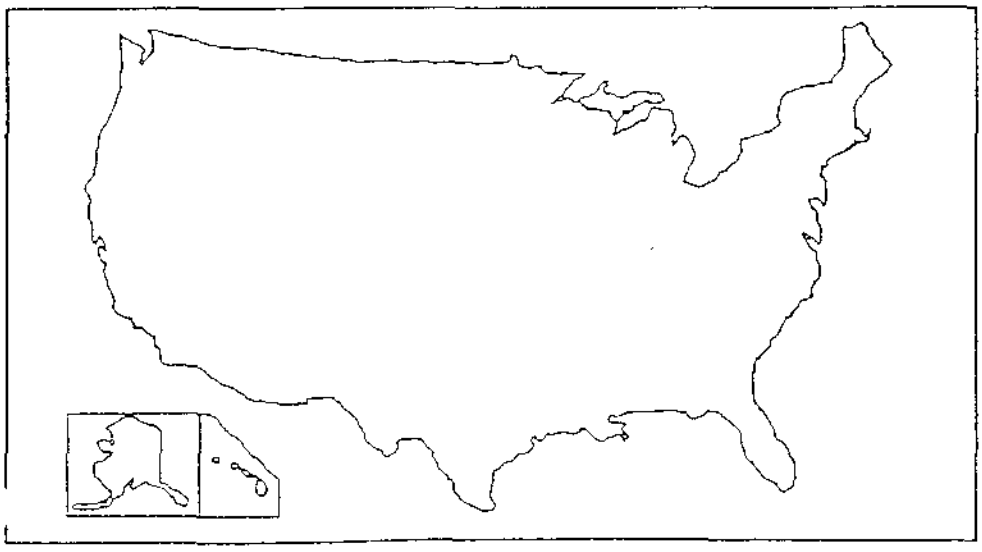
Io



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

37

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.

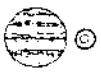
Your Scientific Objective: Use an all-terrain electric vehicle to explore volcanoes. Be careful! They are thought to be very hot and may erupt unpredictably.

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!



Scientific Mission to Europa

Background:

Europa is the most mysterious of Jupiter's satellites. Its surface is one of the smoothest in the solar system. There are no craters larger than 50 kilometers across. This means that Europa may undergo some sort of resurfacing process that may still be occurring. Europa's rocky interior is covered by an icy crust not more than 100 kilometers thick, but possibly as thin as a few hundred meters. There may be an ocean or layer of liquid water, extending as deep as 10 kilometers below the ice. No one knows for certain what the long dark lines are. The large dark areas may be places where Europa has been bombarded by sulfurous material originating from Io.

Your Scientific Objective: Use an all-terrain electric vehicle to explore the dark lines and try to determine their cause. Also drill to determine the depth of ocean and the thickness of surface ice.

Your Permanent Settlement Objective: Establish a system to mine surface ice for export to Io where it will be melted and turned into drinking water, oxygen for breathing, and hydrogen for energy.

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)
- Exposure to cosmic rays and radiation
- There may be a layer of liquid water below the ice
- No air
- Little sunlight (1/25th as much as on Earth)

Good Luck!

4C

Scientific Mission to Ganymede

Background:

Ganymede is the largest moon in the solar system. The light regions have parallel sets of ridges. They are low mountains, somewhat like the Appalachians on Earth. The dark areas resemble the heavily cratered surface of Callisto and are believed to be older than the light areas.

Your Scientific Objective: Use an all-terrain electric vehicle to make a survey of the light and dark areas to try to determine their origins.

Your Permanent Settlement Objective: Construct a hospital to serve all four moon settlements.

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)
- Exposure to cosmic rays and radiation
- No liquid water
- No air
- Little sunlight (1/25th as much as on Earth)

Good Luck!

Scientific Mission to Callisto

Background:

Callisto has an ice crust of unknown depth. Callisto is almost completely covered with large craters. Most of the craters are believed to be very old — close to 4 billion years. The craters are much flatter than craters formed on rocky moons like Earth's Luna. It is not known whether the flatness of the craters on Callisto is caused by melting of the surface when a meteor strikes, or by the very slow movement of the ice over millions of years.

Your Scientific Objective: Use an all-terrain electric vehicle to make a detailed map of the rings surrounding Valhalla.

Your Permanent Settlement Objective: Make a food production facility that can supply food for all the settlements (less radiation shielding to protect farms would be required on Callisto).

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)
- Exposure to cosmic rays and radiation (though less radiation than on the other moons)
- No liquid water
- No air
- Little sunlight (1/25th as much as on Earth)

Good Luck!

4·2

Can You Planet?

Purpose: You will learn various aspects of the planets and their relationships with one another by using tables of planetary facts, Venn diagrams, and drawings of the planets themselves.

Materials: Activity sheets, scissors, pencils, and colored pencils.

Procedure:

Work in small group (three students/group). Each student is responsible for the completing the activity.

1) Working with what you already know about the planets, brainstorm ways in which you can classify the planets.
2) Using Venn diagrams, how can we classify the nine planets.
3) Complete the table entitled "Planetary Facts Helping Table."
4) Use the information from the completed table in step 3 to complete the 2 and 3 circle Venn diagrams.
5) Complete the table entitled "More Planetary Facts (Venn Again)," by developing three individual classification criteria that you develop within your group that are different than those given in the activity.
6) Draw a 3 circle Venn diagram on the sheet entitled "Venn Again."

Analysis:

Use the tables and Venn diagrams to answer the following:

1) Which planets are larger than the earth?

2) Which two planets are the closest in size?

3) What percent of the planets are smaller than the Earth?

4) Which planets have moons?

5) Which planet has the most moons?

6) What is the total number of known moons in our solar system?

7) What is the average number of moons in our solar system?

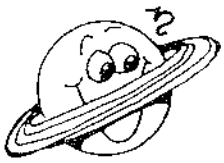
8) Which planets fit into all three categories?

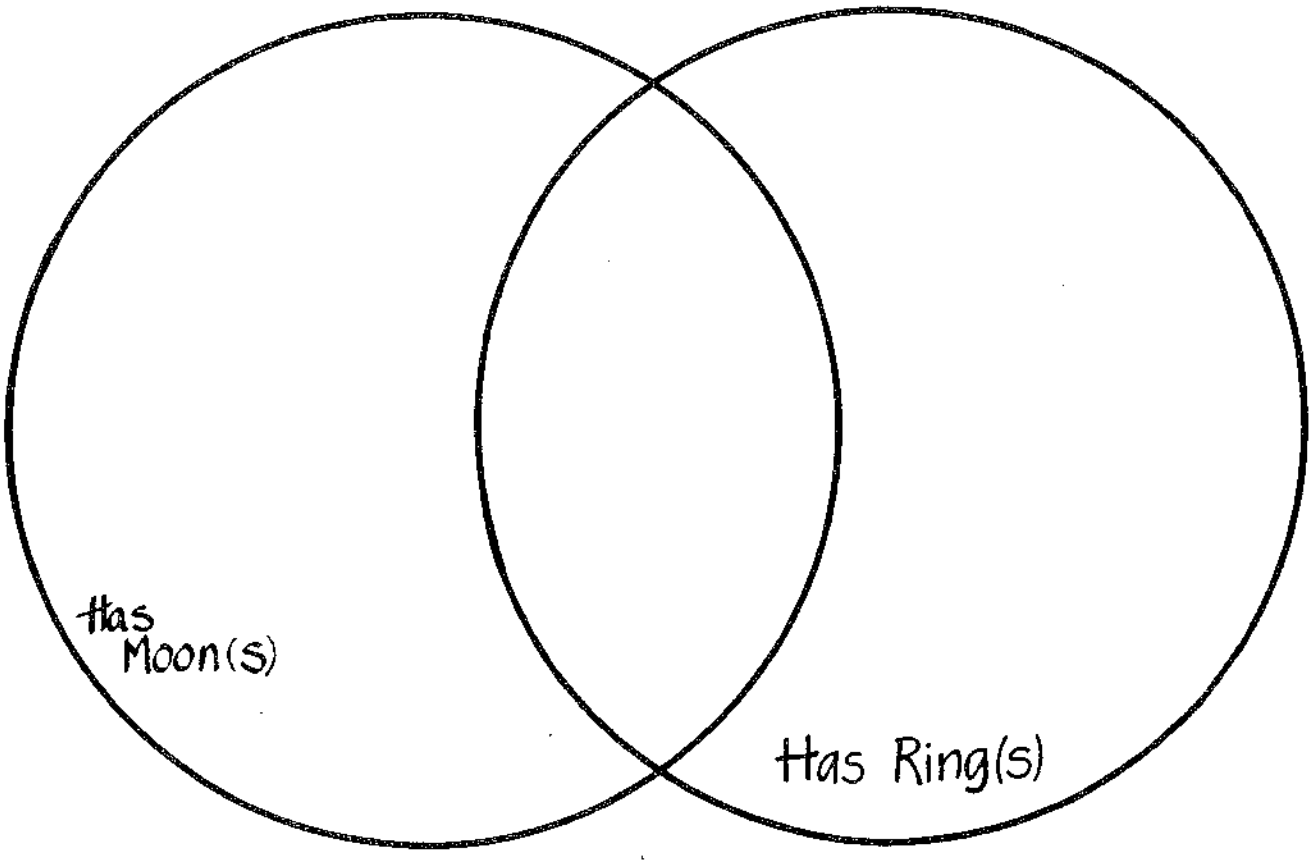
9) Which planets have days which are longer than 24 hours?

Name: _____

CAN YOU PLANET?

Use the information from the chart to place the planets in the correct circle or intersection of circles.

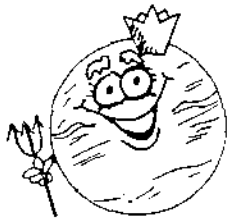




Name: _____

CAN YOU PLANET?

Use the information from the chart to place the planets in the correct circle or intersection of circles.



AG

Extraterrestrial Excursions

Background Information:

The great distances in space are sometimes difficult to comprehend. Looking at the time it would take to travel to the moon and the planets by walking, by car, or by jet plane, it becomes easier to understand what a great undertaking interplanetary space travel would be.

Purpose:

To gain an understanding of how vast space is and the demands that interplanetary space travel would place on humans using current technology.

Materials:

Activity sheets and calculators.

Procedure:

Work in small groups (three/group). Each student is responsible for completing the activity.

1) Using directions given in class by your teacher, complete the sheet entitled "Travel Time."

2) On the sheet with the data table entitled "Extraterrestrial Excursions," write down your age today in years and months.

3) Using a speed of 40,000 km/hr, predict how long it will take to travel to the moon and each of the planets and enter this predicted value in the appropriate column in the data table.

4) Using your predicted value of how long it would take to reach the destinations listed in the table, record your predicted ages on arrival to each of those destinations in the appropriate column.

5) Use the formulas in each of the succeeding columns to compute the travel time to each of the destinations in the following way:
(a) to compute the hours of travel time, divide the distance from earth by the speed of 40,000 km/hr and round to the nearest hour.
(b) to compute the number of days traveled, divide the number of hours by 24 and round to the nearest day.
(c) to compute the number of months traveled, divide the number of days by 30 and round to the nearest month.
(d) to compute the number of years traveled, divide the number of months by 12 and round to the nearest number of years and months.

6) Add the amount in step 5d to your age and this will give you your actual age in years and months at the time of arrival. Enter this value in the appropriate column.

7) Use the information gathered in the "Travel Time" table to answer the questions on the sheet entitled "Special Delivery."

Travel Time

Planetary Body	Walking 2.5 miles/hr 3.6 km/hr	Car 55 miles/hr 80 km/hr	Jet 990 miles/hr 1436 km/hr
Moon			
Mercury			
Venus			
Mars			
Jupiter			
Saturn			
Uranus			
Neptune			
Pluto			

Extraterrestrial Excursions Data

Object and Distance to Earth (km)	Predicted Travel Time	Predicted Age Upon Arrival	Hours	Days	Months	Years	Actual Arrival Age
Moon/384,000							
Mercury 92,000,000							
Venus 41,000,000							
Mars 78,000,000							
Jupiter 629,000,000							
Uranus 2,721,000,000							
Neptune 4,347,000,000							
Pluto 5,750,000,000							

Extraterrestrial Excursions (continued)-

Special Delivery

Imagine that you work for the Solar systems Delivery Service. You need to determine the time necessary to make certain deliveries and return to Earth. The planets are not lined up in a straight line in their orbits around the sun, so you must always return to the Earth for refueling between planets. Use the information in the "Extraterrestrial Excursions" data table to calculate the travel times for the following delivery scenarios:
(Remember, your journey is not complete until you return to the Earth!) Show your work in the space provided.

1)Deliver communication systems to Mercury and Jupiter.

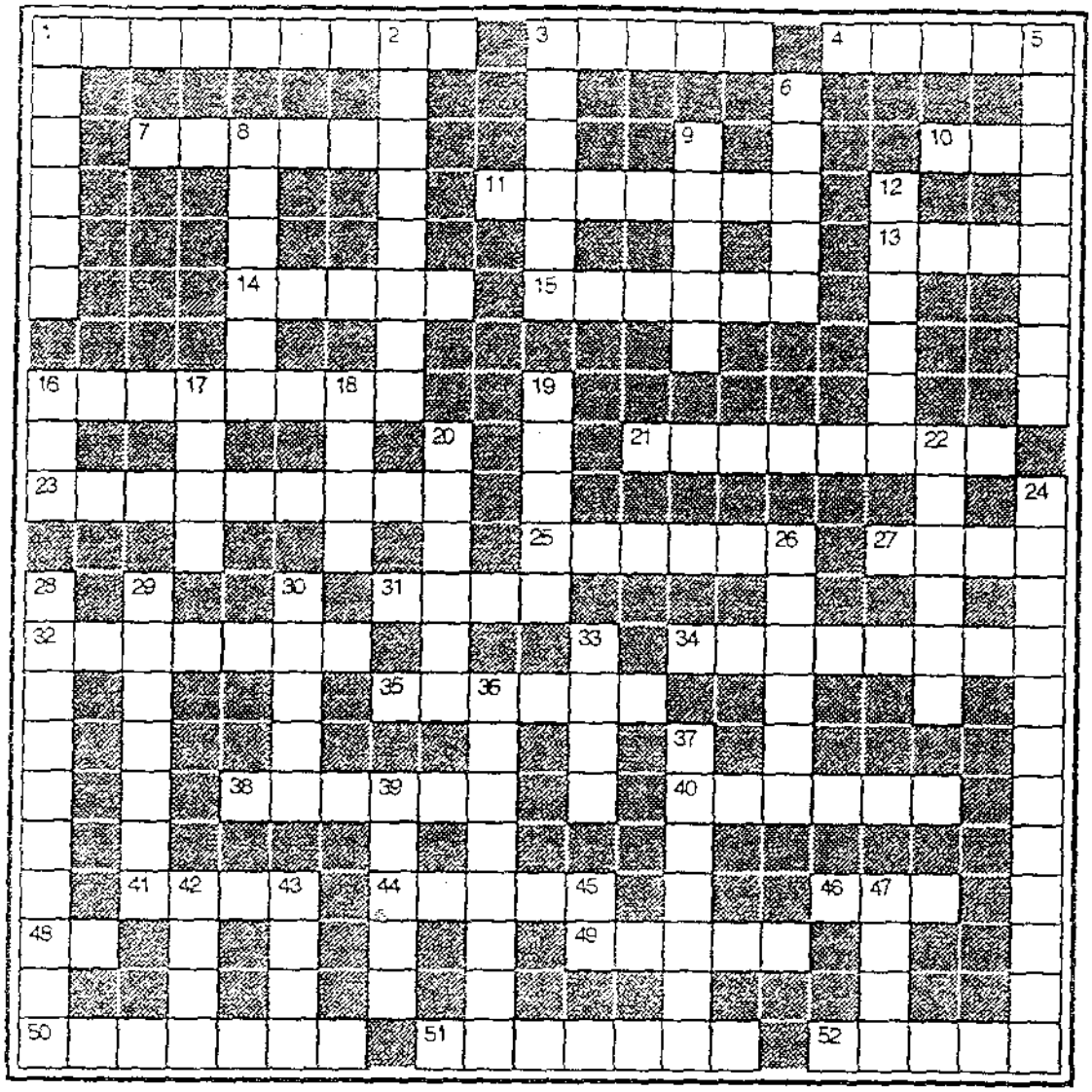
2) Deliver pizza to Venus and Mars.

3) You travel to one outer and one inner planet and back home again. Your journey takes you about 7 years 6 months. To which planets did you travel?

4) Starting at Neptune, you travel home to Earth and then deliver letters to Mars.

Name _____ Date _____ Per ___ Score _____

THE SOLAR SYSTEM



ACROSS
1. TROPIC; AT 23.5 SOUTH LATITUDE
3. AREA OF FULL SHADOW
4. FOUND AROUND SATURN
7. WANDERING BODY
10. THE SUN'S NAME
11. VERY OLD
13. SUN GIVES THIS OFF
14. "SEAS" OF THE MOON
15. PLANET OF MANY RINGS
16. 4 LARGE MOONS OF JUPITER
21. JUPITER'S HEAVILY CRATERED MOON
23. AN ORBITING BODY
25. AN OCEAN; _____ CIRCLE
27. THE RED PLANET
31. THE SUN IS ONE
32. TIME OF EQUAL DAY AND NIGHT
34. JUPITER'S LARGEST MOON
35. DISCOVERED THE OVAL ORBITS OF THE PLANETS
38. NEPTUNE'S LARGEST MOON
40. BILLIARD-BALL MOON OF JUPITER
41. GO TO YOUR _____
44. ITS TAIL IS CAUSED BY THE SOLAR WIND
46. UNIDENTIFIED FLYING OBJECT
48. MOON WITH VOLCANIC ACTIVITY
49. SMALLEST PLANET
50. BLUE PLANET
51. A COMET SEEN EVERY 76 YEARS
52. PATH OF REVOLUTION

DOWN
1. PLUTO'S MOON
2. TURNING OF A PLANET ON ITS AXIS
3. PLANET; ROTATES ON ITS SIDE
5. WINTER OR SUMMER; LONGEST & SHORTEST DAYS
6. SATURN'S LARGEST MOON
8. _____, VEGETABLE, OR MINERAL
9. GODDESS OF LOVE
12. A SATELLITE OF MARS
16. OUTER PLANETS; _____ GIANTS
17. COLD TEA
18. PLANETS ROTATE ON THIS
19. HAVING TO DO WITH THE MOON
20. NOT ROUGH; _____ BEN
22. TO GO FROM PLACE TO PLACE
24. FOUND BETWEEN MARS AND JUPITER
26. TROPIC AT 23.5 NORTH LATITUDE
28. MOVEMENT AROUND THE SUN
29. LARGEST PLANET
30. _____ ECLIPSE
33. _____ SPACE NINE
36. AREA OF PARTIAL SHADOW
37. MESSENGER TO THE GODS
39. OUTDATED, OUT OF STYLE
42. TO LEAVE OUT
43. EARTH'S SATELLITE
45. DECORATE OUTSIDE WITH BATHROOM PRODUCTS
47. NUMBER OF GAS GIANTS

SOJ '95 HJHS

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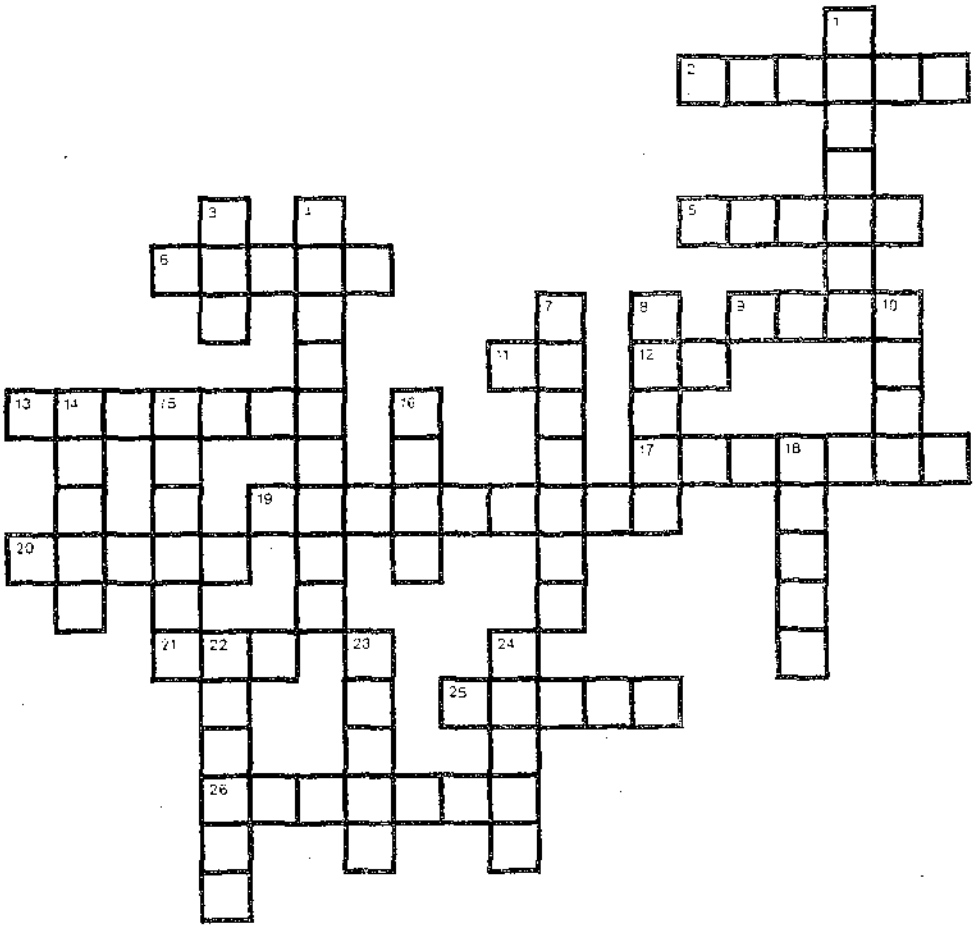
Worlds and Words



ACROSS CLUES

2. A planet with rings
5. This inner planet has one moon.
6. This appears once to have flowed on Mars.
9. The planet with a rusty red surface and ice caps
11. The symbol for the second most common element in the universe
12. The Galilean moons of Jupiter include Callisto, Ganymede, Europa and _____.
13. Mars has the largest known canyon and the largest _____ in the solar system.
17. The force that moves comets and meteoroids
19. Giant reptiles that may have met extinction by comet impact
20. The only moon in the solar system believed to have a substantial atmosphere
21. All the planets revolve around this.
25. The inner planets are also called terrestrial or _____.
26. The most distant gas giant planet in the solar system

DOWN CLUES

1. The largest planet in the solar system
3. Jupiter, Saturn, Uranus and Neptune are _____ giants.
4. A rocky or metallic fragment that falls from space to earth
7. The closest planet to the sun is heavily cratered like our moon.
8. These bands of ice fragments and rocks orbit the outer giant planets.
10. The most distinctive visible feature of Jupiter is its red _____.
14. The path of a satellite around a planet
15. Fictional Martian channels imagined by Percival Lowell
16. A natural satellite
18. Soviet spacecraft have landed on this hot planet.
22. A green gaseous planet that is 'tilted' on its side
23. A small, rocky, icy planet that was discovered in this century
24. The Oort Cloud may be the source of this ic object.

Creative Constellations

In ancient times, people were able to look up in the night sky and see animals, people, and mythological creatures among the stars. These figures even had wonderful stories surrounding them and have become legends over time.

Now is your chance to discover a new constellation and take your place among the stars!

The Constellation

1. Turn to the back of this paper, close your eyes, and randomly make 10 dots with your pen/pencil.
   (Try not to miss your paper!)
2. Darken your dots so that they are easily seen. These are your new stars.
3. Design a constellation around your stars by drawing around them. Make it colorful and creative!

The Myth

1. Take out a separate sheet of binder paper.
2. Now focus all your imagination and create a wonderful story for your new constellation. Include fantastic detail explaining why your figure became a legend!

The Presentation

1. Punch a small hole through each of your stars.
2. Place your paper on the overhead projector and shine your constellation on the screen for everyone to see.
3. Read your story to explain why your figure is among the stars!
4. When finished, show the class your original drawing.

Astronomy

Constellation Project

Instructions:

1) Choose a constellation from the list on the next page. If more than one individual chooses the same constellation, your teacher will resolve it using an objective approach (lottery, number draw, etc.).

2) On a piece of butcher paper (approximately 24"X36") you must include the following components:

(a) A conventional drawing of your constellation. Show all stars according to their magnitudes. Name and label all stars in your constellation.

(b) A mythological drawing of your constellation. Include the stars in the background of your mythological figure.

(c) An H.A. Rey drawing of your constellation.

(d) The origin and mythology associated with your constellation.

(e) Indicate whether your constellation is zodiacal or circumpolar or neither.

(f) Indicate the time of year that your constellation can be seen during prime viewing time (first 2-3 hours after dark).

3) Make sure all components, including your name, can be seen clearly from a distance as you will be hanging your work on the classroom walls.

4) Hang your work on the wall.

Resources:

1) your text

2) the internet – there are numerous sites dedicated to constellations.

3) H.A. Rey

Astronomy

Constellation Project

Constellation	Prominent Stars	Number of Stars	Season	Zodiac (Y/N)
Lyra	Vega	7	Summer	N
Aquila	Altair	8	Summer	N
Cygnus	Deneb	5	Summer	N
Ursa Major	Mizar	18	All Year	N
Ursa Minor	Polaris	7	All Year	N
Scorpio	Antares	15	Summer	Y
Corona Borealis	Alphecca	7	Summer	N
Orion	Rigel	7	Winter	N
Bootes	Arcturus	12	Summer	N
Auriga	Capella	6	Winter	N
Leo	Regulus	10	Spring	Y
Virgo	Spica	6	Summer	Y
Canis Major	Sirius	16	Winter	N
Taurus	Aldebaran	27	Winter	Y
Gemini	Castor & Pollux	11	Winter	Y
Hercules	Raselgethi	13	Summer	N
Pisces	P. beta	7	Winter	Y
Aquarius	A. alpha	10	Autumn	Y
Pegasus	Alpheratz	9	Summer	N
Andromeda	Mirach	19	Summer	N
Cepheus	Alderamin	5	All Year	N
Cassiopeia	C. beta	5	All Year	N
Draco	Thuban	8	All Year	N
Perseus	Algol	12	Autumn/Winter	N
Sagittarius	Nunki	8	Summer	Y
Ophiuchus	Sabik	30	Summer	Y
Libra	Zubenelgenubi	5	Summer	Y
Delphinus	D. beta	5	Summer	N
Capricornus	C. beta	13	Autumn	Y
Aries	Hamal	10	Autumn/Winter	Y
Cetus	Diphda	12	Autumn	N

STAR SIGNS - LEVEL 2

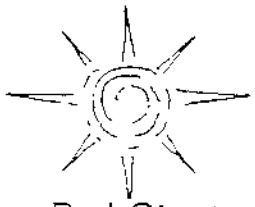
Long before the time of television, movie theaters or video games our ancestors amused themselves by studying the night sky and telling stories about the pictures they saw there. The zodiac names we use today are actually the names our ancestors gave to special star groups known as constellations. How many of the ancient constellation names can you correctly identify? Place the constellation's letter on the line next to its description.

A. Gemini	_____ The Water Carrier
B. Cancer	_____ The Crab
C. Aries	_____ The Goat
D. Libra	_____ The Twins
E. Ursa Major	_____ The Dragon
F. Capricornus	_____ The Winged Horse
G. Leo	_____ The Scorpion
H. Draco	_____ The Bull
I. Pegasus	_____ The Archer
J. Taurus	_____ The Fish
K. Pisces	_____ The Hunter
L. Aquarius	_____ The Lion
M. Sagittarius	_____ The Scales
N. Scorpius	_____ The Ram
O. Orion	_____ The Great Bear

Life Cycles of Stars

Young Star

Energy from nuclear fusion is equal to force of gravity.

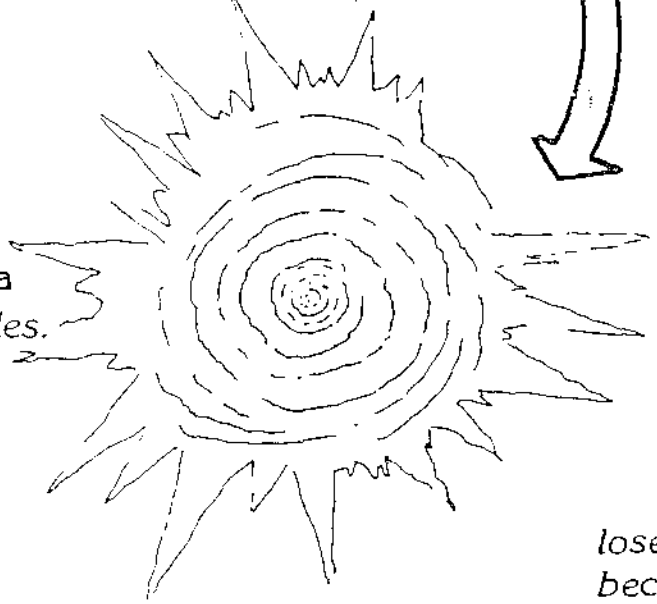


Red Giant

Unstable forces cause star to expand.

White Dwarf

small, dense stars resulting from the collapse of Red Giant



Supernova

Star explodes.

Black Dwarf

loses energy and becomes a cold, black object in space

Black Hole

a stellar object so dense light cannot escape

Neutron Star (Pulsars)

very dense object made up of neutrons

1. At which life-cycle stage are stars the most stable? _____

   Why? _____

2. What type of stellar object has the greatest density? _____

   What is the evidence for this? _____

3. What is the gigantic explosion of a Red Giant called? _____

4. Some neutron stars emit pulses of radiation and are called _____.

5. Which types of stars are invisible? _____

6. If you were looking at the sky and a supernova explosion occurred, why would you *not* see it? _____

_____

NAME DATE CLASS

Chapter 24

Text Pages 684–690

Evolution of Stars

Circle the term in the puzzle that fits each clue. Then write the term on the line. In the puzzle, the terms read across or down.

E I B L A C K H O L E N S
H N E U T R O N S T A R T
R M A I N S E Q U E N C E
D C E I E N P R P O P O G
I O S E B L U E E D T H I
A L A T U M A S R S C A A
G O Y E L L O W G N B E N
R R C O A N V E I R T E T
A W H I T E D W A R F D I
M N T S U P E R N O V A O
E N F U S I O N T E R G Y

1. A _____ is a large cloud of dust and gas that becomes a star.
2. A graph that shows the relationship between a star's absolute magnitude and temperature is an _____ .
3. A star that is a _____ uses helium for fuel and has expanding outer layers.
4. The _____ of atoms powers the sun and other stars.
5. The temperature and brightness of stars are indicated by _____ .
6. About 90 percent of the stars, including our sun, are _____ stars.
7. A _____ is produced when the outer core of a star explodes after the core collapses.
8. The hottest, brightest stars in the main sequence are a _____ color.
9. Medium hot and bright stars like our sun are _____ in color.
10. When a star has no fuel left and its outer layers escape into space, it is a _____ .
11. As heavier and heavier elements are formed by fusion, a star expands into a _____ .
12. When a collapsed core becomes so dense only neutrons can exist there, a _____ star is formed.
13. A _____ is so dense that nothing, including light, can escape its gravity field.
14. Write the remaining letters in the puzzle to reveal a famous scientist's theory.

_____

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NAME DATE CLASS

Chapter 24

Text Pages 691–697

Galaxies and the Expanding Unverse

Use the terms in the box to complete the following sentences.

Milky Way	200 billion stars	Andromeda	Local Group
galaxy	cluster	Doppler shifts	big bang theory
irregular	spiral	elliptical	Clouds of Magellan

1. A _____ is a large group of stars, gas, and dust held together by gravity.
2. A _____ is a group of galaxies.
3. _____ galaxies have many different shapes and are usually smaller and less common than other types of galaxies.
4. The two types of _____ galaxies are barred and normal.
5. Galaxies shaped like footballs are _____ galaxies.
6. The _____ are two irregular galaxies about 170 000 light-years away from Earth.
7. The solar system in which we live is in the _____ Galaxy.
8. The _____ is an explanation for the formation of the universe.
9. A spiral galaxy about 2.2 million light-years away is in the constellation of _____.
10. The Milky Way Galaxy contains more than _____.
11. Both the Milky Way and Andromeda galaxies are members of the cluster named the _____.
12. _____ shifts show that outside galaxies are moving away from the Local Group.

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Spectroscopy

Answer and do the following for the respective light sources:

1) **White light**

(a) What do you see when you look through the spectroscope?

(b) What is the arrangement of colors that you see?

2) **Hydrogen**

(a) How is this light different from the white light?

(b) What is the brightest color line?

(c) What are the two next brightest color lines?

(d) On the sheet labeled 'Drawing Spectra,' write the word, Hydrogen, next to the right of Element 1.

(e) Draw the spectrum of Hydrogen, using the appropriate colors, as you see it through the spectroscope.

3) **Helium**

(a) How is this light different from the white light?

(b) What is the brightest color line?

(d) On the sheet labeled 'Drawing Spectra,' write the word, Helium, next to the right of Element 1.

(e) Draw the spectrum of Helium, using the appropriate colors, as you see it through the spectroscope.

3) **Mercury Vapor**

(a) How is this light different from the white light?

(b) What are the most prominent color lines?

(c) On the sheet labeled 'Drawing Spectra,' write the words, Mercury Vapor, next to the right of Element 2.

(d) Draw the spectrum of Mercury Vapor, using the appropriate colors, as you see it through the spectroscope.

4) **Neon**

(a) How is this light different from the white light?

(b) What are the most prominent color lines?

(c) On the sheet labeled 'Drawing Spectra,' write the word, Neon, next to the right of Element 3.

(d) Draw the spectrum of Neon, using the appropriate colors, as you see it through the spectroscope.

H-R Diagram and Stellar Lifetimes

I. Create an H-R diagram (use the diagram between page 458-459 as a reference). 20 points.

(a) use 4 pieces of unruled 8.5"X11" paper, taped together (2 pieces alongside each other and the other two below, forming a cross).

(b) on the horizontal axis, label the surface temperature (3000 K – 30,000 K) and the spectral class (OBAFGKM).

(c) on the vertical axis, label the luminosity (0.0001 – 1,000,000) note: in the book the vertical axis goes up to only 10,000.

(d) Draw the boundaries and label where the following types of stars are situated on the H-R diagram: Red Giants, Blue Giants, Main Sequence, Red Dwarfs, and White Dwarfs.

II. Plot the stars in Appendix 3, page A-5 (in the back of the textbook), Table 4: The Twenty Brightest Stars, on your H-R diagram. 40 points.

(a) plot the stars using their x and y coordinates.

(b) for the star's x-coordinate, use the spectral type listed in Table 4.

(c) for the star's y-coordinate, use the visual luminosity listed in Table 4.

Note: for both spectral type and visual luminosity, use the A data and not the B data in Table 4.

III. Determine the relative lifetimes of all 20 stars. 40 points.

(a) Use the star's visual luminosity and figure 17.22b at the bottom of page 398 in your textbook to determine the star's mass. Record the mass in the data table below.

(b) Determine each star's relative lifetime by using the numbers 1-20:

H-R diagram (continued) –

the star with the greatest mass will have the shortest lifetime, assign this star the number 1 and record it in the data table below. The star with the smallest mass will have the shortest lifetime, assign this star the number 20 and record it in the data table below.

Star Name	Star Mass	Relative Lifetime

TABLE 4 The Twenty Brightest Stars

NAME	STAR	SPECTRAL TYPE* A	SPECTRAL TYPE* B	PARALLAX (arc seconds)	DISTANCE (pc)	APPARENT VISUAL MAGNITUDE* A	APPARENT VISUAL MAGNITUDE* B
Sirius	α CMa	A1V	wd†	0.37	2.7	−1.46	+8.7
Canopus	α Car	F0Ib-II		0.033	30	−0.72	
Alpha Centauri	α Cen	G2V	K0V	0.77	1.3	−0.01	+1.3
Arcturus	α Boo	K2III		0.091	11	−0.06	
Vega	α Lyr	A0V		0.13	8.0	+0.04	
Capella	α Aur	GIII	M1V	0.071	14	+0.05	+10.2
Rigel	β Ori	B8Ia	B9	—	250	+0.14	+6.6
Procyon	α CMi	F5IV-V	wd†	0.29	3.5	−0.37	+10.7
Betelgeuse	α Ori	M2Iab		—	150	+0.41	
Achernar	α Eri	B5V		0.050	20	+0.51	
Hadar	β Cen	B1III	?	0.011	90	+0.63	+4
Altair	α Aql	A7IV-V		0.20	5.1	+0.77	
Acrux	α Cru	B1IV	B3-	0.008	120	+1.39	+1.9
Aldebaran	α Tau	K5III	M2V	0.063	16	+0.86	+13
Spica	α Vir	B1V		0.013	80	+0.91	
Antares	α Sco	MIIb	B4V	0.008	120	+0.92	+5.1
Pollux	β Gem	K0III		0.083	12	+1.16	
Formalhaut	α PsA	A3V		0.14	7.0	+1.19	+6.5
Deneb	α Cyg	A2Ia		—	430	+1.26	
Mimosa	β Cru	B1IV		—	150	+1.28	

NAME	VISUAL LUMINOSITY* (Sun = 1) A	VISUAL LUMINOSITY* (Sun = 1) B	ABSOLUTE VISUAL MAGNITUDE* A	ABSOLUTE VISUAL MAGNITUDE* B	PROPER MOTION (arc seconds/yr)	TRANSVERSE VELOCITY (km/s)	RADIAL VELOCITY (km/s)
Sirius	23.5	0.04	+1.4	+11.6	1.33	17.0	−7.6‡
Canopus	1510		−3.1		0.02	2.8	+20.5
Alpha Centauri	1.56	0.46	+4.4	+5.7	3.68	22.7	−24.6
Arcturus	115		−0.3		2.28	119	−5.2
Vega	55.0		+0.5		0.34	12.9	−13.9
Capella	166	0.01	−0.7	+9.5	0.44	29	+30.2‡
Rigel	4.6×10^4	126	−6.8	−0.4	0.00	1.2	+20.7‡
Procyon	7.7	0.0006	+2.6	+13.0	1.25	20.7	−3.2‡
Betelgeuse	1.4×10^4		−5.5		0.03	21	+21.0‡
Achernar	219		−1.0		0.10	9.5	+19
Hadar	3800	182	−4.1	−0.8	0.04	17	−12‡
Altair	11.5		+2.2		0.66	16	−26.3
Acrux	3470	2190	−4.0	−3.5	0.04	24	−11.2
Aldebaran	105	0.0014	−0.2	+12	0.20	15	+54.1
Spica	2400		−3.6		0.05	19	+1.0‡
Antares	5500	115	−4.5	−0.3	0.03	17	−3.2
Pollux	41.7		+0.8		0.62	35	+3.3
Formalhaut	13.8	0.10	+2.0	+7.3	0.37	12	+6.5
Deneb	5.0×10^4		−6.9		0.003	6	−4.6‡
Mimosa	6030		−4.6		0.05	36	

**A and B columns identify individual components of binary systems.*
† "wd" stands for "white dwarf."
‡ Average value of variable velocity.

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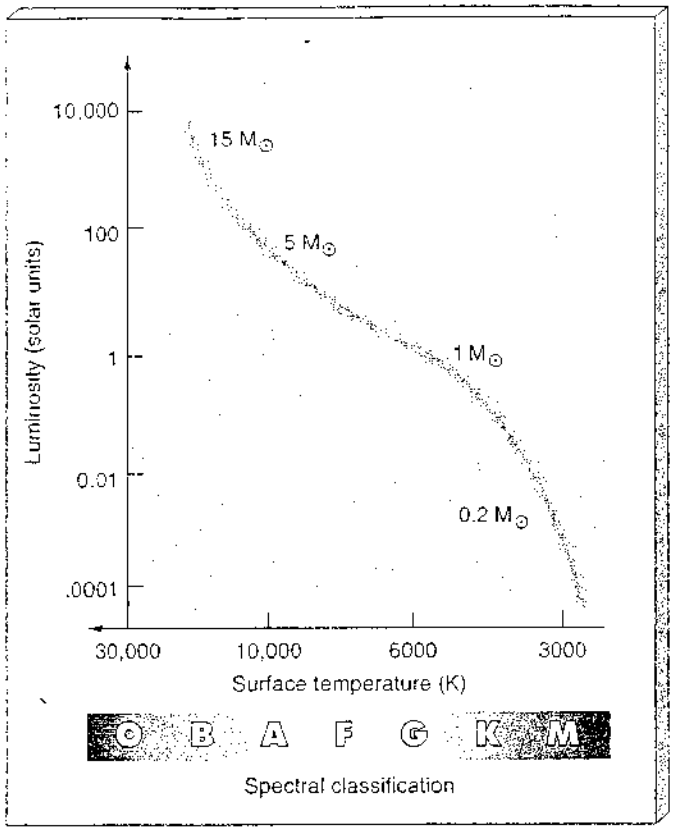


Figure 17.21 Mass, more than any other stellar property, determines a star's position on the main sequence. Stars that form with low mass will be cool and faint; they lie at the bottom of the main sequence. Very massive stars are hot and bright; they lie at the top of the main sequence.

Figure 17.22 illustrates how a main-sequence star's radius and luminosity depend on its mass. The two plots, called the *mass–radius* and *mass–luminosity* relations, are based on observations of binary-star systems. Along the main sequence, both radius and luminosity increase with mass. As a (very rough) rule of thumb, radius increases in direct proportion to mass, whereas luminosity increases much faster—more like the *cube* of the mass. For example, a 2–solar mass main-sequence star has a radius roughly twice that of the Sun and a luminosity of 8 (2^3) solar luminosities; a 0.2–solar mass main-sequence star has a radius of about 0.2 solar radii and a luminosity of 0.008 (0.2^3) solar luminosities.

STELLAR LIFETIMES

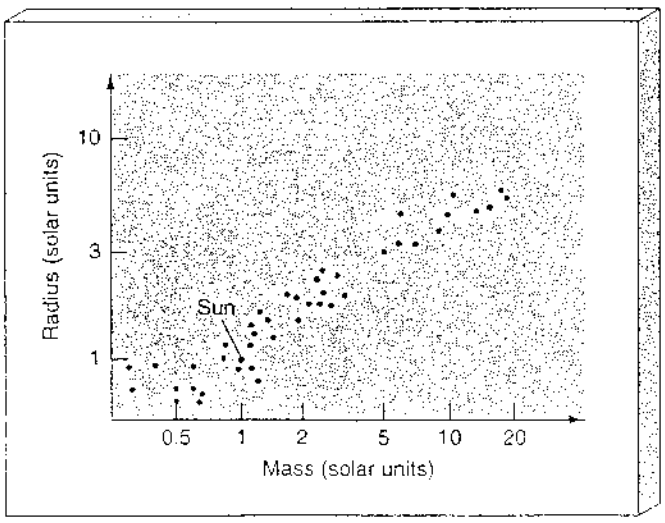
The rapid rate of nuclear burning deep inside a star releases vast amounts of energy per unit time. How long can the fire continue to burn? We can estimate a star's lifetime simply by dividing the amount of fuel available (the mass of the star) by the rate at which the fuel is being consumed (the star's luminosity):

$$\text{stellar lifetime} \propto \frac{\text{stellar mass}}{\text{stellar luminosity}}.$$

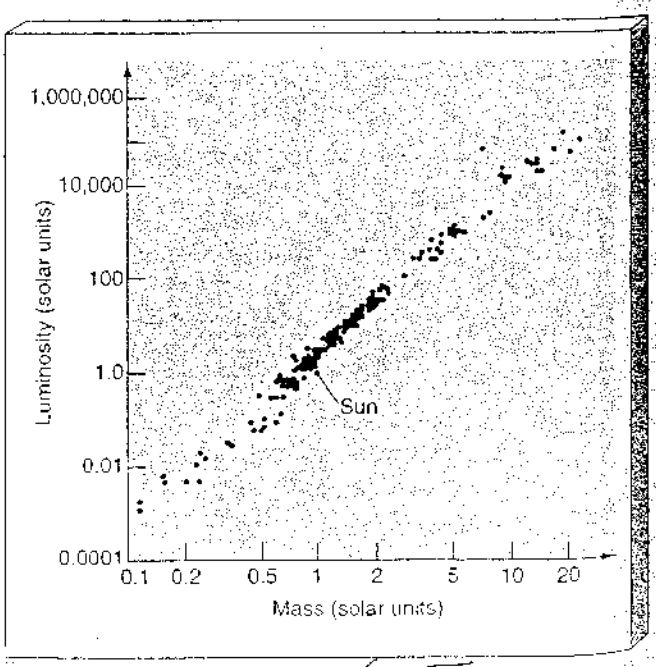
Because the mass–luminosity relation tells us that a star's luminosity is roughly proportional to the cube of its mass, we can rewrite this expression to obtain, approximately,

$$\text{stellar lifetime} \propto \frac{1}{(\text{stellar mass})^2}.$$

For example, O and B stars have masses 10 to 20 times that of the Sun and luminosities thousands of times higher than the solar luminosity. Accordingly, these massive stars can survive only for short times. Their nuclear reactions proceed so rapidly that their fuel is quickly depleted despite their large masses. From the given proportionalities, we see that the lifetime of a 20–solar mass O star is roughly $20/20^3 = 1/400$ of the (10-billion-year) lifetime of the Sun, or about 25 million years. We can be sure that all the O and B stars we now observe are quite young—less than



(a)



(b)

Figure 17.22 (a) Dependence of stellar radius on mass for main-sequence stars. The radius increases roughly in proportion to the mass over much of the range. (b) Dependence of luminosity on mass. The luminosity increases much faster than the mass.

Astronomy

Galaxy Quest

Classify the 15 images of galaxies on the following page according to the Hubble classification system (general category and type). In addition, provide a rationale for your selections.

Image #	General Category	Symbol	Type	Rationale
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Message From Space

Activity 1: Making Contact

Background Information:

SETI scientists have sent one well known message into space using a mathematically coded picture to try to communicate with any lifeforms who might happen to receive signals. A culture intelligent enough to build radio receivers may recognize the mathematical patterns and be able to decode the picture.

The simplest code for sending a picture by radio signals is a 'binary code.' A binary code has only two types of signals. They can be called by many names such as "1" and "0," "on" and "off," "beep" and "boop." A bar code on an item from a grocery store is a binary code in which the two signals are "black" and "white." Also, digital television sets receive binary signals and create a picture from binary codes.

A simple way to make a picture that can be turned into a binary code is by making the picture out of a rectangular grid of small squares. Each small square piece of the picture is called a bit and each bit is either black or white.

Procedure:

Work Alone

1) Read the section above entitled "Background Information."

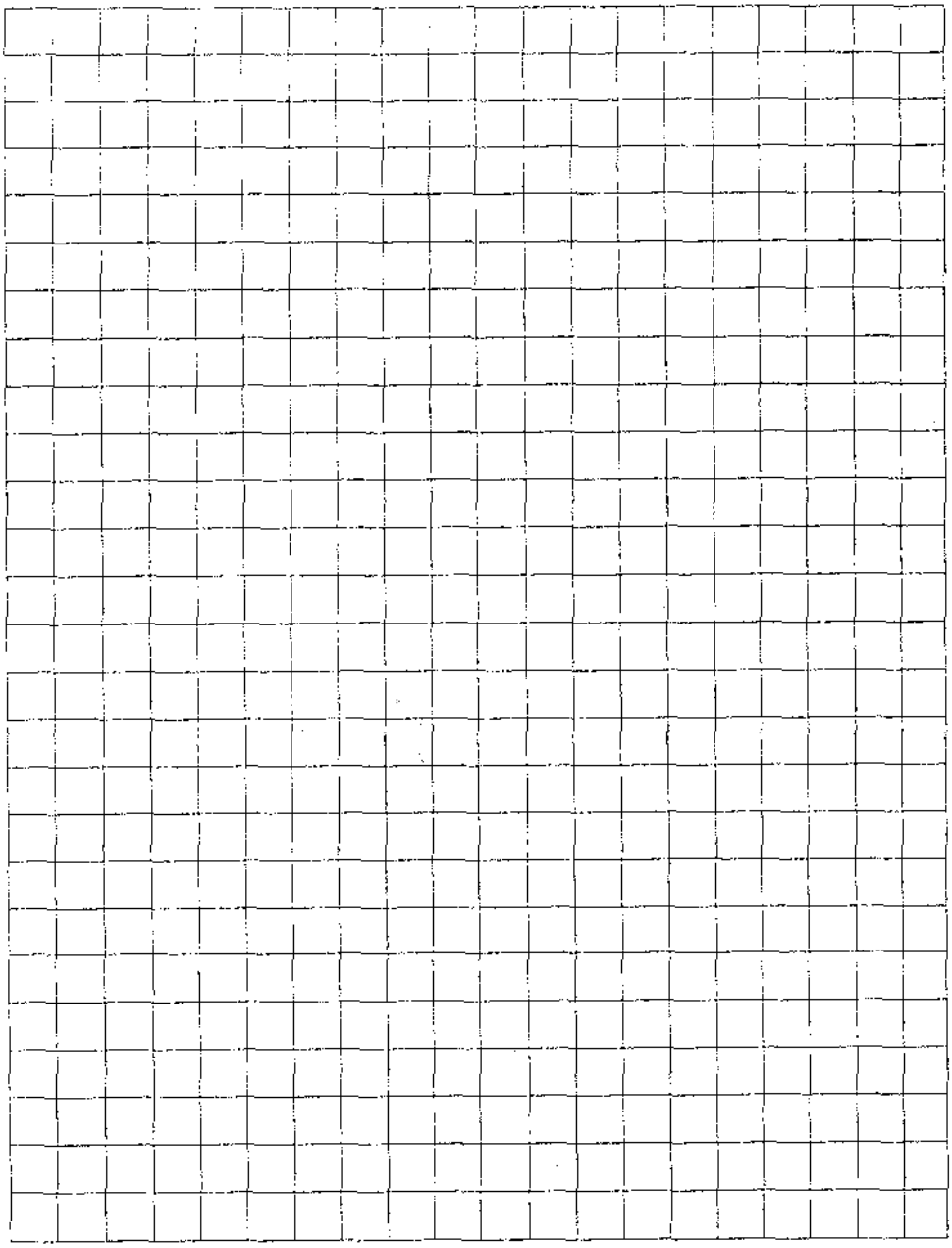
2) In the message that you are going to decode, you have a set of 80 bits, a binary code, that you must turn into a picture.

3) Your teacher will read the signals in the binary message and you will fill in the grid.

4) The grid you make must be a rectangle that contains 80 squares. Think of all of the ways that you can make a rectangular grid using 80 squares and sketch them out on a piece of graph paper (supplied by your teacher).
5) From the grids you sketched, choose one and use it according to the following scheme: Fill in the squares from left to right, completing rows from top to bottom.
6) Your teacher will read the signals to you and as you hear them fill in the squares of your grid. A "beep" signal means to fill in the square, and a "click" signal means to leave the square blank and go on to the next.
7) Your teacher will read the signals slowly, but it is very important that you keep up. One slip could spoil the whole message. To save time you can make a quick scribble, or even an"x" for each square that gets a "beep" signal and then fill it in after all of the signals have been read.
8) Do not distract your classmates while the signals are being read by your teacher.
9) Once all of the bits have been read and you have completed your grid, see if you can read a clear message. Compare your completed grid with those of your classmates.
10) Class discussion of the results.

A Binary Message *(From One Earthling to Another)*

1.	beep	41.	click
2.	click	42.	click
3.	beep	43.	beep
4.	beep	44.	click
5.	beep	45.	click
6.	beep	46.	beep
7.	click	47.	click
8.	beep	48.	beep
9.	click	49.	beep
10.	click	50.	click
11.	beep	51.	beep
12.	click	52.	click
13.	click	53.	beep
14.	beep	54.	click
15.	beep	55.	click
16.	beep	56.	beep
17.	beep	57.	click
18.	click	58.	click
19.	beep	59.	beep
20.	click	60.	click
21.	beep	61.	click
22.	click	62.	beep
23.	click	63.	click
24.	beep	64.	beep
25.	click	65.	beep
26.	click	66.	click
27.	beep	67.	beep
28.	click	68.	click
29.	click	69.	beep
30.	beep	70.	beep
31.	click	71.	click
32.	beep	72.	beep
33.	beep	73.	beep
34.	beep	74.	click
35.	beep	75.	beep
36.	click	76.	beep
37.	beep	77.	click
38.	beep	78.	beep
39.	click	79.	beep
40.	beep	80.	beep



1. Mark off a section of the graph paper with a rectangle that contains exactly 80 squares. Each square is for one bit (a "beep" or a "click") in the message.
2. Get ready to fill in the squares as someone reads the list of bits in the message. Start in the upper left-hand corner and move across the rectangle bit by bit. As you finish a row, move to the next row starting at the left.
3. For each bit that is a "beep" fill in the square. For each bit that is a "click" leave the square blank and move on to the next square.
4. Compare your picture to those of students who used different rectangles for their grids. Which grid is the right one for decoding the message?

Activity 2: Interpreting a Message From Space

Background Information:

In this activity you will interpret a series of fictitious messages from space. You may come up with several possible meanings for some parts of the message, and there will be other parts of the message for which you may not find any meaning at all. As with any real science investigation, there is no "answer key" to say what is right and wrong. Only further investigation of the message and its source will help show which interpretations make sense.

The alleged extraterrestrial message is on grids that are 61 squares across by 67 squares down, for a total of 4087 squares or bits. Notice that there are only two possibilities for the size of the grids (excluding having all of the bits in a straight line). The reason for this is simple; 67 and 61 are prime numbers. If ET's want us to decode their messages easily they can make the dimensions of the grid prime numbers. That gives us fewer wrong choices when we are trying to decode the message. When SETI broadcast a message into space in 1974 they used a grid that was 23 across by 73 down. The messages that you will be working with in this activity have been decoded from a binary signal. The code was allegedly received by our radio telescope from a distant cluster of stars.

Procedure:

Work in small group of 2 students/group

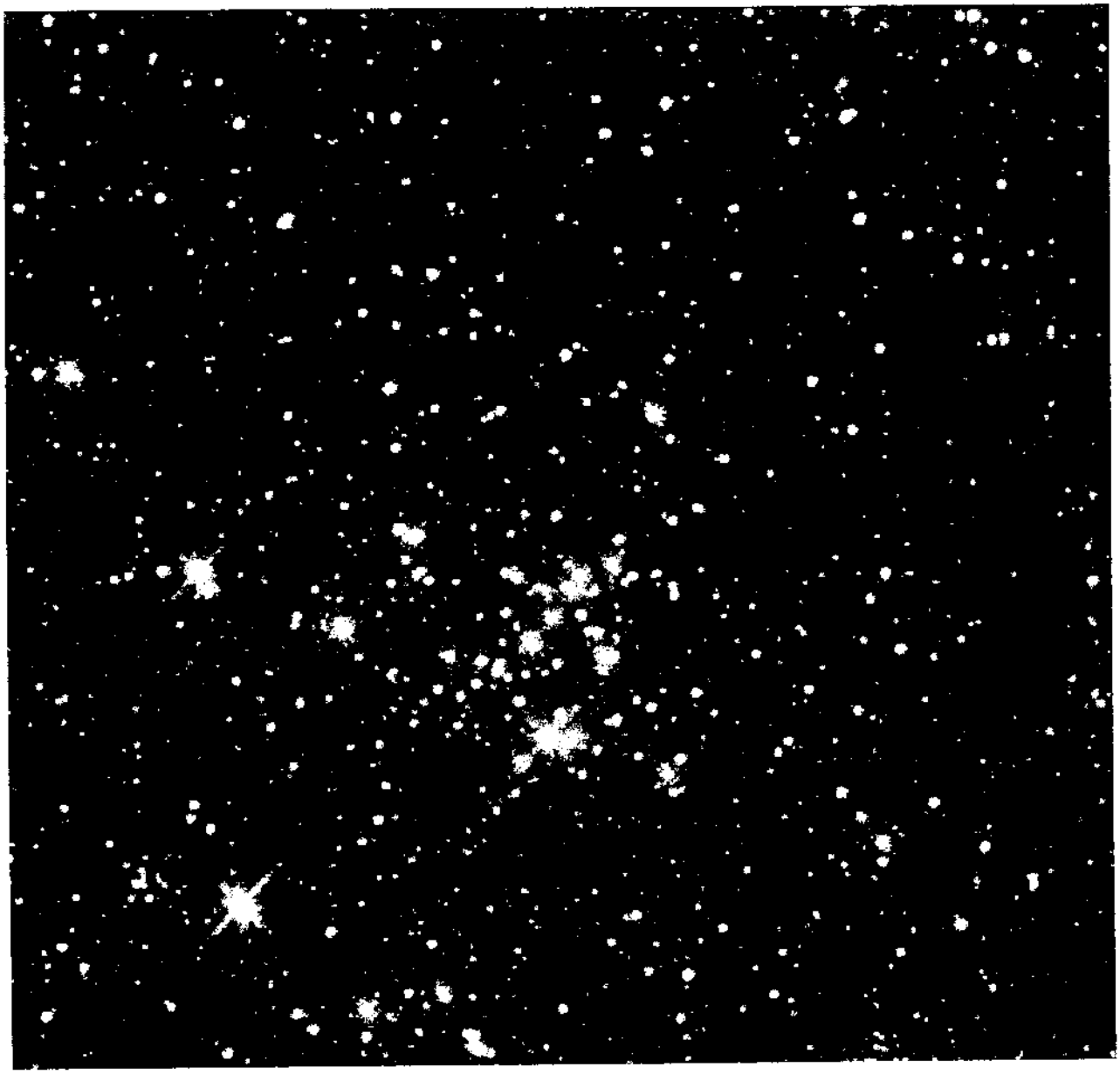
1) Look at the first message with your group. Take about 3-5 minutes to interpret and discuss within your group.

2) Be prepared to participate in a whole class discussion and share interpretations.

3) We will continue this process for all of the messages.

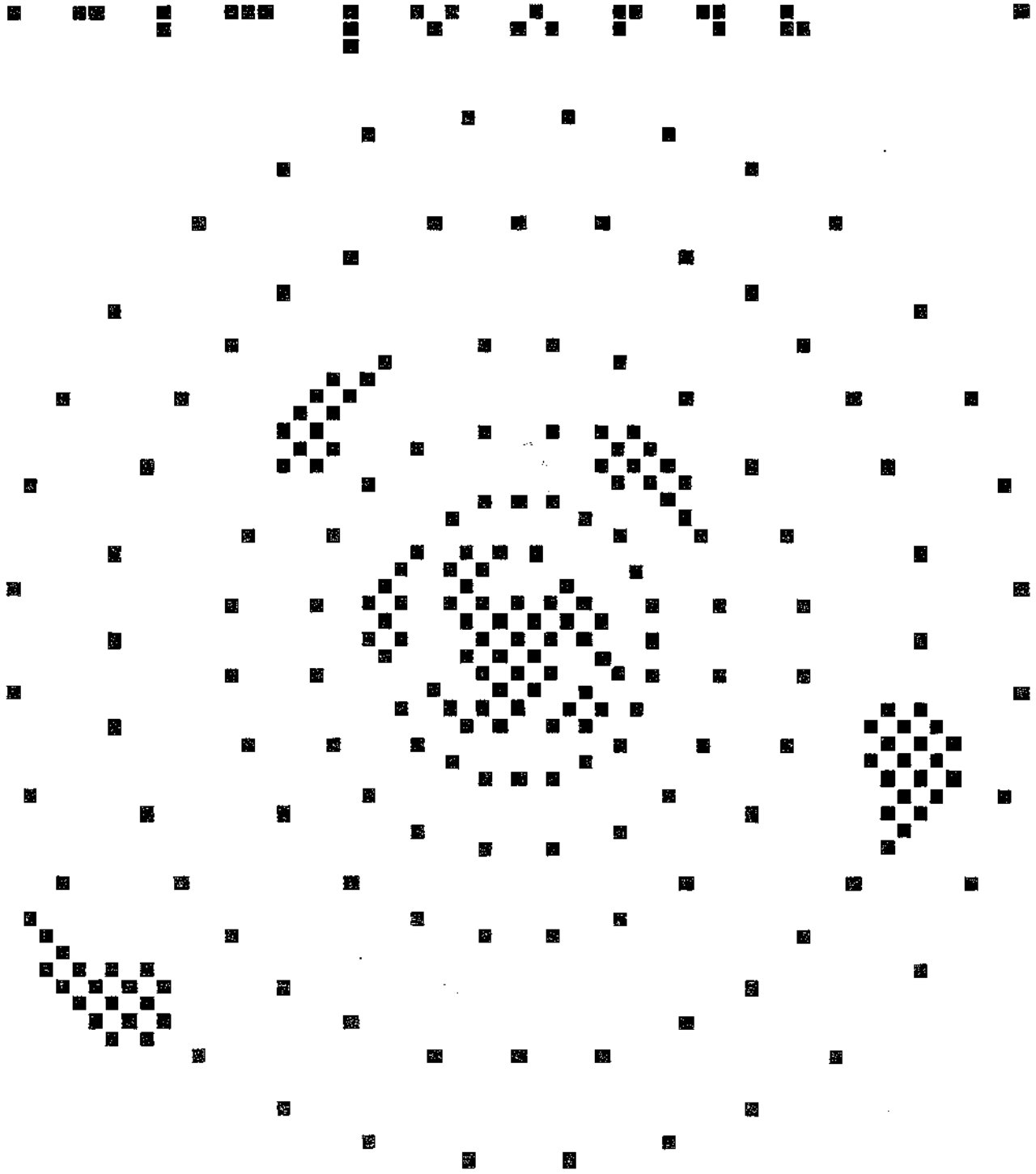
4) Write your interpretations for each of the 7 messages on the sheet entitled "Interpreting Messages From Space."

STAR CLUSTER THE MESSAGE CAME FROM



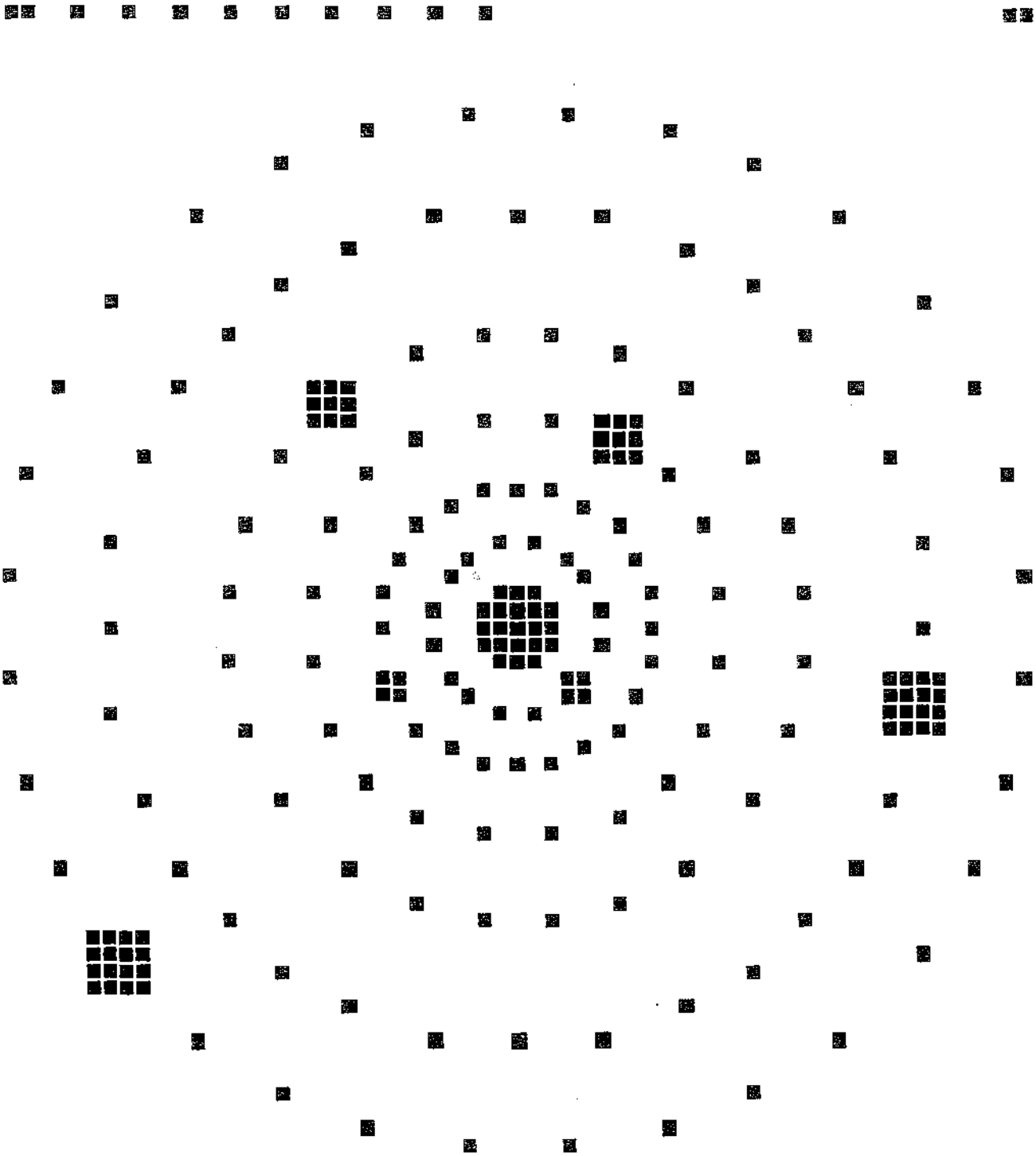
MESSAGE FROM SPACE

PAGE 1



MESSAGE FROM SPACE

PAGE 2



MESSAGE FROM SPACE

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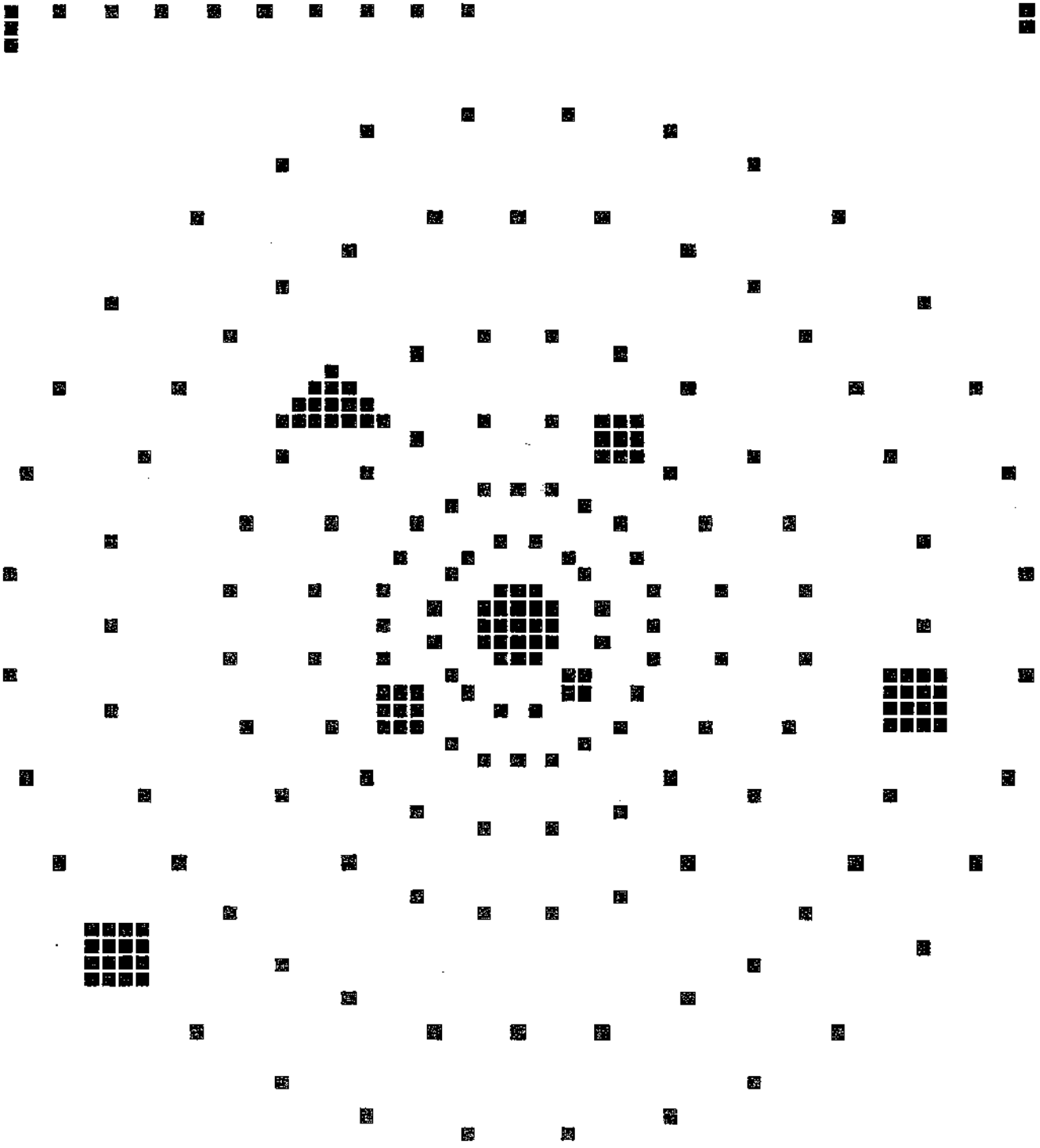

MESSAGE FROM SPACE

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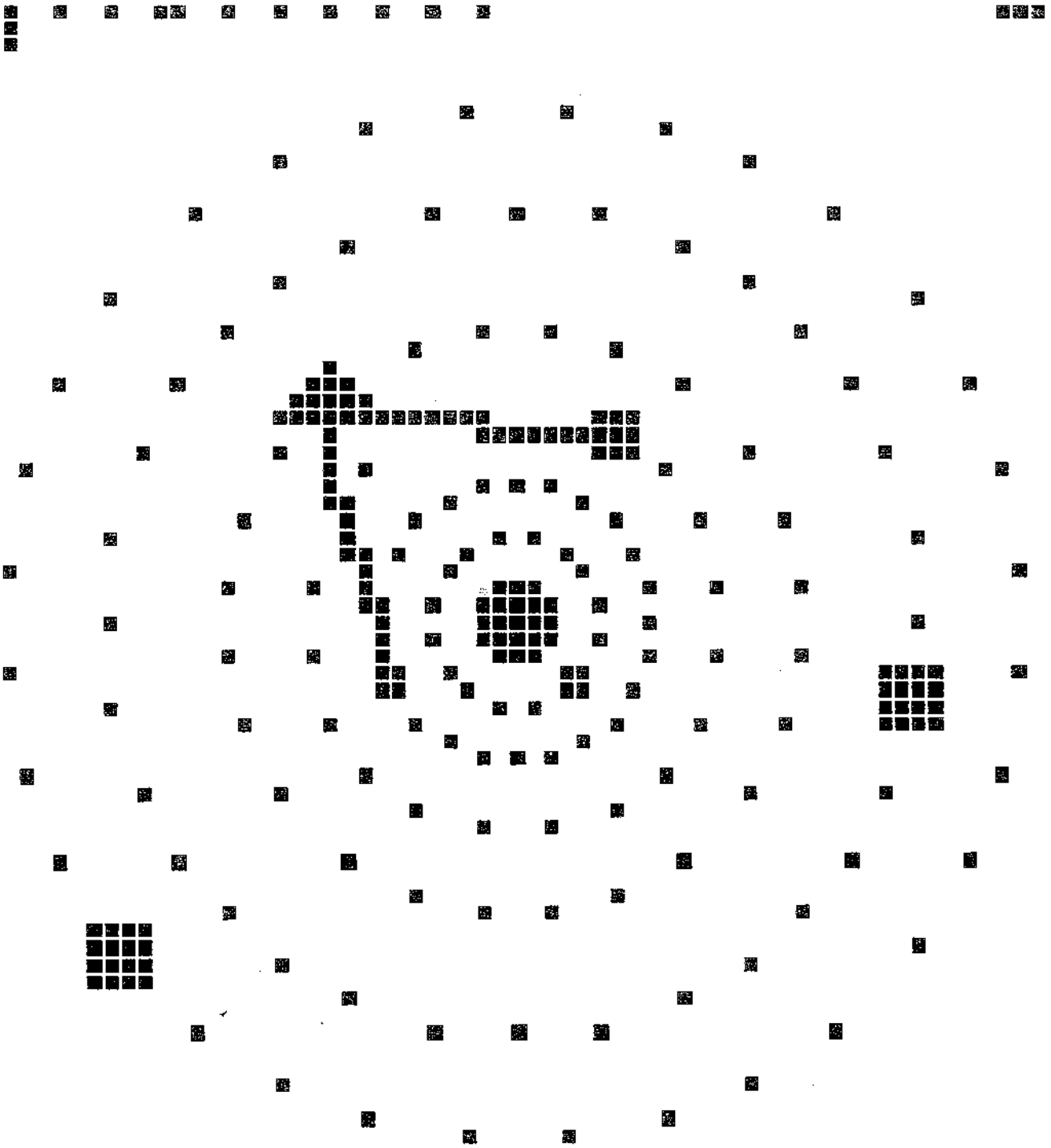

MESSAGE FROM SPACE

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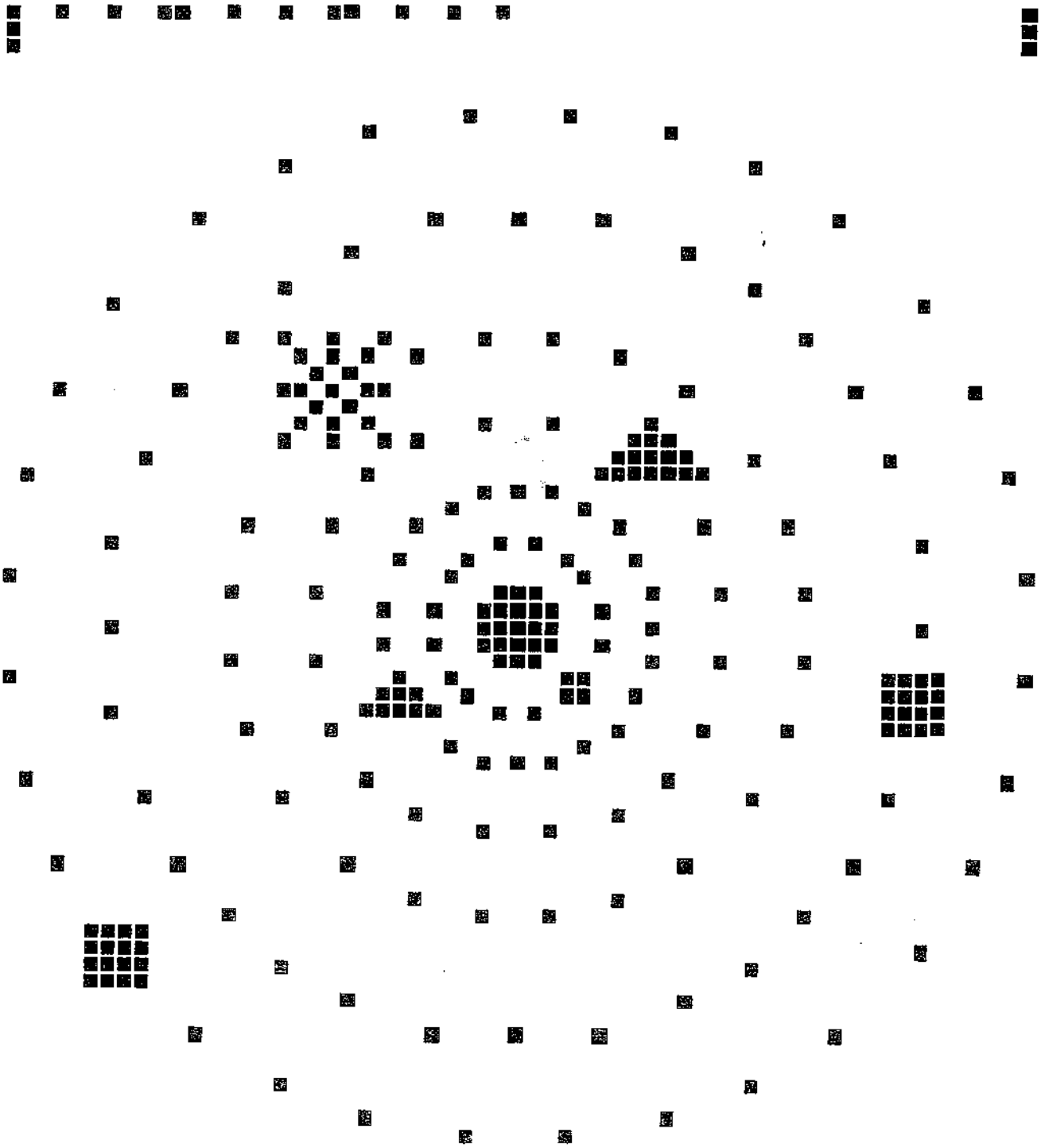

MESSAGE FROM SPACE

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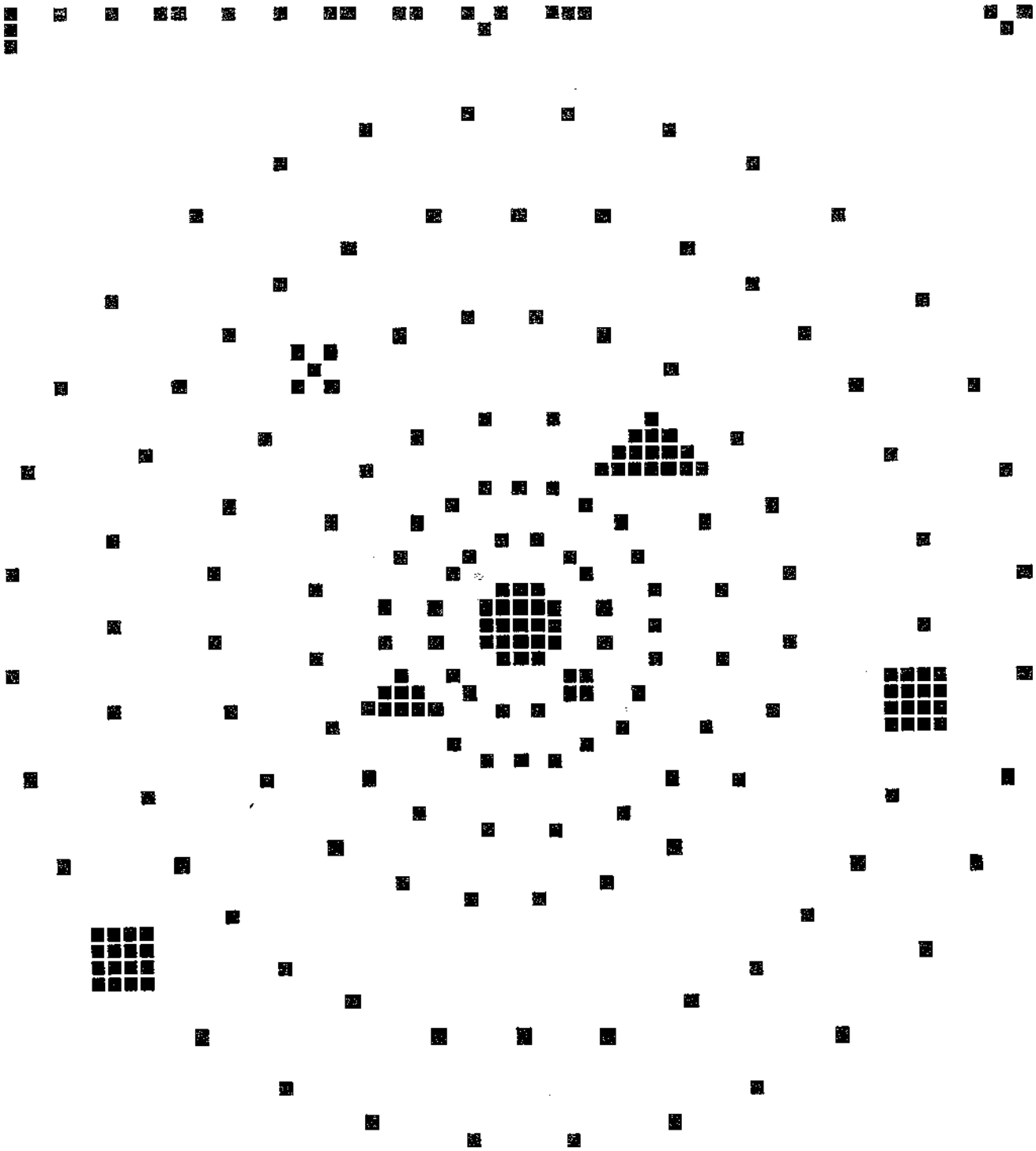

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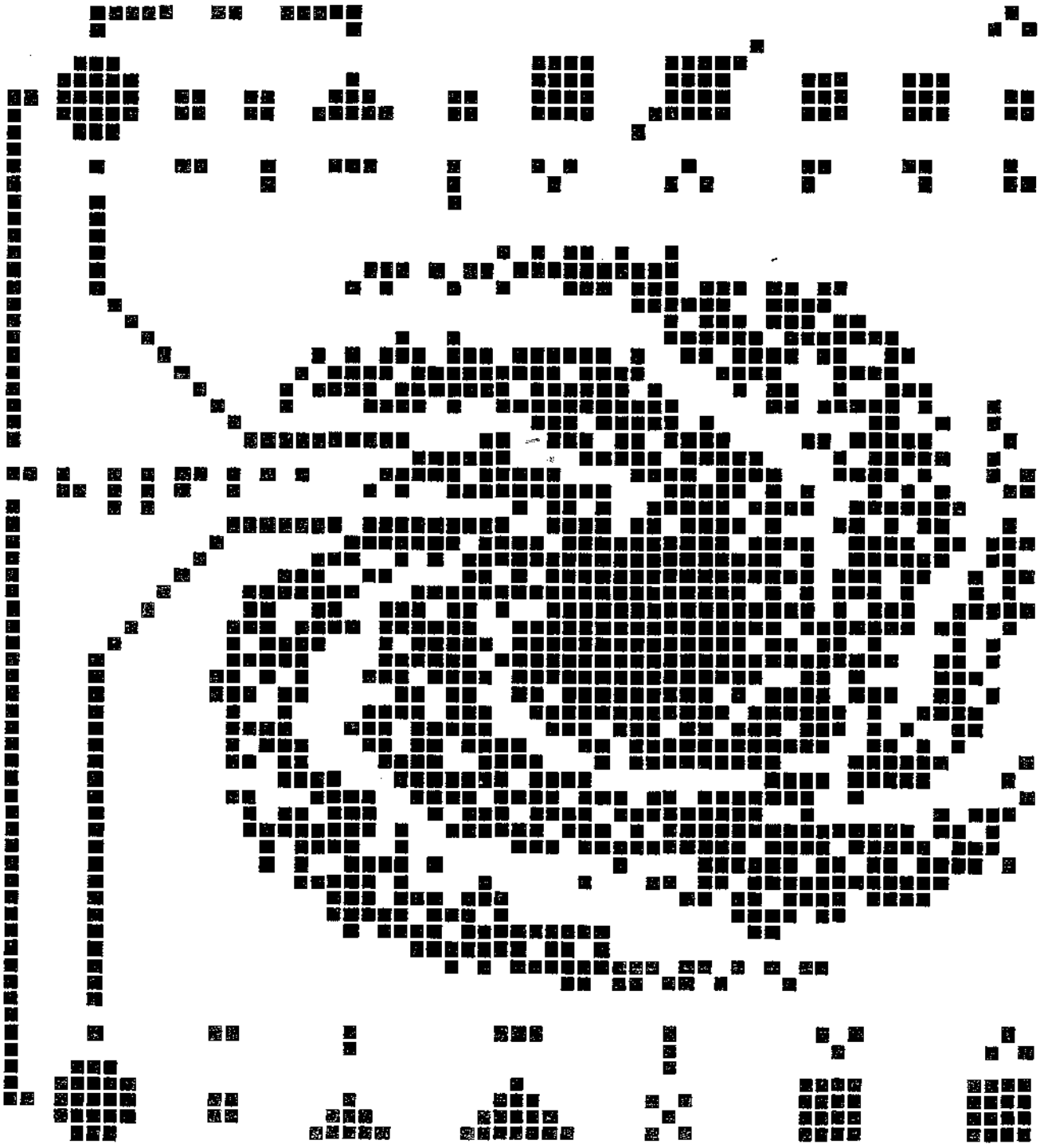
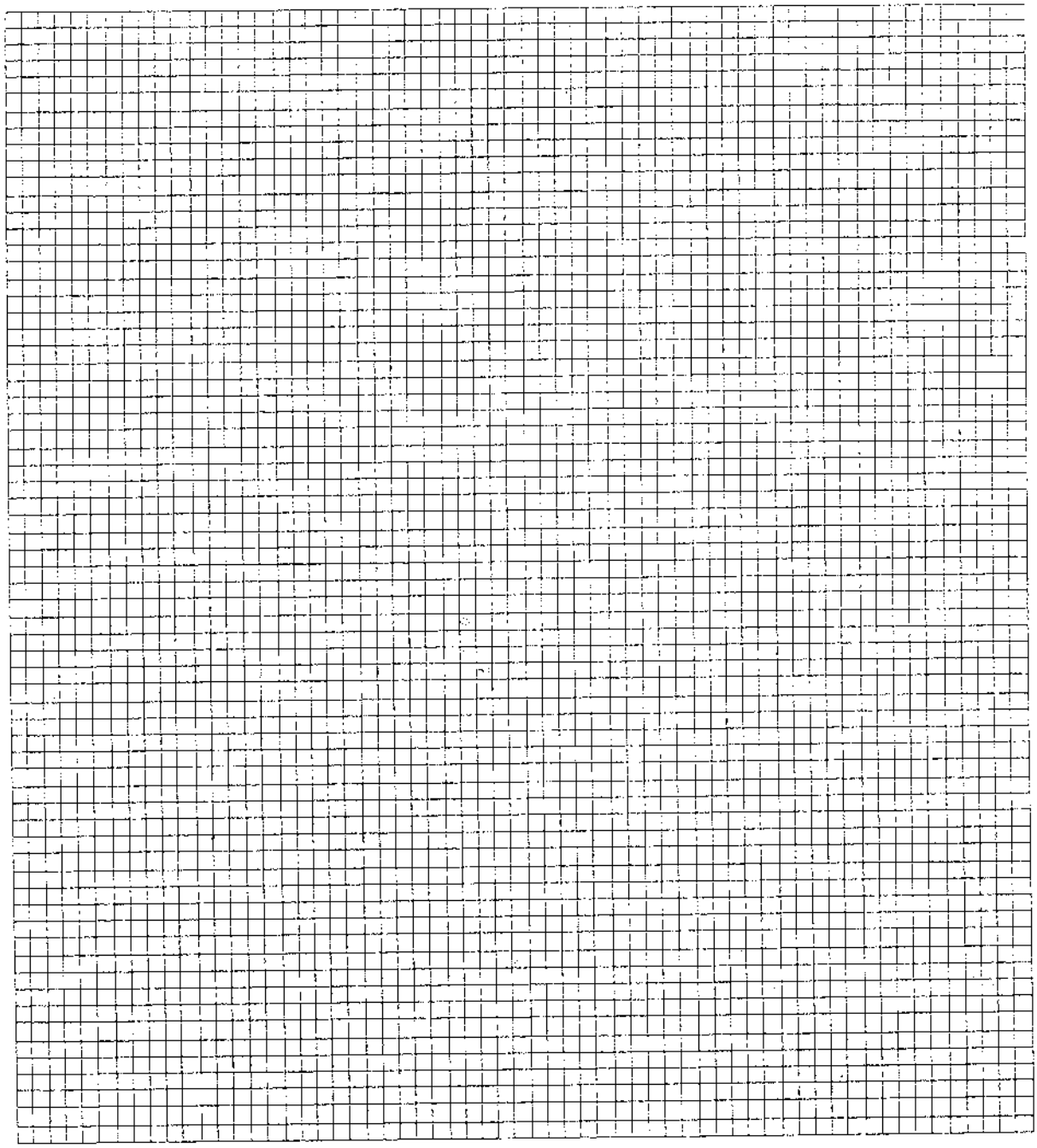


Grid for Message

61 bits by 67 bits, 4087 bits total



Interpreting Messages From Space

Message 1:

Message 2:

Message 3:

Message 4:

Message 5:

Message 6:

Message 7:

Real Science or Tabloid Fiction?

SETI Reading Assignment

A series of articles, modified and adapted from actual articles, are provided in the next several pages of your workbook. The readings are a homework assignment. For this exercise, you will be responsible for deciding which articles are serious and which are not. That is, which seem to be based on scientific thinking, and which are sensationalized fictions. While the distinction between the two is quite obvious upon a first reading, the idea here is less to pose a challenge than to help you see that with even a small amount of care, you should be able to recognize sensationalized fiction when you see it!

There are 7 articles for this assignment. The titles are: 1) Is There Anybody Out There? 2) Aliens Came Here In A Spaceship And May Have Built The Pyramids! 3) Scientists Discover a Solar System Like Ours. 4) Texas Woman Has Terrifying Encounter. 5) Europa May Have Ingredients For Life. 6) Astronomers See New Planet's Shadow Cross A Distant Star. 7) Flying Saucer Crash Site.

You must prepare written responses to the following questions and be prepared to discuss them the next day in class:

- In analyzing the articles what "red flags" did you look for?
- What did you have a hard time believing? Why?
- What made an article believable to you? Why?
- Is information readily available in the article? Or does it state that the information can't be revealed for one reason or another?
- Is the article vague or illogical?
- Is there credible confirmation offered for claims in the article?
- What about the writing style? Does it provide clues to the article's validity?

Is There Anybody Out There?

Radio Telescopes Seek Signals from Other Planets

By Vivian Milligan

There have been many "false alarms," but so far scientists say that they have not found any signs of extraterrestrial life. "It is, of course, only a start," said Peter Backus, of the Phoenix Project.

The Phoenix Project is a search organized by the SETI Institute. Using radio telescopes around the world, they are searching the skies for radio signals from intelligent extraterrestrials.

Although some scientists argue that the search is foolish, many serious astronomers say that detecting messages from intelligent extraterrestrials is very possible.

They argue that there probably is life on an Earth-like planet circling a star like our Sun. No one knows how many Earth-like planets there are, but because there are so many stars like our Sun, even in our own galaxy, these scientists say that the odds are that there might be many such planets.

The search is focused on stars that are like our Sun, and that are relatively nearby. In this case, "nearby" means within 200 light years distance, or, in other words, one quadrillion 200 trillion (1,200,000,000,000,000) miles away!

Radio signals can travel huge distances in space, although it can take hundreds of years for them to travel that far. On Earth, we've only had the technology to send radio signals for about one hundred years. In a few hundred years though, our radio and television signals could be picked up by an extraterrestrial listener many light years away.

Jill Tarter, Director of the SETI Institute, said, "It is the most important question the human species has asked itself...are we alone or are we not?"
For more information about Project Phoenix, see:

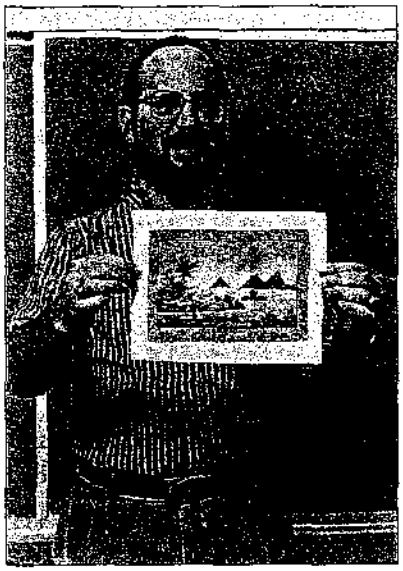
phoenix info@seti-inst.edu
http://www.seti.org

Aliens came here in a spaceship—and may have built the Pyramids!

Jungle Find! 15,000-year-old UFO!

Expert says ETs started a colony on Earth

By Kevin Erickson



Dr. Ivan Bergman would not reveal the exact location of the UFO.

MOSCOW - Russian scientists say they have found a 15,000-year-old spaceship in an African jungle—but that's not all. They also found strange metal documents at the site which claim the ETs later built a colony. This means that their descendants may be walking among us today!

Dr. Ivan Bergman says that the spaceship proves the ETs had the technology to reach our planet thousands of years before the Pyramids were built. He reported that the spaceship was found in the jungles of Kenya on October 27, but he would not pinpoint the exact location for "security reasons."

He also said the spaceship had been taken apart and shipped to Moscow for study. "It's in amazingly good condition, considering it's 15,000 years old!"

The documents have not been translated, but they include pictures of aliens living in pyramid-shaped huts. Bergman said, "We think that the fact that they built pyramid-shaped huts may mean that they also built the Pyramids thousands of years later."

In an exciting prediction, Dr. Bergman told reporters, "We may someday be able to make a copy of their spaceship, and travel to other parts of the galaxy too."

Scientists Discover a Solar System Like Ours

New Finding Makes Extraterrestrial Life More Likely

By Felicia Cort

Astronomers have found a distant planetary system much like our own. The system has a sun-like star orbited by three planets. The discovery was made by astronomers from San Francisco State University, Harvard, Colorado, and Australia.

Up until now, the only planetary systems found with stars like our Sun had just one planet. This discovery proves that there are other systems like ours out there, with more than one planet. Astronomers think that there are many, but this is the first time they've actually been able to find one.

The discovery "implies that planets can form more easily than we ever imagined, and that our Milky Way is teeming with planetary systems," said Dr. Debra Fischer, one of the astronomers. It's thought that extraterrestrial life is most likely to be found around stars that are similar to our Sun.

The star is called Upsilon Andromedae, and it is 44 light-years away. A light year is the distance light travels in a year, which is 6 trillion miles. It is orbited by three planets the size of Jupiter.

Since they are so far away, the planets are too small to be seen, even with our most powerful telescopes. They were discovered by studying "wobbling" in the way Upsilon Andromedae moved. As they orbit the star, the gravitational pull of the three planets tugs on it, and make the star "wobble" slightly.

In our solar system, gas giants, such as Jupiter, Saturn, Uranus, and Neptune, formed much farther from the Sun than those around Upsilon Andromedae. Because until recently the only planets that could be studied have been our own nine, scientists had generally thought that gas giants could not form so close to a "yellow" star like our Sun.

R. Paul Butler and Geoffrey Marcy have been studying Upsilon Andromedae for 11 years. They discovered one planet in the system in 1996, before Fischer discovered the other two. Marcy said, "I am mystified as to how such a system of Jupiter-like planets might have been created." He added, "This will shake up the theory of planetary formation."

A map of the orbits of Upsilon Andromedae's three planets can be seen at www.physics.sfsu.edu/planetsearch.

Texas Woman Has Terrifying Encounter

'My Dog was Eaten by a Space Alien!'

Alien dog-eater! Jaine Barber holds up a picture of the alien that ate her poodle Fluffy, as drawn by an artist.

UFO researcher Len Willard

By
Dwight Duwigahut
Global News Agency

A 34-year-old Texas woman says she watched in horror as a space alien ate her dog Fluffy. Although her story may sound ridiculous, reports of other animal devourings have been coming in from certain areas of the world for months. These same spots have also had many recent UFO sightings.

"People may not believe me, but I swear it's true," said Miss Barber. "I heard a whirring sound, and the bushes in my backyard started blowing around. The next thing I knew, a flying saucer appeared overhead, and a lizard-like alien was lowered down.

"I started to run away, but it stared at me with glowing eyes, and I couldn't move. Just then Fluffy ran up to the alien wagging her tail. I was horrified that I couldn't move to help stop it from eating my little Fluffy."

Miss Barber described the alien as being about the size of a man, with green scales, a large tail, and a lizard-like head.

"After the alien ate Fluffy, it disappeared. The spaceship then started whirring, and then it disappeared too."

Miss Barber then called Huntsville-based UFO researcher Matthew Stone. Stone said "recently there have been dozens of sightings like this in Brazil, Florida, New Mexico, and Argentina."

Europa May Have Ingredients for Life

Water, energy and organic matter likely!

By Kimi Tucker

Instruments on the Galileo spacecraft, which is orbiting Jupiter, have discovered organic chemicals (the building blocks of life) on the moons Callisto and Ganymede, which are neighbors of Europa.

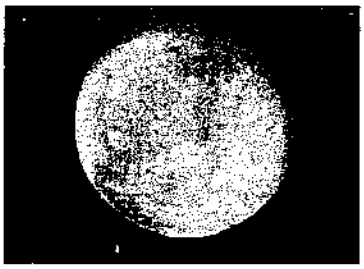
The chemicals are thought to have come from comets and meteorites. Although the chemicals have not yet been found on Europa, it is close by and could very well have them too.

It was already known that Europa has water and heat. If it also has organic chemicals, it is a strong candidate for life of some kind to have evolved.

"This doesn't mean there is life on Europa," said Dr. McCord, lead author of a study published in the journal *Science*. "The exciting thing now is the evidence that Europa may have all three of the ingredients."

To see if life could exist in icy conditions like those on Europa, scientists have been looking for places on Earth with similar conditions. In studying ice a mile deep in Antarctica, they have found primitive life forms 100,000 years old.

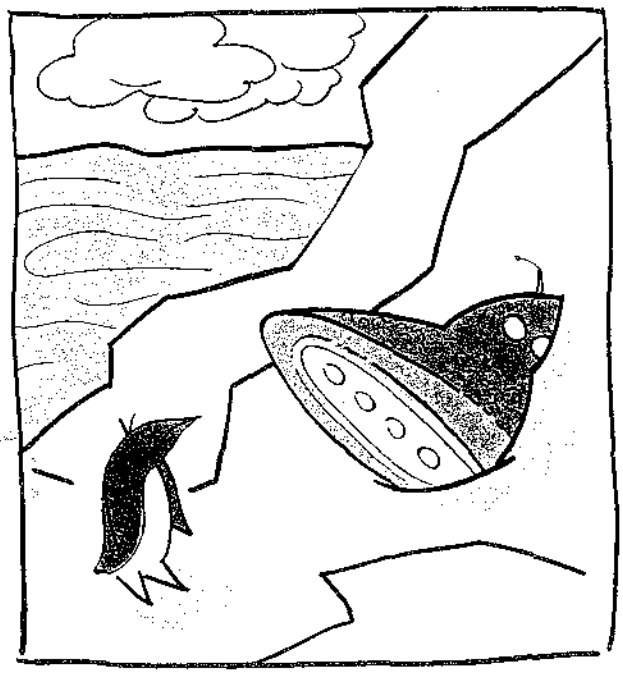
No organic chemicals have been found on Europa, but scientists think there may be a rich organic soup under its thick layer of ice. This could be a warm, liquid place where life could have evolved.



Flying Saucer Crash Site

34 Alien Corpses Found in Alien Spaceship in Siberia

By Lynn Sneider



YAKUTSK, Siberia - An alien spaceship was discovered in a huge block of ice in Siberia. This is already being hailed as the most important discovery in the history of the world!

According to Dr. Yuri Logoff, "Over the years there have been many UFO sightings and alien abductions reported—but now we finally have concrete evidence. This find is the first proof of life on other planets."

The strange-shaped flying saucer is made of a type of metal unlike anything found on Earth. It has a 60- foot diameter, and has strange bumps along the outside.

Most interesting of all, scientists used scanners to explore inside the craft, and found at least 34 alien bodies. Dr. Logoff says that it will take until mid-November 2003 to thaw them out.

Since the spacecraft seems unharmed, Dr. Logoff says that he thinks that the extraterrestrials may have run out of fuel, landed, and then starved to death, stranded in the ice.

He predicted, "When we've finished thawing out these aliens, we will shock the world!"

Astronomers See New Planet's Shadow Cross A Distant Star

By Robert Sanders
Public Affairs

Astronomers have witnessed for the first time a distant planet passing in front of its star, providing direct and independent confirmation of the existence of extrasolar planets that to date have been inferred only from the wobble of their star.

"This is the first independent confirmation of a planet discovered through changes in a star's radial velocity and demonstrates that our indirect evidence for planets really is due to planets," said Geoffrey Marcy, professor of astronomy.

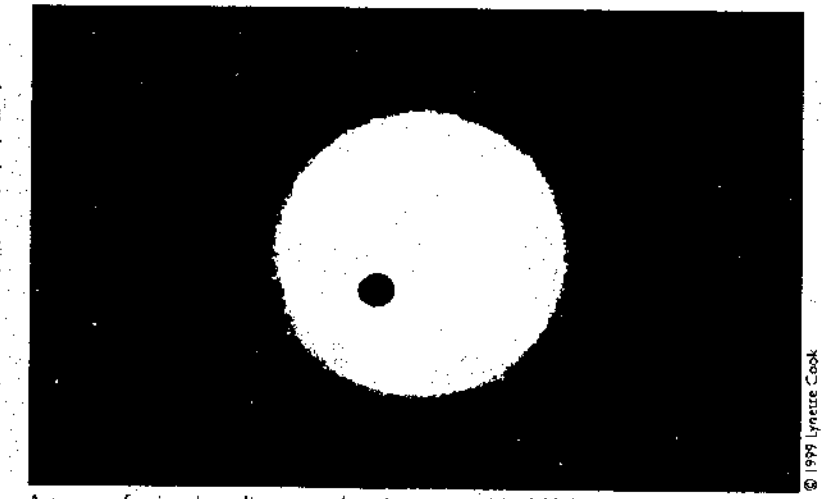
"This is the first independent confirmation of a planet discovered through changes in a star's radial velocity and demonstrates that our indirect evidence for planets really is due to planets,"

Geoffrey Marcy, professor of astronomy

Marcy and his colleagues, Paul Butler of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington in Washington, D.C., and Steve Vogt of UC Santa Cruz and Lick Observatory, first detected a wobble in the star called HD 209458 on Nov. 5. Ascribing the wobble to a nearby planet, they were able to estimate its orbit and approximate mass.

As with all new planets they detect, the team immediately brought it to the attention of collaborator Greg Henry, an astronomer at the Tennessee State University Center of Excellence in Information Systems in Nashville. He conducts research with several automatic telescopes at Fairborn Observatory, a non-profit research foundation located in the Patagonia Mountains of southern Arizona.

Henry turned one of his automatic telescopes on the star at the time Marcy and Butler predicted the planet would cross the face of the star if the planet's orbital plane were lucky enough to carry it between Earth and the star. Until now, none of the 18 other extrasolar planets Marcy and Butler have discovered has had its orbital plane oriented edge-on to Earth so that the planet could be seen to transit the star, nor have any of the other planets discovered by other researchers.



© 1999 Lynette Cook

A team of scientists discovered a planet roughly 153 light years away.

However, on Nov. 7, Henry observed a 1.7 percent dip in the star's brightness.

"This planetary transit occurred at exactly the time predicted from Marcy's observations, confirming absolutely the presence of a companion," Henry said. "The amount of dimming of the star's light during the transit also gives us the first-ever measure of the size and density of an extrasolar planet. We've essentially seen the shadow of the planet and used it to measure the planet's size."

The star HD 209458 is 153 light years or or 859,000 billion miles away in the constellation of Pegasus, and is about the same age, color and size as our own sun. It is very near the star, 51 Pegasi, around which the first extrasolar planet was discovered in 1995.

With the orbital plane of the planet known, the astronomers for the first time could determine precisely the mass of the planet and, from the size of the planet measured during transit, its density.

Interestingly, while the planet's mass is only 63 percent of Jupiter's mass, its radius is 60 percent bigger than that of Jupiter. This fits with theories that predict a bloated planet when, as here, the planet is very close to the star.

The density, about 0.2 grams per cubic centimeter, means it is a gas giant like Jupiter. However, such gas giants could not have formed at the distance this planet is from its star.

"This supports the theory that extrasolar planets very near their star did not form where they are, but formed farther out and migrated inward," Henry said.

Various groups around the world have been searching for planets by looking for dimming of stars, or as Marcy says, "staring at the sky and seeing if any star blinks." To date, none of these searches has turned up a new planet.

"With this one, everything hangs together," Marcy said. "This is what we've been waiting for."

More information on the artist rendering can be found at (www.spaceart.org/lcook/extrasol.html)

Science Fiction Story Writing

"Not one of those worlds will be identical to Earth. A few will be hospitable; most will appear hostile. Many will be achingly beautiful. In some worlds there will be many Suns in the daytime sky, many moons in the heavens at night, or great particle ring systems soaring from horizon to horizon. Some moons will be so close that their planet will loom high in the heavens, covering half the sky. And some worlds will look out onto a vast gaseous nebula, the remains of an ordinary star that once was and is no longer."

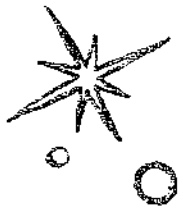
Carl Sagan, Cosmos

Background Information:

In this activity you will be writing a science fiction story about the lifeforms who sent the 7 page message in the activity entitled "Message From Space." Before getting started think about science fiction books, movies, or TV shows that you have enjoyed. Think about what you particularly enjoyed and why did they work. The best science fiction stories are strange and different from what we are used to, but also have realistic elements with well-thought out details. Your story can be as strange as you want it to be, but you must show how these strange things could actually happen on this distant world. You must avoid a story line in which ET's travel to Earth because traveling across such huge distances in space is considered impossible (at this point in time).

Planning Your Story:

1) You will work alone and write a 4-5 page science fiction story.
2) Your story should be typed or word processed, use 12 point font, and double-space.



Name(s): _____

Science Fiction Ideas

1. What is the name of the planet?

2. What is the atmosphere like? What does the sky look like?

3. What are the days, years, and seasons like?

4. What is the surface of the planet like—water, ice, land?

5. What kinds of animals and plants live there?

6. What are the intelligent creatures like?

7. What and how do they eat?

8. How do they breathe?

9. How do they communicate?

10. How do they protect themselves from the elements?

11. Do they have any enemies?

12. Are there natural disasters they have to deal with?

13. Do they have families? How do they reproduce?

14. Do they live underwater or on land?

15. What kind of music, art, sports, and/or entertainment do they have?

16. Do they have countries and/or governments? Do they have wars?

17. What were they trying to tell us in their message?

18. Who is the main character in your story?

19. What is your main character like?

20. What is the story you're going to tell?

21. What other characters are in the story?

22. Briefly make a plan for your story, including beginning, middle, and ending. Use the other side of this page if necessary.

3) Before writing your story, answer the questions on the sheet entitled "Science Fiction Ideas."
4) Many great stories have only a few main characters, with one lead character, from whose perspective the story is told.
5) Tell the story of what happened to the planet, and why the ET's sent the message. You can also choose to write about what happened when the ET's received a reply to their message from Earth. Alternatively, you could write a story of some other huge event in the planetary system, or you could just tell a story involving the everyday life of an ET.
6) To put yourself in the position of the ET's, imagine that you are on a planet that supports life in the planetary system that you designed.
7) Review the rubric for the writing assignment before you start writing.

Rubric

1) Student includes some descriptions of the ET's planet, including:

- what kind of star is at the center of the planetary system.
- where the planet is in the star's lifezone.
- what kind of surface the planet has.
- other conditions that make lifeforms possible.

2) Student includes how the ET's are physically adapted to its planet.

3) Student describes how the behavior of the ET's in the story relates to the environment in which the story is set.

4) Student compares and contrasts the ET's environment to our solar system, including conditions on Earth and other planets.

5) Student demonstrates an understanding of the conditions thought necessary for life to exist.

The Drake Equation

Frank Drake, the "father" of SETI is the originator of the Drake Equation, a mathematical equation designed to estimate the number of civilizations in the Milky Way Galaxy with whom we could potentially communicate. The equation was first presented as part of the agenda for a scientific meeting to discuss the likelihood that SETI searches would make a discovery of extraterrestrial intelligence.

Now that you have studied the requirements for life to evolve on other worlds, you will get a chance to look at whether or not it is likely. To find out if communication is likely to take place between earth and an ET civilization, one important thing to consider is the number of civilizations in the galaxy with whom we might communicate. Since we do not know how many intelligent civilizations there are in the galaxy, the equation is used only to make an educated estimate of this number.

In this activity you will proceed step-by-step through the Drake Equation and make your own estimate concerning the chances that someone out there really might be sending messages to us or be able to receive our messages. Follow the prompts on the sheet entitled "Data Sheet for the Student: The Drake Equation," to come up with your own estimate. Make sure you also answer the six questions (#'s 11-16) that follow the exercise. Work in teams of two.

THE DRAKE EQUATION

Should we be sending messages into space? Is it very likely that we might receive a message from space? Use the Drake Equation to help you make your own estimate of the number of civilizations in the Milky Way Galaxy that may exist now. Read each step and write your estimate in the box to the right.

1. Number of stars in our galaxy: 400 billion (400,000,000,000)

Although we can't be sure, most astronomers agree that this number is probably a good estimate.

Divide this number by:

2. Lifetime of our galaxy: about 10 billion years (10,000,000,000)

Write the number in the box.

3. The average rate of turnover of stars per year.

Some stars last a long time, others are more short-lived. On an average, this is the number of stars that are born and that die per year.

4. Fraction of stars with long enough lifespans for intelligent life to evolve.

It took about 5 billion years after our Sun formed for intelligent life with the technology to communicate through space to evolve on Earth. If we call 5 billion years the minimum amount of time needed, then what fraction of the 400 billion stars do you think has a lifespan of 5 billion years or more?

all = 1.0 3/4 = 0.75 1/2 = 0.5 1/4 = 0.25 other

Write your estimate in decimals in the box.

5. Average number of planets per star.

Our solar system has 9 planets. Our Sun is considered an average star. What do you think the *average* number of planets around stars is?

20 10 5 other

Write the number in the box.

6. Fraction of planets suitable for life.

In our solar system, out of nine planets, Earth is the only one known to be in the lifezone, and Mars almost is. Some astronomers also argue that there may be lifezones on some moons around gas giants. If we only count Earth, the fraction of planets in the lifezone of our star is 1/9 or 0.11. Of the planets around other stars, what fraction do you think are in a lifezone?

1/4 = 0.25 1/10 = 0.1 1/40 = .025 1/50 = .02 1/100 = .01 other

Write the decimal in the box.

7. Fraction of planets suitable for life, where life actually does occur.

Earth is the only example we have of a planet in a lifezone, and life *did* evolve. What fraction of planets in lifezones do you think would evolve life?

all = 1.0 3/4 = 0.75 1/2 = 0.5 1/4 = 0.25 1/8 = 0.125 other

Write the decimal in the box.

7

8. Fraction of planets with life that develop intelligent civilizations.

Earth is the only example we have of a planet that evolved life, and on Earth, intelligent civilizations have developed. What fraction of planets with life do you think would develop intelligent civilizations?

all = 1.0 3/4 = 0.75 1/2 = 0.5 1/4 = 0.25 1/8 = 0.125 other

Write the decimal in the box.

8

9. The average lifespan of civilizations with the technology and desire to communicate through space.

This one is the hardest to estimate. The average lifespan of stars suitable for life is 5–10 billion years. On Earth, we only developed the technology to communicate through space during the last 100 years. Do you think our civilization could last 5 billion years, or do you think it will end before then? Now, what about the *average* civilization in our galaxy?

1,000 years 10,000 years 1,000,000 years 1,000,000,000 years 5,000,000,000 years other

Write the number in the box. Multiply the numbers in boxes 3–9.

9

10. This number is your own personal estimate of the number of civilizations in the Milky Way Galaxy right now with whom we might communicate.

10

11. Look at the number you ended up with, and think about your result. Do you think there is much chance we might pick up a message from an extraterrestrial civilization if we listen?

12. Do you think we should be trying to communicate with extraterrestrial civilizations or not? Why or why not?

13. Remember that you just estimated how many intelligent civilizations there may be in our galaxy, but there are billions of galaxies in the Universe. How many civilizations in the *Universe* do you think there are right now with whom we might communicate?

14. There may be planets where life has evolved, but it has NOT reached an intelligent enough level to communicate through space. How many such planets do you think there are in our galaxy?

15. Compare your result with a classmate's. If they are very different, try to figure out why.

16. Since the final estimate is the hardest and has the most chance of being inaccurate, you may want to try changing it to see how the change affects the outcome.

Powers of Ten

Video Quiz

1) What is meant by the term 'Powers of Ten,' and how does it relate to this video?

2) Explain how the images in the video are organized? Why do you think the individuals who created this video chose this format?

3) How many powers of ten (starting at 10^0) are required to see the following:

(a) The curvature of the earth.

(b) The whole earth.

(c) The moon's orbit around the earth.

(d) The boundaries of the solar system.

(e) The entire Milky Way galaxy.

4) Answer the following two-part question:

(a) What is the largest structure shown and at what power of ten can it be seen?

(b) What is the smallest structure shown and at what power of ten can it be seen?

5) As a traveler from elsewhere coming into our solar system, at what power of ten could you visually detect signs of life on earth?

Astronomy

Mysteries of Deep Space:
Exploding Stars and Black Holes

Video Quiz

1) What is a supernova?

2) What causes a supernova to happen?

3) Supernovae are cataclysmic. Why do astronomers say that such destructive events are also agents of creation?

4) What is a black hole?

5) What are some of the characteristics of black holes?

6) How do supernovae and black holes shape the landscape of a galaxy? The universe?

/10

Astronomy

The Milky Way's Invisible Light

Video Quiz

1) What is a galaxy?

2) Why is our galaxy called the Milky Way?

3) What is meant by the term 'Invisible Light?'

4) What are the different types of invisible light referred to in the video?

5) What is the shape and structure of our galaxy?

6) How did astronomers use the different types of invisible light to determine the shape and structure of our galaxy?

Mysteries of Deep Space:
Search For Alien Worlds

Video Quiz

1) Name the two Americans known for discovering extrasolar planets.

2) Explain how astronomers have been able to detect planets outside of our solar system.

3) Discuss the history of our fascination with the planet Mars. In your discussion, include our earliest thinking, as well as our current understanding about the possibility of finding life on Mars.

4) What is meant by the term 'Life Zone' and what is its significance with respect to the search for life elsewhere in the universe?

5) Why do astronomers think that there is life on other worlds?

Time Travel

Video Quiz

1) What are the limitations of attempting to explore the universe via space travel?

2) What is meant by the term time travel?

3) What is a wormhole?

4) Who is Kip Thorne?

5) What is the connection between black holes and time travel?

6) Is it possible to travel backwards in time? Why or why not?

7) According to the video, will time travel be possible in the future? If so, how?

Astronomy

Part 1: Life Beyond Earth: Are We Alone?

Video Quiz

1) What are the 3 essential things required for life as we know it?

2) What is Charles Darwin known for and what significance does his accomplishment have in relation to finding life beyond earth?

3) How does the 'discovery' of Tasmania by Europeans similar to concerns we have about our being discovered by aliens from other worlds?

4) What is the habitable zone? What planets lie within it?

5) Name the two missions that we sent to Mars? What did we find?

6) Why were we hopeful that we would find life on Mars and Venus? How are these two planets similar? How are they different?

7) To understand how life may get started elsewhere, we need to understand how life got started on earth. What is our current thinking on this topic?

8) What significance do extreme environments have on our concept of the habitable zone?

9) What is terraforming and how might it be used on Mars?

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Astronomy

Part 2: Life Beyond Earth: Is Anybody Listening?

Video Quiz

1) In our effort to find life beyond earth, why is some form of communication preferable to space travel?

2) According to the Ferris, what is the generally accepted thinking regarding UFO sightings?

3) What are some of the ideas that humans have developed to make our presence on earth known to potential extraterrestrials?

4) Why is radio communication considered to be the most effective means of establishing contact with ET's?

5) What did Ferris mean by the comment that "We have been inadvertently communicating our broadcasts for years?"

6) What is Fermi's question/paradox?

7) In our search for intelligent life in the universe why is it important that ET's have a symbolic language?

8) Why might it be important to know how long human civilization will last in our quest to make contact with ET's?

9) Why did Ferris say that the great void is not space, but time?

The History Channel

The Universe

The Moon

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) What is the name given to our moon by the Romans?

2) The moon takes about 27 Earth days to go around the Earth which is approximately the length of a day on the Moon. What is the explanation for this?

3) Why is it not possible to hear sound on the Moon?

4) If you were standing on the Moon, what color would the sky be? Why?

5) List three hazards that an astronauts space suit protects against on the Moon. List one hazard that the space suit does not protect against.

6) What is the name given to the dark regions on the Moon? What does the name mean and why were they called this by early astronomers?

7) Name two large impact sites on the Moon and the prominent features associated with them.

8) Before our so-called Modern Era, the Moon was used for timekeeping. What is the difference between the solar calendar and the lunar calendar? Why was the lunar calendar used?

9) Explain how the moon causes two high tides on Earth each day.

10) What gravitational effect exerted by the Moon on the Earth is responsible for the continued survival of life on Earth?

11) The French astronomer, Edwin Roche, developed the Co-Accretion theory to explain the origin of the Moon. What are the main highlights of this theory? What is the main problem with this theory?

12) George Darwin, son of the great evolutionary biologist Charles Darwin, put forth another theory on the Moon's origin called the Fission Theory. List the main ideas and problems associated with this theory.

13) What is the name of the current, most widely accepted theory on the origin of the Moon? Describe the main features of this theory.

14) Name two advantages mentioned in the movie of having a permanent Moon base.

The History Channel

The Universe

The Inner Planets: Mercury and Venus

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Venus is often referred to as the Earth's Sister Planet. Name four characteristics that the two planets have in common to support this association.

2) Venus has a retrograde rotation. What does this mean and what do astronomers think is the main cause for this?

3) Why is it so hot on the surface of Venus? Why is this especially alarming for us here on the Earth?

4) Describe the composition of the Venusian atmosphere and the surface conditions on the planet.

5) Which planet has more volcanoes, the Earth or Venus? What effect does this have on the atmospheres of the two planets?

6) Venus was named after the Roman goddess of Love and Beauty. Why? If the Romans knew what we know today about Venus, do you think that they would have given it the same name? Why or why not?

7) What is the color of Mercury's surface? On Mercury the sky is dark and starry always. Why?

8) Mercury has no atmosphere. Why?

9) If a person weighs 150 pounds on the Earth, how much would they weigh on Mercury? Why?

10) Mercury is known for having great temperature variations on its surface. Explain why.

11) In Roman mythology Mercury is the 'Winged Messenger,' a reference to its speed. Why then is Mercury's year shorter than its day?

12) Mercury is described as a dead planet. Why?

13) Mercury and the Earth are in the same "neighborhood," astronomically speaking. However, Mercury has millions of impact craters on its surface and the Earth has relatively few of these features. Explain.

14) In 1974 Mariner 10 mapped one-half of Mercury's surface including the largest crater in the Solar System. What is the name of this crater and how was it formed? Why is the area around this feature called "Weird Terrain?"

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The Universe

Mars: The Red Planet

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences on a separate piece of paper.

1) Astronomers think that Mars once had liquid water on its surface. List the evidence that supports this idea.

2) In order for Mars to have had liquid water on its surface, it had to have had a substantial atmosphere like that on Earth. However, today Mars has a very thin atmosphere and no liquid water on its surface. How did Mars lose most of its atmosphere?

3) Mars has frozen polar ice caps. What are they made of?

4) List three pieces of evidence that support the idea that Mars has liquid water below its surface.

5) While observing Mars through a telescope the Italian astronomer, Schiapperelli, observed a series of criss-cross lines on the planet's surface. What did he call them and how did the mistranslation of the name he gave them lead to the idea that they were created by intelligent life?

6) Name the U.S. astronomer who worked out of his own observatory in Arizona that carried on a two decade long obsession with Schiapperelli's criss-cross lines. What major engineering project undergoing construction during this astronomer's lifetime influenced his interpretation of what he observed?

7) On Halloween in 1938, a infamous radio broadcast took place. Name the broadcaster, the nature of the broadcast, and the effect it had on its listeners.

8) For Mariner 4, Mariner 9, and the Viking mission provide the following information: (i) the year of the mission, (ii) the purpose of the mission, (iii) discoveries or new information that resulted from the mission.

9) What are Spirit and Opportunity? What have they accomplished?

10) Name the current Mars mission, its purpose, and how it was designed to accomplish its purpose.

11) Before the most current mission to Mars was launched, what dramatic discovery was beamed back to the Earth in the form of images taken by an already existing Mars orbiter?

12) What is one speculation about how life began on Earth that has a connection to Mars?

13) In what sense might humans on Earth be Martians?

14) Why is Mars red in color?

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The Universe

Jupiter: The Giant Planet

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Many astronomers consider Jupiter to be a mini-solar system. Why?

2) Jupiter is the largest planet in the Solar System. How does it compare in size to the Earth? How many Earth's would fit inside jupiter?

3) If a person weighs 150 pounds on the Earth, how much would they weigh on Jupiter? Why?

4) Why do astronomers say that Jupiter is a failed star?

5) Why is Jupiter sometimes referred to as the 'vacuum cleaner' of the Solar System? In what sense does the Earth owe its existence to Jupiter?

6) What is the Giant Red Spot? Characterize what it would be like to be inside this feature.

7) Name the four moons discovered by Galileo.

8) One of the Galilean moons has active volcanoes on its surface. Name the moon and state why it is actively volcanic.

9) Which of the four Galilean moons most closely resembles the planet Mercury? Why?

10) Which one of the Galilean moons is thought to have liquid water beneath its surface?

11) Describe the plans for determining if there is life on the moon mentioned in question #10.

12) If you are out in a remote area and listening to AM radio you can hear whistling tones that are said to originate from Jupiter. Name the feature of Jupiter that produces these sounds and describe its characteristics.

13) In 1979 a spacecraft observing Jupiter solved the secret of the origin of the whistling tones mentioned in question #11. Name the spacecraft and what it discovered about the origin of those signals.

14) What feature associated with Jupiter did the spacecraft mentioned in question #12 discover?

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The Universe

Saturn: Lord of the Rings

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Saturn is characterized as an oblate spheroid. What does this mean and why does it occur?

2) How did Saturn form?

3) What does the conservation of angular momentum have to do with the rate at which Saturn spins?

4) Saturn's rings are only 65 feet thick and made up of billions of pieces of space debris. What is this space debris made of and how large are the pieces?

5) List two possibilities for the origin of Saturn's rings.

6) Galileo was the first astronomer to observe Saturn. Draw a picture of what he saw. Who was the fist person to discover that Saturn has rings?

7) How many rings does Saturn have? Name them. What is ringshine and why are Saturn's rings so bright?

8) Describe two ways in which Saturn's rings can erode and eventually disappear?

9) What evidence is there that supports the idea that Saturn's rings are young compared to the age of Saturn, itself?

10) What role do so-called 'Shepherd Moons' have in the maintenance of Saturn's rings? Cite an example.

11) What is the origin of Saturn's name? What word in our culture is closely associated with it?

12) Saturn has even more dynamic storms than Jupiter. Astronomers theorize that there is lightning associated with Saturn's storm clouds. Why hasn't lightning been observed by any of the spacecraft orbiting the planet?

13) Saturn has the second largest moon in the Solar System. What is the name of this moon? What feature does this moon have that no other moon in our Solar System has? According to astronomers, what does this feature have in common with the Earth? Name the spacecraft that landed on this moon.

14) Describe the experiment that simulated the feature on the moon mentioned in question #13. What is the significance of this experiment with respect to the origin of life?

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The Universe

The Outer Planets

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Why did astronomers think that there was a 'Planet X' out beyond Neptune?

2) Who started the search for Pluto? Who carried on his work and eventually found it? Once Pluto was 'discovered,' why did some astronomers think that it wasn't 'Planet X?'

3) Astronomers later realized that there was no 'Planet X.' What convinced them of this?

4) Why is Pluto referred to as the "ultimate time machine?"

5) In what sense does Pluto have a temporary atmosphere?

6) Why did astronomers vote to kick Pluto out of the most exclusive club in our Solar System, that is, as a member of the other Planets? How is Pluto now classified? Describe NASA's New Horizons mission and how it relates to Pluto?

7) Uranus is a featureless, pale blue planet. What is the origin of the blue color?

8) What influence did the formation of Jupiter and Saturn have on the formation of Uranus and Neptune? Why are Uranus and Neptune called the 'Ice Giants?'

9) Jupiter, Saturn, and Neptune have very turbulent atmospheres. However, the atmosphere of Uranus is relatively calm. Why?

10) Who first discovered Uranus, and why was the discovery so significant?

11) How were the rings of Uranus discovered? What is the likely origin of these rings?

12) Why are the winds on Neptune greater than the winds on Jupiter and Saturn? Why do some astronomers think that Neptune is still forming?

13) In 1989 Voyager 2 discovered a huge storm on Neptune which was named 'The Great Dark Spot.' Five years later, what did the Hubble Space Telescope notice about this storm?

14) Neptune has 13 moons. Which one of these is the largest? How does the size of this moon compare to our moon? What are some of the unique characteristics about this moon?

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The Universe

Life and Death of a Star

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Stars form from the gravitational collapse of huge clouds of the element hydrogen (H). To form a star the size of our sun, how large must the cloud of H be?

2) What is a protostar and how is it formed? Once the core of a protostar reaches 18 million degrees, what happens? Why is this significant?

3) What prevents gravity from crushing a star? Include a diagram with your explanation.

4) What does it mean when astronomers say that a star is in equilibrium? What stage in a star's lifetime does this represent?

5) What important characteristic of a star does its color represent?

6) What is the most common type of star? List 3 of its characteristics (not including its color).

7) What two aspects of a star's life does its mass determine?

8) Describe, in detail, what will happen to the Sun in 5 billion years?

9) Why can't gravity crush a White Dwarf star? In what sense is a White Dwarf a "retired" star? What is another possible fate for a White Dwarf star?

10) Describe in detail the process leading up to a star becoming a Type II Supernova. Why can't a star that becomes a Type II Supernova fuse beyond iron (Fe)?

11) Why are Supernova explosions important? In what sense do we as humans owe our very existence to them?

12) How does a Type II Supernova become a Neutron Star? A Black Hole? How were Neutron Stars first identified by astronomers?

13) Our Sun is not massive enough to become a Supernova and explode. Describe one scenario that could make the Sun explode. Why would this make the Sun explode?

14) What are Blue Stragglers? What are Brown Dwarfs?

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The Universe

Beyond the Big Bang (Part 1)

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Why is the name 'Big Bang' a misnomer?

2) What is meant by the statement that the Big Bang is a centuries old quest of accumulated discoveries backed up by real evidence?

3) Provide two examples of simple structures used by ancient people to help them understand the Universe.

4) In what sense did ancient people use the night sky as a clock?

5) What is meant by the statement, "The history of Cosmology is the relentless retreat of the Earth from center stage?"

6) The early Greeks were the first to distinguish the planets from the stars in the night sky. Do we use Greek or Roman names today for the planets in our Solar System?

7) For each of the four astronomers, list their contributions to our modern understanding of the Universe: (i) Aristotle, (ii) Ptolemy, and (iii) Copernicus.

8) List the astronomical achievements of Kepler. What was the one thing that he observed but did not understand why it occurred?

9) Galileo was able to verify the ideas of both Copernicus and Kepler. How did he do it? What problems did Galileo face as a result of his ideas?

10) List Newton's contributions toward our understanding of how the Universe works. What was unique about his approach? What is it that he never really understood?

11) What was Einstein's belief about the Universe? What is ironic about this?

12) What is the main idea behind Einstein's Special Theory of Relativity? How did his later General Theory modify the Special Theory?

13) Einstein stated that not even light could escape the effects of gravity? How was this prediction of Einsteins's verified?

14) One of the consequences of Einstein's theory was that the Universe must be either expanding or contracting. Rather than accept this, what did Einstein propose?

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The Universe

Beyond the Big Bang (Part 2)

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Who was Lemaitre and why did Einstein say to him, "Your math is correct, but your physics is abominable?"

2) How was the astronomer Edwin Hubble able to destroy Einstein's concept of a static Universe and his Cosmological Constant?

3) What is the Steady-State Theory and who first proposed it?

4) Who is Ralph Alpher and what did he contribute to support the Big Bang Theory?

5) What was the so-called 'Smoking Gun' that provided the final proof that the Big Bang is the correct explanation of how the Universe came into being? What were the names of the individuals who did the work?

6) Once the Big Bang was finally accepted by the majority of astronomers, there was still a problem that it could not answer. What was this problem?

7) List the four fundamental forces in the Universe.

8) What is the Inflation Theory and who is the originator?

9) In June of 2001 NASA launched the Wilkinson Microwave Anisotropy Probe (WMAP) mission. What was the purpose of this mission? What did it accomplish?

10) According to astronomers, what happened one-billionth of a second after the Big Bang? Less than one second after the Big Bang? Three minutes after the Big Bang?

11) What occurs 380,00 years after the Big Bang? One billion years after? Five billion years after?

12) Our Universe has been expanding for about 13.7 billion years. How big is it now?

13) Describe what will happen to the inner and outer planets of our Solar System in 5 billion years.

14) What will happen to our Universe billions of years from now?

The History Channel

The Universe

Search for ET

Directions: Do not write on this page. Do not turn in this page when the assignment is collected for credit. Do not rewrite the questions. Answer in complete sentences.

1) Most scientists believe that the quest for ET must begin with a study of how life began on Earth. Describe the Urey-Miller experiment performed at the University of Chicago and how it relates to the question of how life may have begun on Earth. What did the famous astronomer, Carl Sagan, say about this experiment?

2) Richard Hurt, a scientist at Cal Tech studies planets and designs possible life forms that potentially could exist on those environments. Describe the life form that he designed to live on Jupiter and how it would be adapted to the environment found on Jupiter.

3) Europa, one of Jupiter's moons, is thought to have liquid water below its icy surface. In fact, it may have twice as much water as is found on Earth. What evidence do scientists cite to support the idea that Europa has water?

4) Europa's surface shows an intricate system of cracks and fissures? What causes these features?

5) What evidence is there to support the idea that these fissures open and close? Describe how the opening and closing of these structures may contribute to providing some of the nutrients and building blocks necessary to sustain life.

6) The top of Europa's ice layer contains oxygen. How did it get there?

7) What types of life forms might exist below the surface of Europa? Include a diagram with your answer. Where would life on Europa get the necessary energy and nutrients to sustain life?

8) What are some possible ways that we can actually look for life on Europa, that are currently being discussed by scientists? What possible risks are involved by this approach?

9) Describe how the surface of Saturn's moon, Titan, may have some form of microbial life. Describe the NASA JPL (Jet Propulsion Lab) design for exploring Titan.

10) What are the advantages of trying to detect intelligent life in the Universe using radio signals over interstellar space travel?

11) What does the acronym SETI stand for? How would SETI scientists distinguish a radio signal that had a natural origin over one that was sent by an intelligent civilization?

12) Explain the significance of the following quote with respect to the search for intelligent life. "Absence of evidence is not evidence of absence."

13) Describe another way, other than radio, in which we might encounter ETs. In your description, also include some of the ways in which humans are working toward this same goal.

14) Describe how discovering ET life could be of great benefit to us here on the Earth. How would it change our perspective?

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