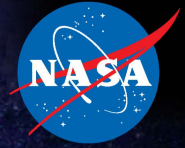


National Aeronautics and
Space Administration



ANSWER KEY

Forward to the Moon with Artemis

.....
EXPLORER ACTIVITIES

Ages 5-12



EXPLORE MOON *to* MARS

As the nation celebrates the 50th anniversary of the Apollo Moon landing on July 20, 2019, NASA has its sights set on traveling forward to the Moon—

this time to stay!

NASA's new Artemis mission will land the first American woman and the next American man on the surface of the Moon by 2024.

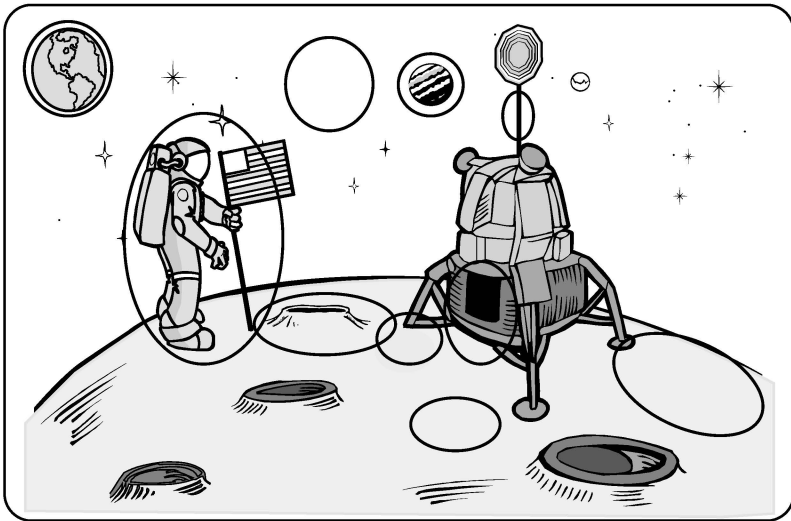
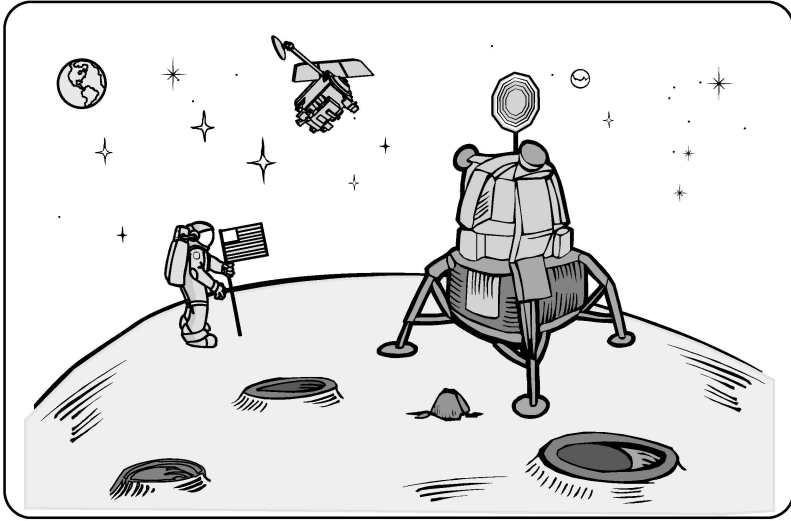
Activity Ratings:

- ★ easiest
- ★★ more challenging
- ★★★ most challenging



Lunar Exploration

Find and circle 10 differences between the two images.



Celebrating 50 Years of Apollo
and looking forward to
Artemis, the Next Era of Space Exploration



The Artemis Generation

Complete the word cloud by writing words that represent what it takes to get to the Moon by 2024 inside the dashed boxes.



Artemis was the *twin sister of Apollo* and the *goddess of the Moon* in Greek mythology.

Artemis is the name of NASA's ambitious program to land humans on the **Moon by 2024**.



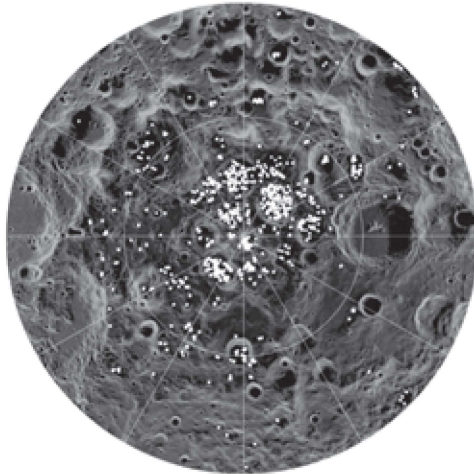
Landing at the Moon's South Pole

Jot down your ideas of why NASA chose the South Pole for the 2024 Artemis landing site.

The South Pole of the Moon has a lot of water ice. Some areas of the South Pole receive over 200 Earth days of continuous sunlight.

Shipping water to the Moon is extremely expensive.

Water ice on the Moon can be melted and potentially used for drinking water and for cooling equipment. Water can be split into hydrogen and oxygen. Hydrogen could be used to make rocket fuel and oxygen could be used for breathing. Areas of the lunar surface exposed to sunlight provide a source of power and light. The sunlight can be harvested to illuminate a lunar base and power its equipment.



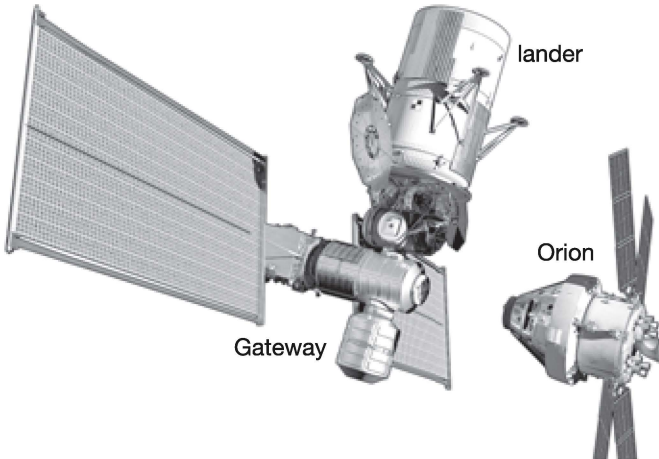
The light spots represent water ice on this satellite image of the Moon's South Pole.

Coding Takes You Everywhere

Fill in the blanks using 0's and 1's to complete the pattern.

0	0 0 0 0	8	1 0 0 0
1	0 0 0 1	9	1 0 0 1
2	0 0 1 0	10	1 0 1 0
3	0 0 1 1	11	1 0 1 1
4	0 1 0 0	12	1 1 0 0
5	0 1 0 1	13	1 1 0 1
6	0 1 1 0	14	1 1 1 0
7	0 1 1 1	15	1 1 1 1

Binary code uses 0's and 1's to represent letters and numbers. It allows people on Earth to talk to astronauts in space.



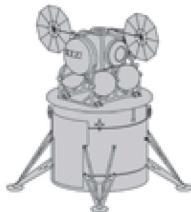
Artemis astronauts will travel in Orion to the Lunar Gateway. The lander will shuttle astronauts to the surface of the Moon. More parts will be added to the Gateway over time.



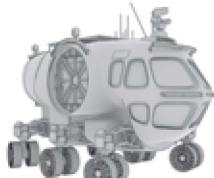
Decode the Binary Message

Using 0's and 1's, complete the binary code for capital letters.

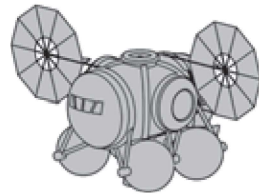
A	01000001	N	01001110
B	01000010	O	01001111
C	01000011	P	01010000
D	01000100	Q	01010001
E	01000101	R	01010010
F	01000110	S	01010011
G	01000111	T	01010100
H	01001000	U	01010101
I	01001001	V	01010110
J	01001010	W	01010111
K	01001011	X	01011000
L	01001100	Y	01011001
M	01001101	Z	01011010



Lander



Rover



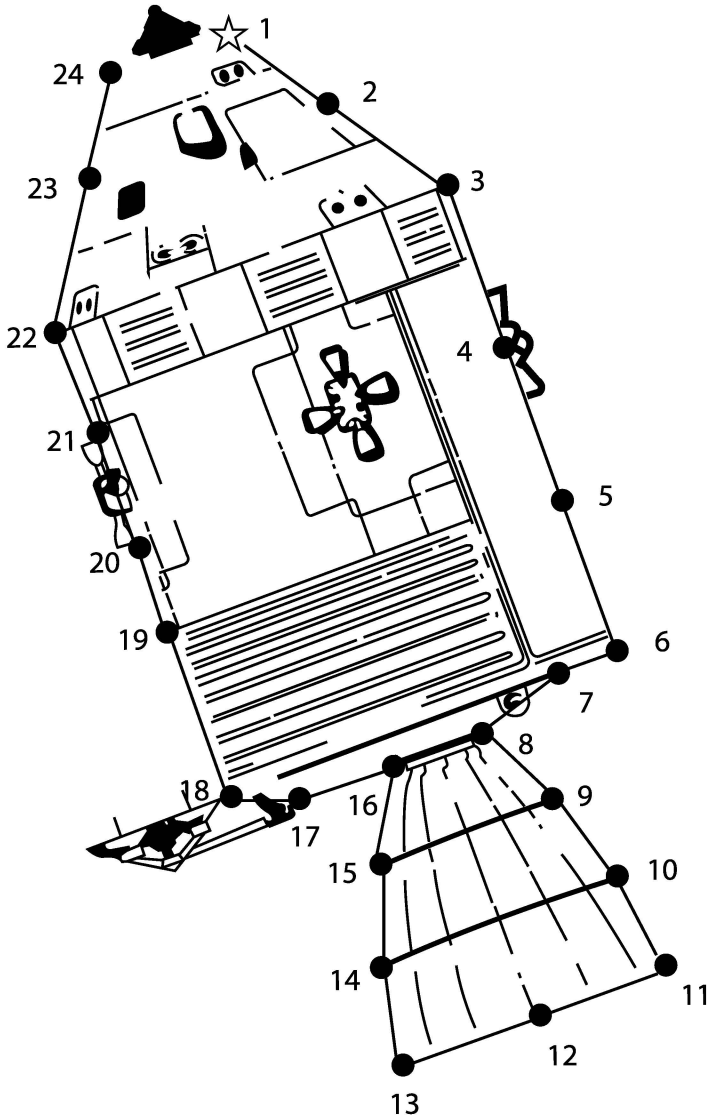
Ascent Vehicle

Use the code to reveal the message.

J	O	I	N	T	H	E
01001010	01001111	01001001	01001110	01010100	01001000	01000101
A	R	T	E	M	I	S
01000001	01010010	01010100	01000101	01001101	01001001	01010011
M	I	S	S	I	O	N
01001101	01001001	01010011	01010011	01001001	01001111	01001110

Apollo Command and Service Module

Connect the dots.

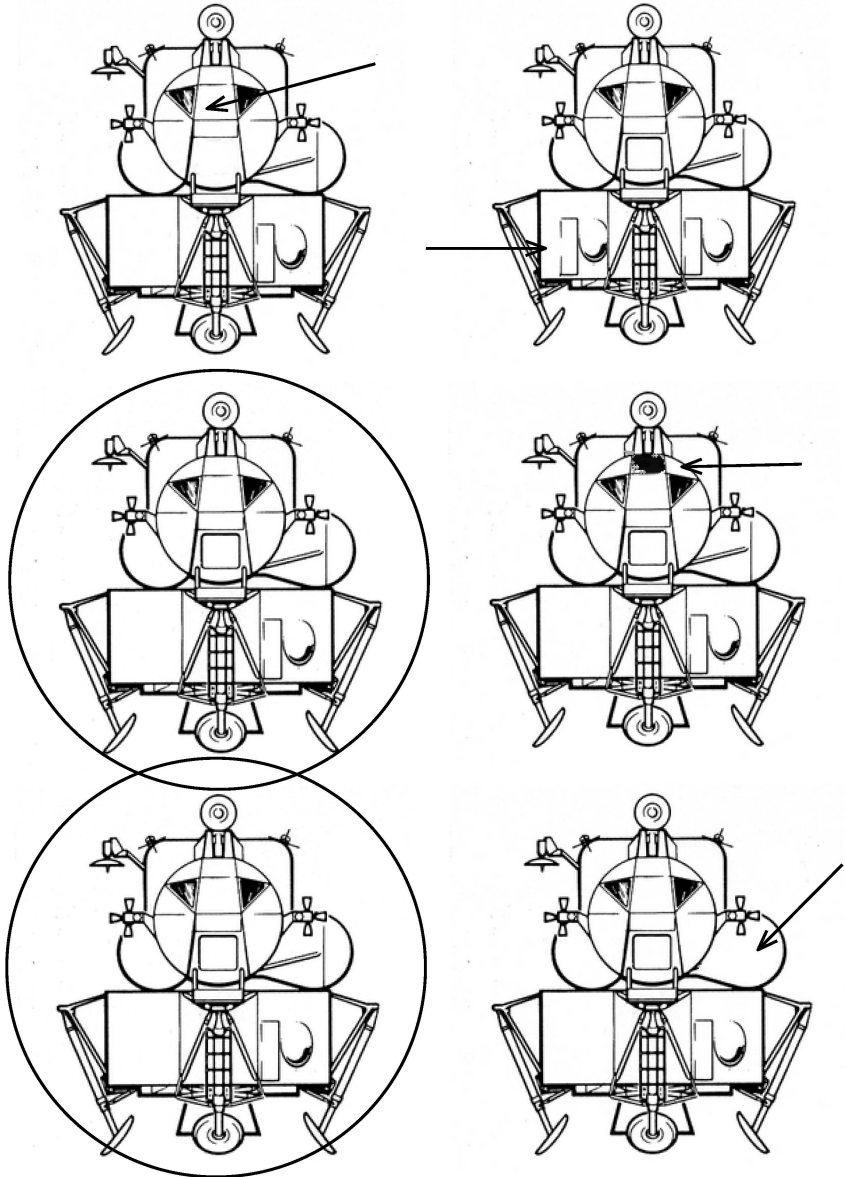


Carried Apollo astronauts from Earth to lunar orbit and back to Earth.



Apollo Lunar Modules

Circle the two identical Lunar Modules.

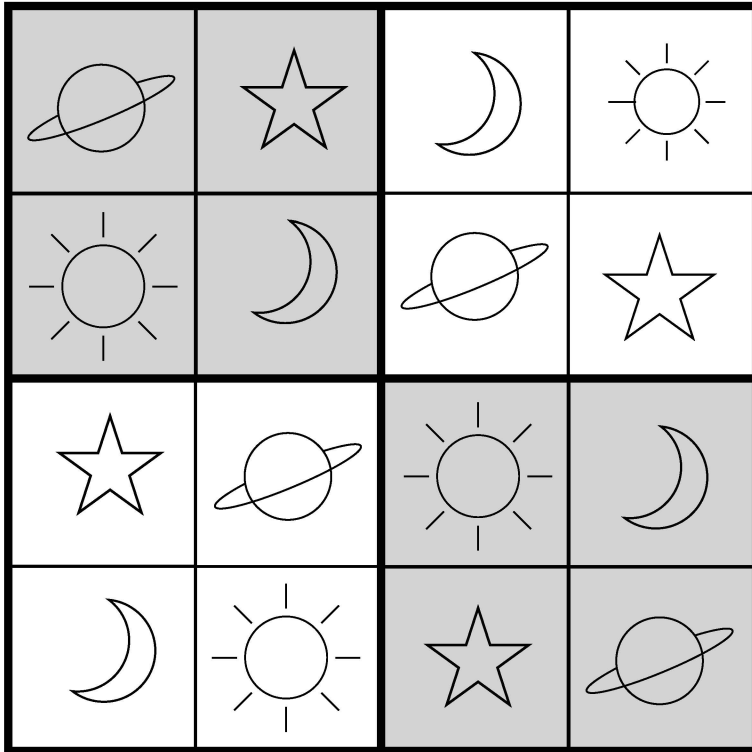
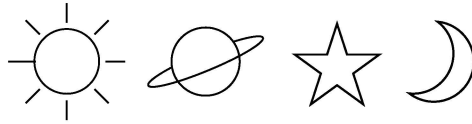


Carried Apollo astronauts from the Command and Service Module to the surface of the Moon and back. Also called the LEM (Lunar Excursion Module).



Space Explorer Puzzle

Fill in the empty squares. Each shape should appear once in each row, column, and two-by-two block.



Did You Know?

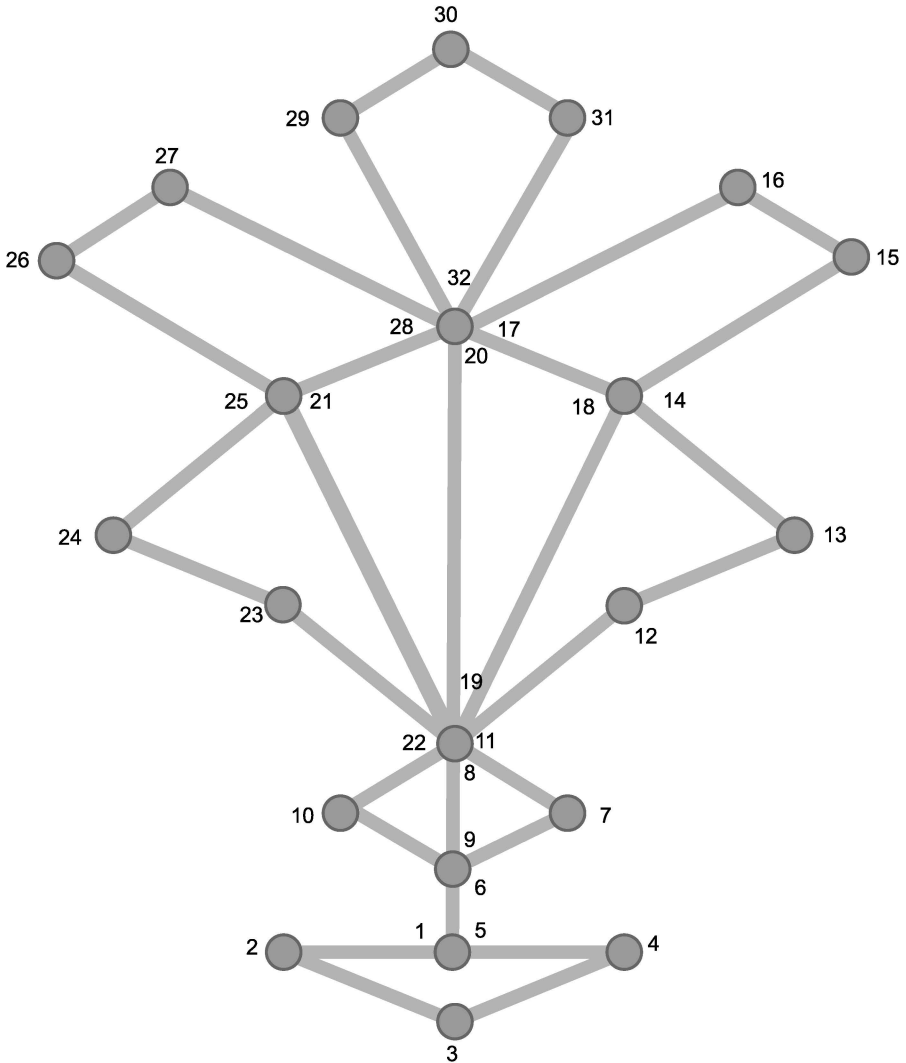
On July 20, 1969, Neil Armstrong became the first person to walk on the surface of the Moon?

To date, 24 humans have visited the Moon and 12 have walked on its surface.



Continuous Path

*Trace the shape below with one continuous line.
Do not retrace any lines, and do not add new ones.*



“That’s one small step for a man, one giant leap for mankind.”

First words spoken from the
surface of the Moon.

Neil Armstrong, July 20, 1969.





Forward to the Moon and on to Mars

Traveling to the
Moon and **Mars**
requires **powerful rockets**.

The **SLS (Space Launch System)**, is NASA's **newest**
and most **powerful rocket**.

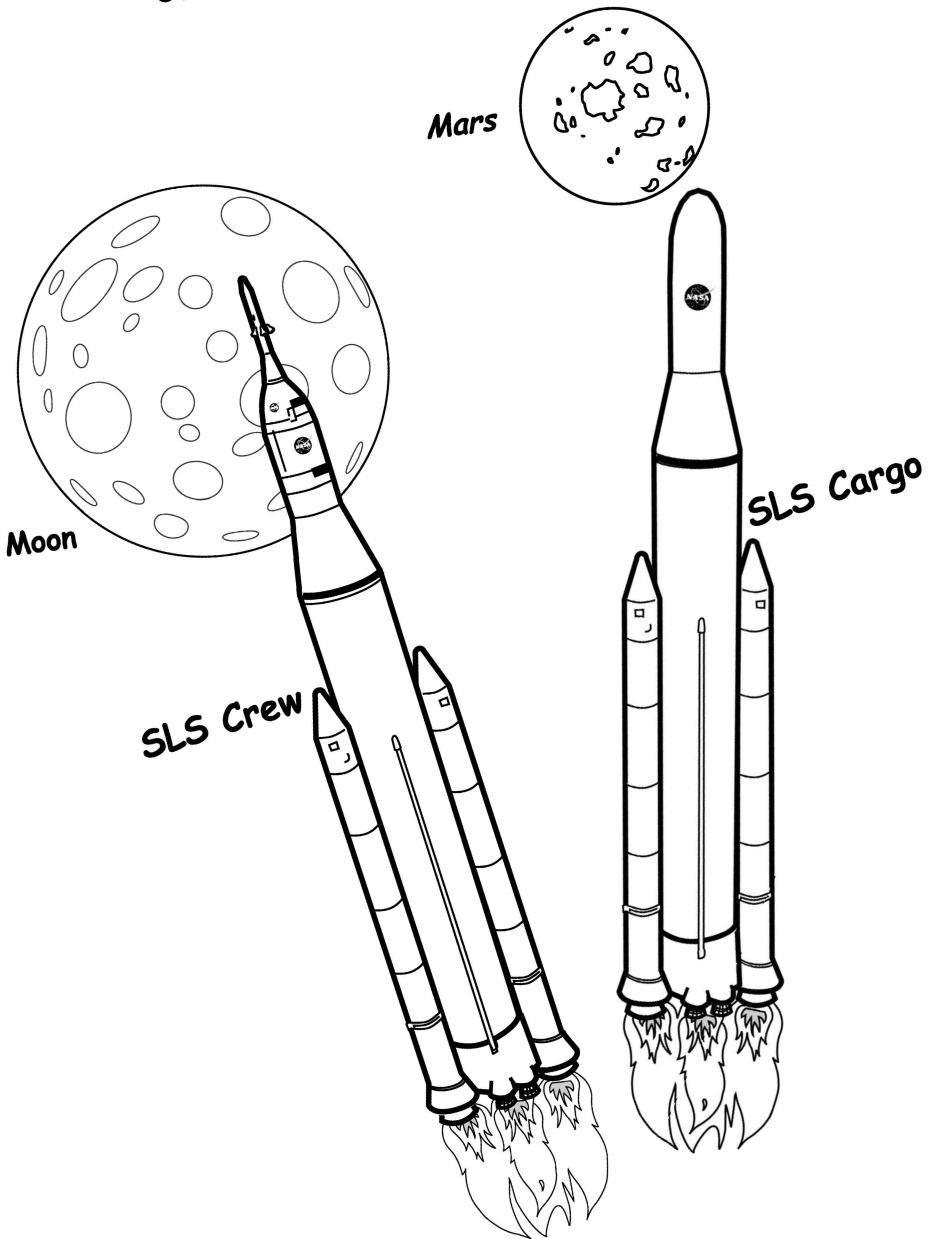
SLS Crew will transport the **Orion spacecraft, astronauts**, and a
large cargo supply to
deep space destinations.

SLS Cargo will launch
heavy cargo to
deep space destinations.

SLS will provide the power
to help Orion reach a **speed**
of at least **24,500 miles per**
hour needed to break out
of **low-Earth orbit**.

NASA's Newest Rockets

Color SLS Crew and SLS Cargo.



NASA's Next Human Spacecraft

*Match the words on the opposite page to the clues below to reveal the name of NASA's next human spacecraft.
(Activity continues on page 13)*

1. NASA is building the Lunar Gateway, a new spaceship that will orbit the:
2. The Space Launch System has two types of rockets, one for heavy cargo and one for:
3. Satellites show that the Moon's South Pole has large amounts of water stored as:
4. The Space Launch System will be NASA's newest and most powerful:
5. The Latin word for Moon is:



1. M O O N

2. C R E W

3. I C E

4. R O C K E T

5. L U N A

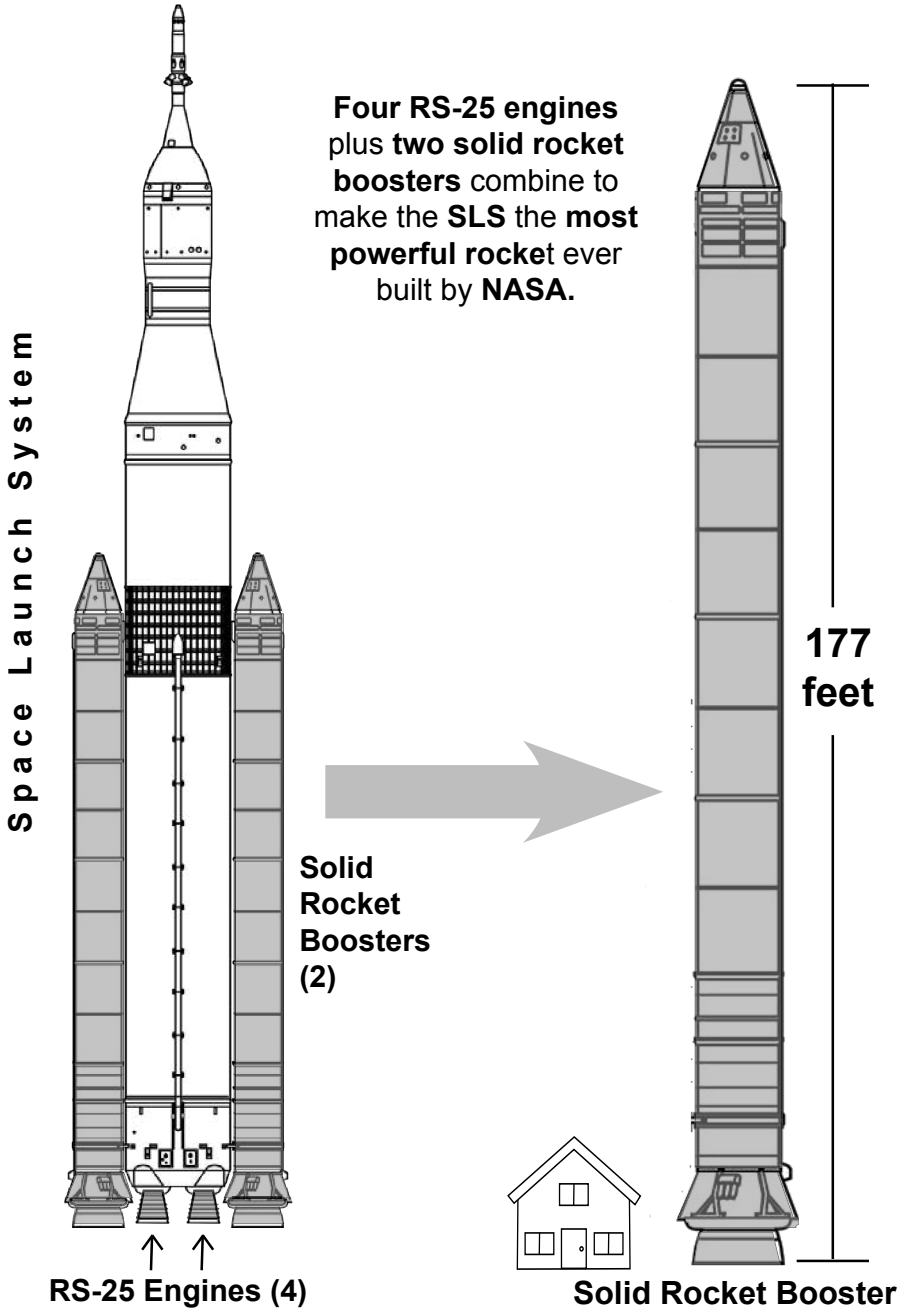
ice luna crew Moon rocket

The O R I O N

spacecraft will launch atop the
Space Launch System and take
humans farther into space
than ever before.

Providing Power for the SLS

(Activity continues on page 15.)



If the average house is **20 feet tall**, about how many houses could be stacked on top of each other to reach the height of the solid rocket booster?

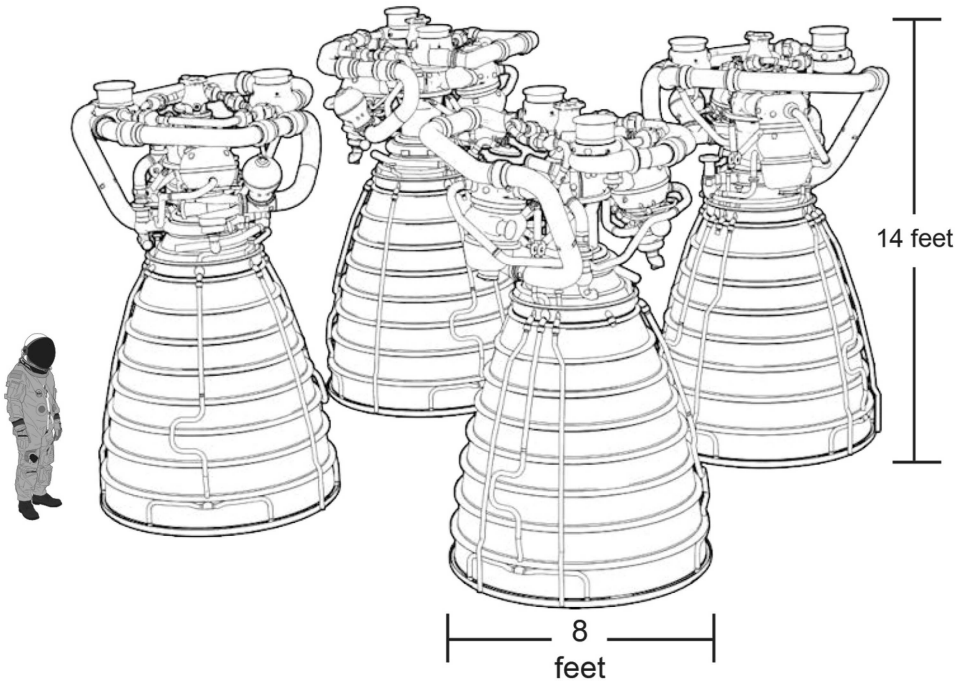
Answer: **9**

9 x 20 feet = 180 feet

If the average astronaut is **6 feet tall**, about how many astronauts could stand on top of each other to reach the height of the RS-25 engine?

Answer: **2**

2 x 6 feet = 12 feet



RS-25 Engines
RS-25 Engines



Make New Words

Make as many words as you can from the letters in:

P R O P U L S I O N

There are many more words than those below.

Two- to three-letter words:

in	is	ion	lip
oil	our	pin	pun
rip	run	sin	sip
sir	son	sun	urn

Four-letter words:

lion	loon	oils	onus
pool	poor	pops	pour
ruin	soup	spur	upon

Five-letter words:

irons	lions	plops	polio
pupil	slurp	sloop	spoil
spool	spoon	spurn	unrip

Six-letter words:

poison	poplin	porous	prison
--------	--------	--------	--------

PROPULSION - to drive an object forward.

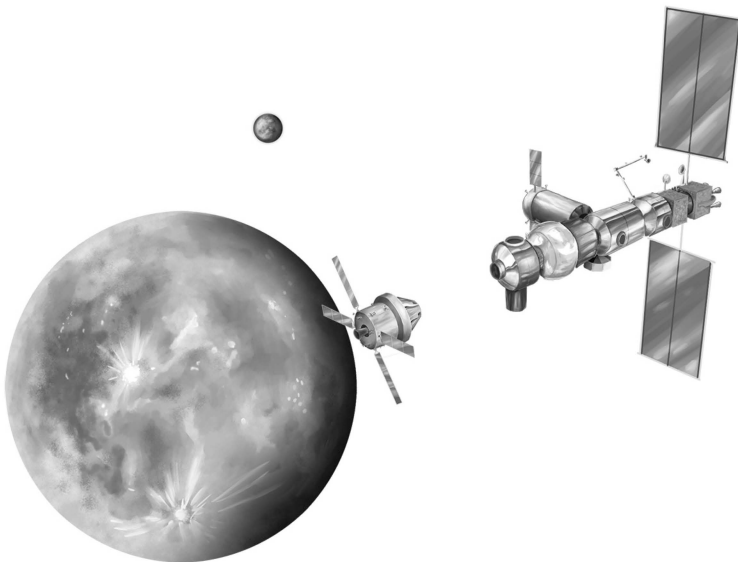


Lunar Gateway

NASA is working with its partners to design and build the Lunar Gateway, a small spaceship that will orbit the Moon.

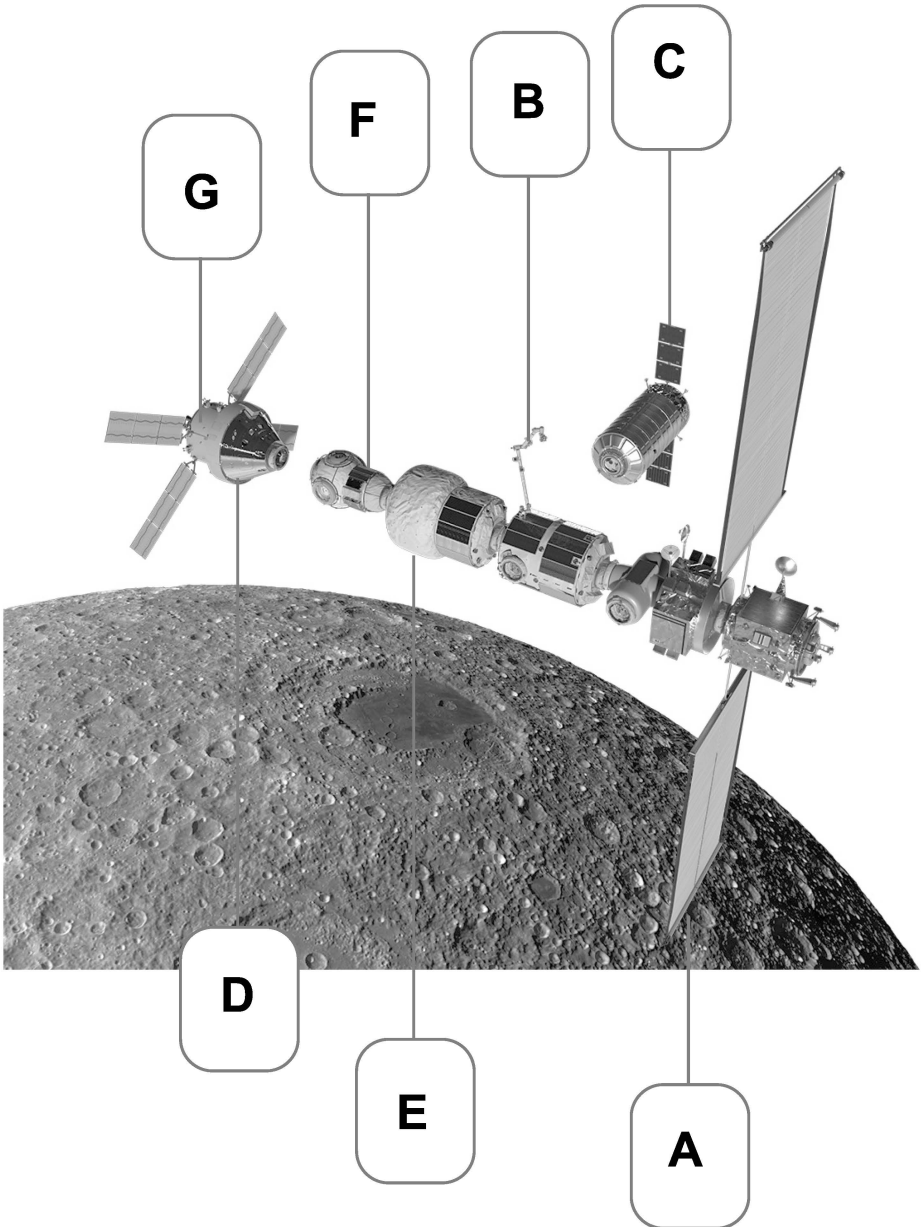
Astronauts will live and work in the Gateway for several months at a time. They will travel to the surface of the Moon and explore how the Moon can help astronauts travel to Mars.

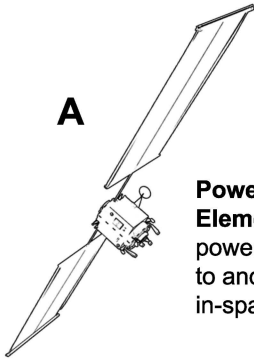
Living in the Lunar Gateway will help astronauts learn how to survive in deep space and prepare for future expeditions to Mars.



Living and Working in Space

Match each part of the Lunar Gateway on the opposite page to the assembled model below. Write the letter of each part in the correct boxes.
(Activity continues on page 19.)





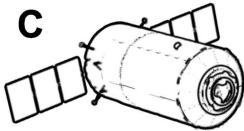
A

Power and Propulsion Element. Provides power, communication to and from Earth, and in-space transportation.



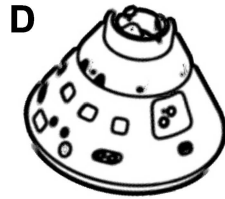
B

Robotic Arm. Mechanical arm to help spacecraft dock to the Lunar Gateway.



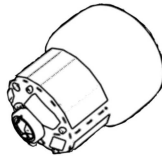
C

Cargo Resupply. Delivers food and other cargo to the Lunar Gateway.



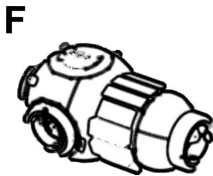
D

Orion Spacecraft. Transports astronauts deeper into space than ever before.



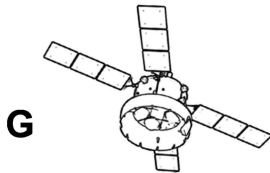
E

Habitation Module. Where astronauts will live and work.



F

Airlock. Airtight room with two entrances that allow astronauts to go on a spacewalk without letting air out of the spacecraft.

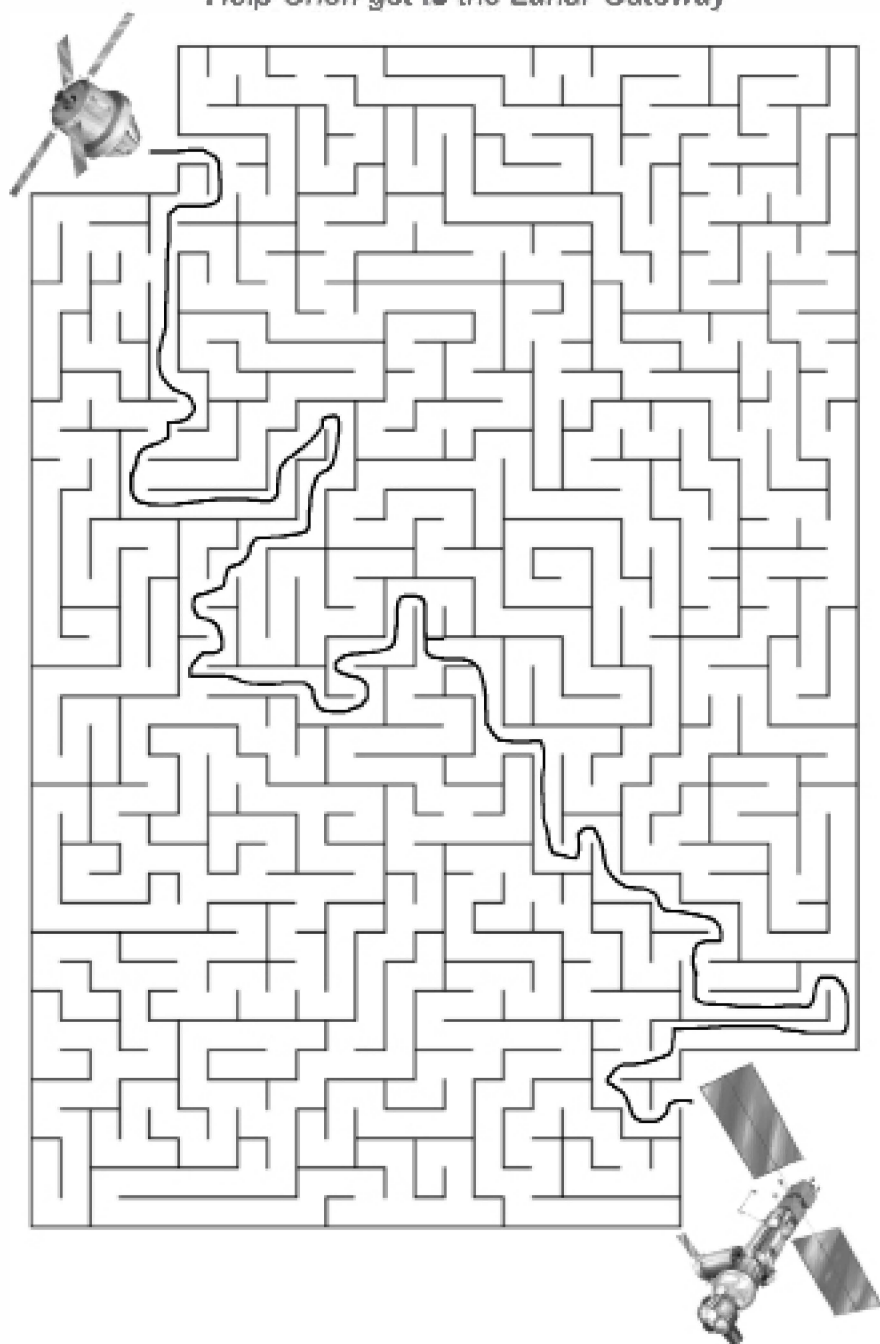


G

Orion Service Module. Supplies electricity, propulsion, temperature control, and the air and water needed for space travel.

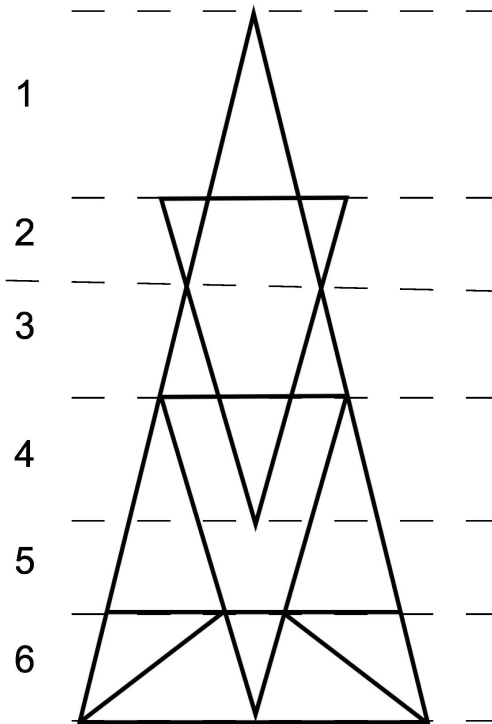
Destination: Lunar Gateway

Help Orion get to the Lunar Gateway



How Many Triangles?

How many triangles are in the drawing below?



There are 22
triangles.

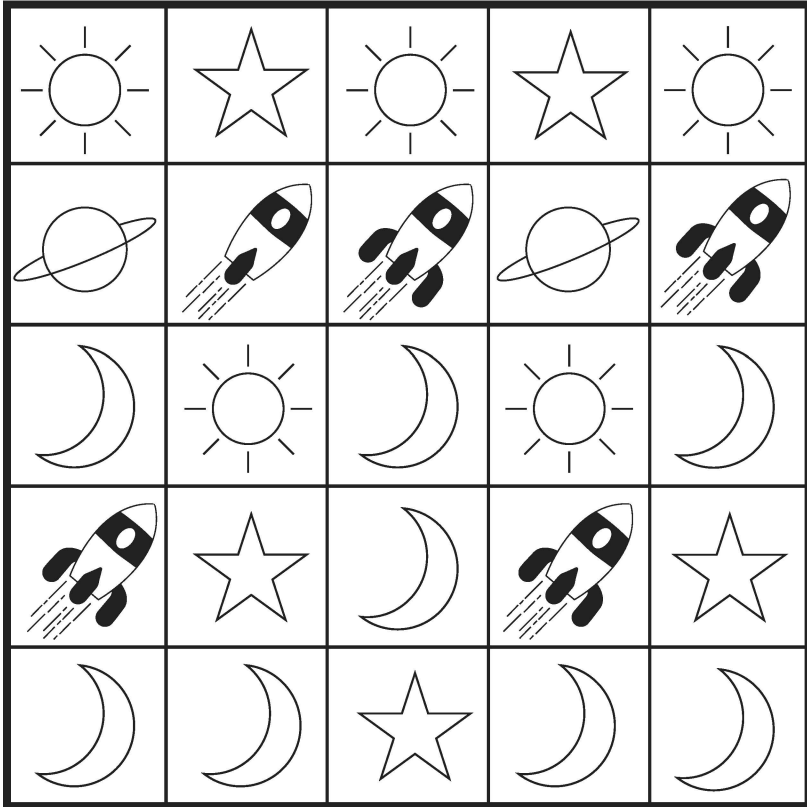
Divide the diagram into six	1-level triangles	11
levels. Count the number of	2-level triangles	2
triangles that occupy one	3-level triangles	7
level, then the number of	4-level triangles	0
triangles that occupy two	5-level triangles	1
levels. Continue this pattern	6-level triangles	1
until you reach six levels.		<hr/>
		22





Complete the Pattern

Draw the picture that comes next in each row.



Space Haiku

Create a haiku. Use the words below or choose your own.

A haiku is a poem with three lines.
The first line has five syllables. The second line, seven.
The third line has five syllables.

space
galaxy
solar
launch
surface
wonder
mission

gateway
stars
system
rocket
challenge
astronaut
Artemis

explorer
liftoff
challenge
Moon
explore
Mars
human

life
frontier
Orion
planet
lunar
unknown
quest

Title

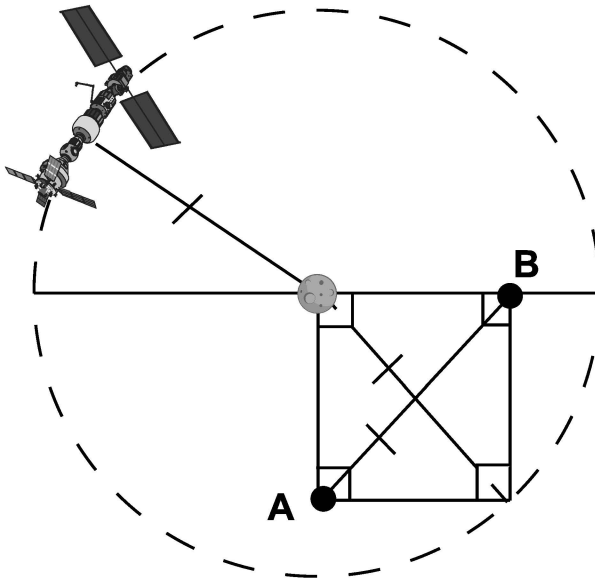
5 syllables

7 syllables

5 syllables

Lunar Gateway Orbit

Determine the distance between the Moon and the Lunar Gateway.



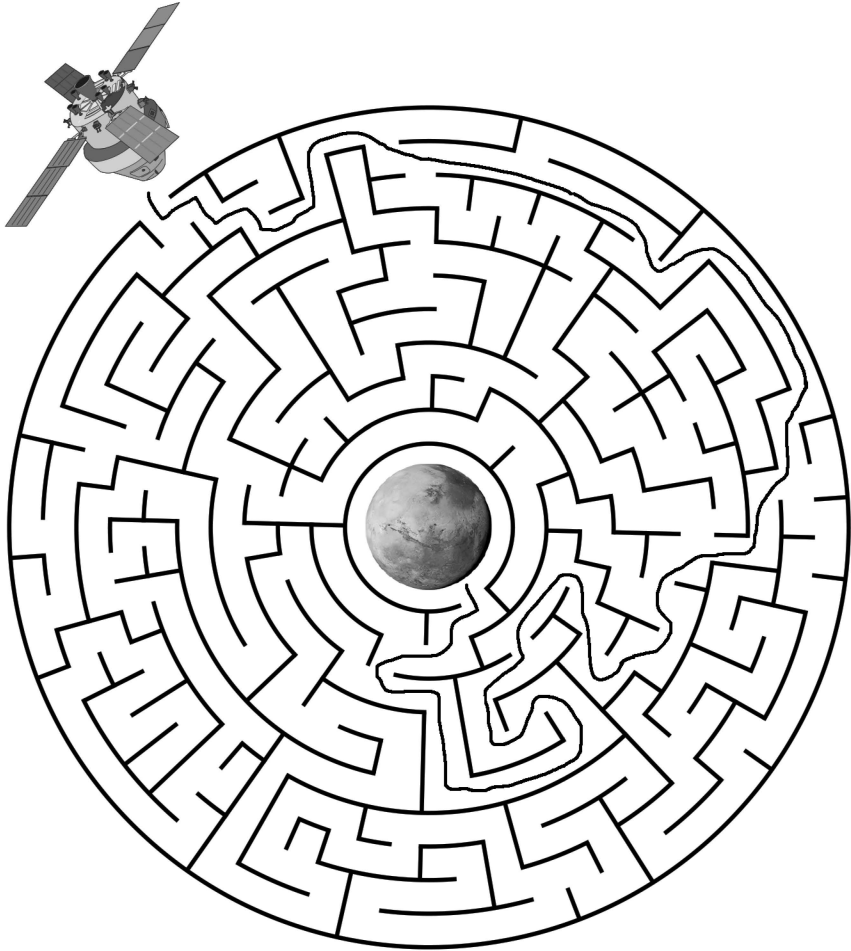
The Lunar Gateway is in a circular orbit around the Moon. If the distance between point A and point B is 930 miles, what is the distance between the Moon and the Lunar Gateway?

The Lunar Gateway is 930 miles from the Moon.

We know the quadrilateral is a rectangle because of the two right angles on opposite corners. The diagonals of a rectangle are of equal length. The diagonal of the rectangle is also the radius of the circle. The distance between the Gateway and the Moon is equal to the radius of the circle. Therefore, the Gateway is 930 miles from the Moon.

Orion Maze

Help Orion find Mars.

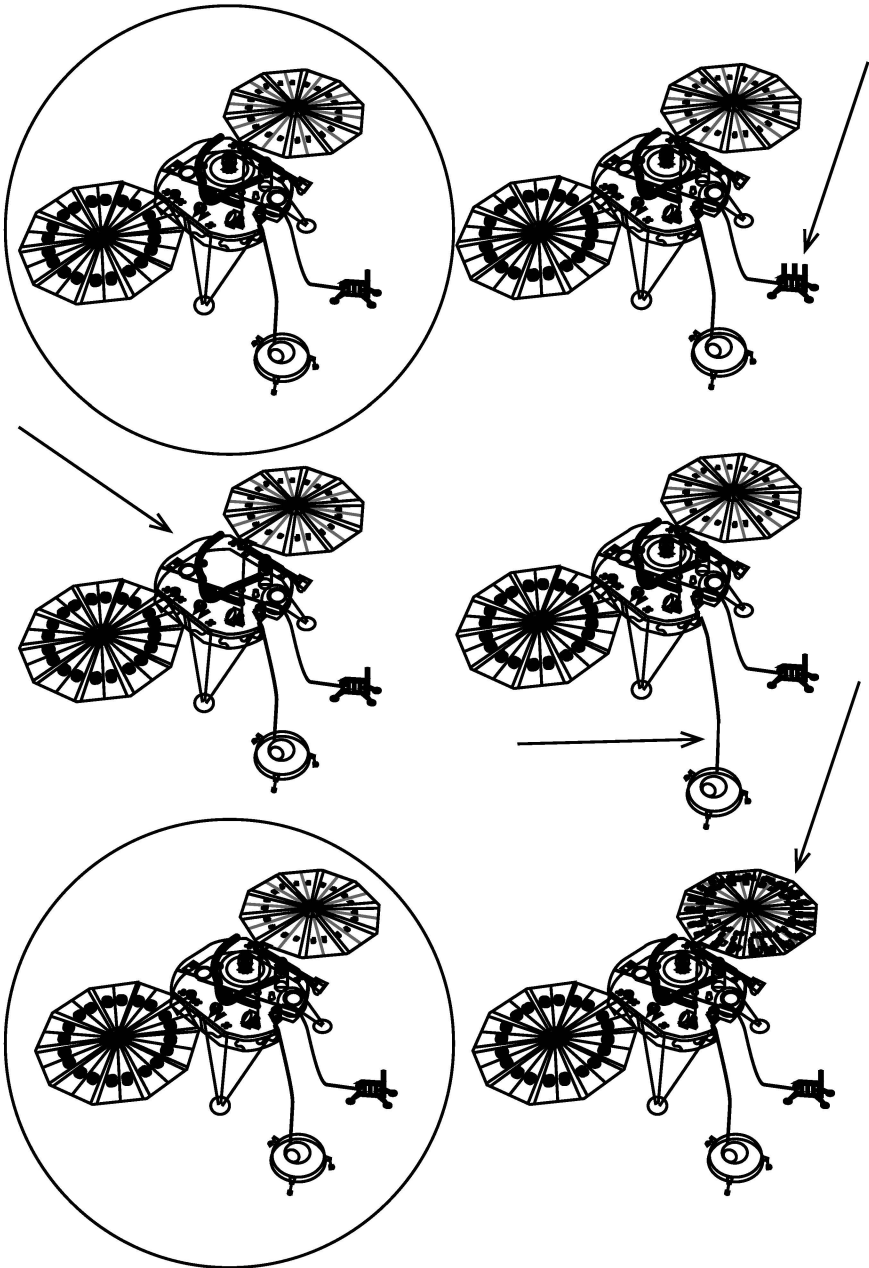


The Orion spacecraft will carry astronauts to the Lunar Gateway, Mars, and other deep space destinations. Orion is designed to keep crew safe during long periods of space travel and will be able to withstand the harsh environment of reentry into the Earth's atmosphere.



Identical Landers

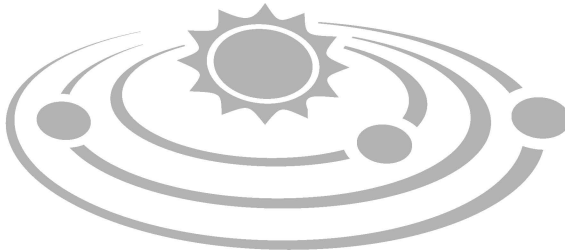
Circle the two identical Mars Insight landers.



Sudoku

Fill the empty squares so that each number 1 through 6 appears exactly once in each row, column, and each three-by-two block.

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



Moon to Mars Word Search

Circle the words below.

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

ASTRONAUT
PROPULSION
GATEWAY
MARS
LANDER
EXPLORE

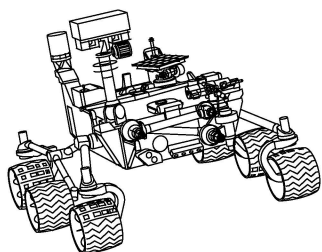
ROCKET
MOON
CARGO
SLS
MISSION
ROVER

POWERFUL
ORION
ROBOTIC
INNOVATIVE
ENGINE
SPACECRAFT

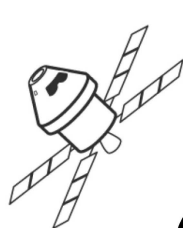
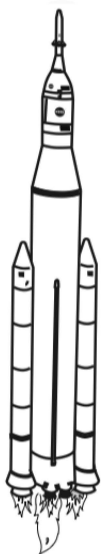


Space Exploration Memory Test

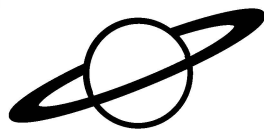
Study the page for 30 seconds. Then turn the page and write down as many objects and words as you can remember.



galaxy



space



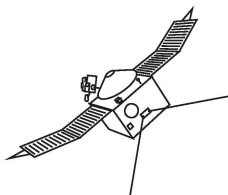
Gateway



technology



Mars



engine

Artemis



Space Exploration Recall

Study the previous page for 30 seconds. Write down as many objects and words as you can remember.

rover

NASA logo

star

Apollo patch

moon

globe

satellite

galaxy

United States

technology

rocket

space

Orion capsule

Gateway

planet

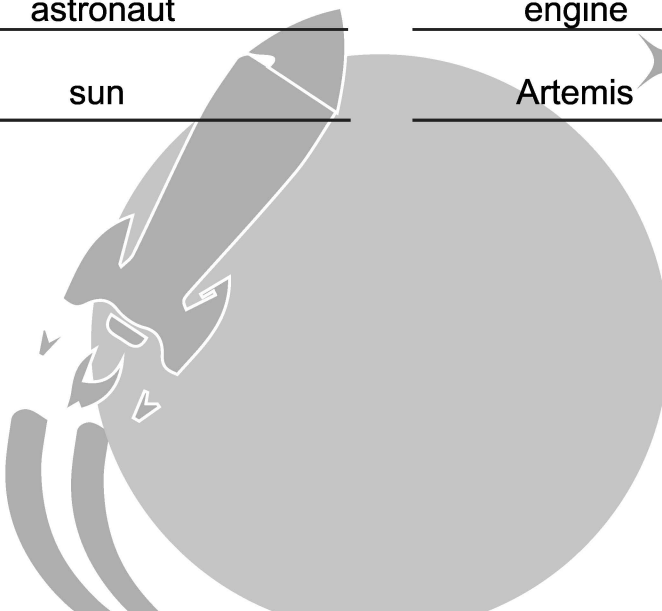
Mars

astronaut

engine

sun

Artemis



Sudoku

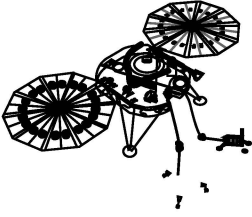
Fill the empty squares so that each number 1 through 9 appears exactly once in each row, column, and each three-by-three block.

9	5	4	6	3	8	2	7	1
8	7	3	2	4	1	5	6	9
1	6	2	7	9	5	8	3	4
2	9	7	8	6	3	4	1	5
6	4	5	1	7	2	9	8	3
3	1	8	4	5	9	7	2	6
4	3	1	9	2	7	6	5	8
7	8	9	5	1	6	3	4	2
5	2	6	3	8	4	1	9	7

NASA hires people with excellent math skills to achieve its complex and challenging missions.



Alphabet Path



1. In one continuous line, connect the letters of the alphabet from A to Z. If you do not see the next letter of the alphabet in a neighboring circle, add the correct letter to a shaded circle.

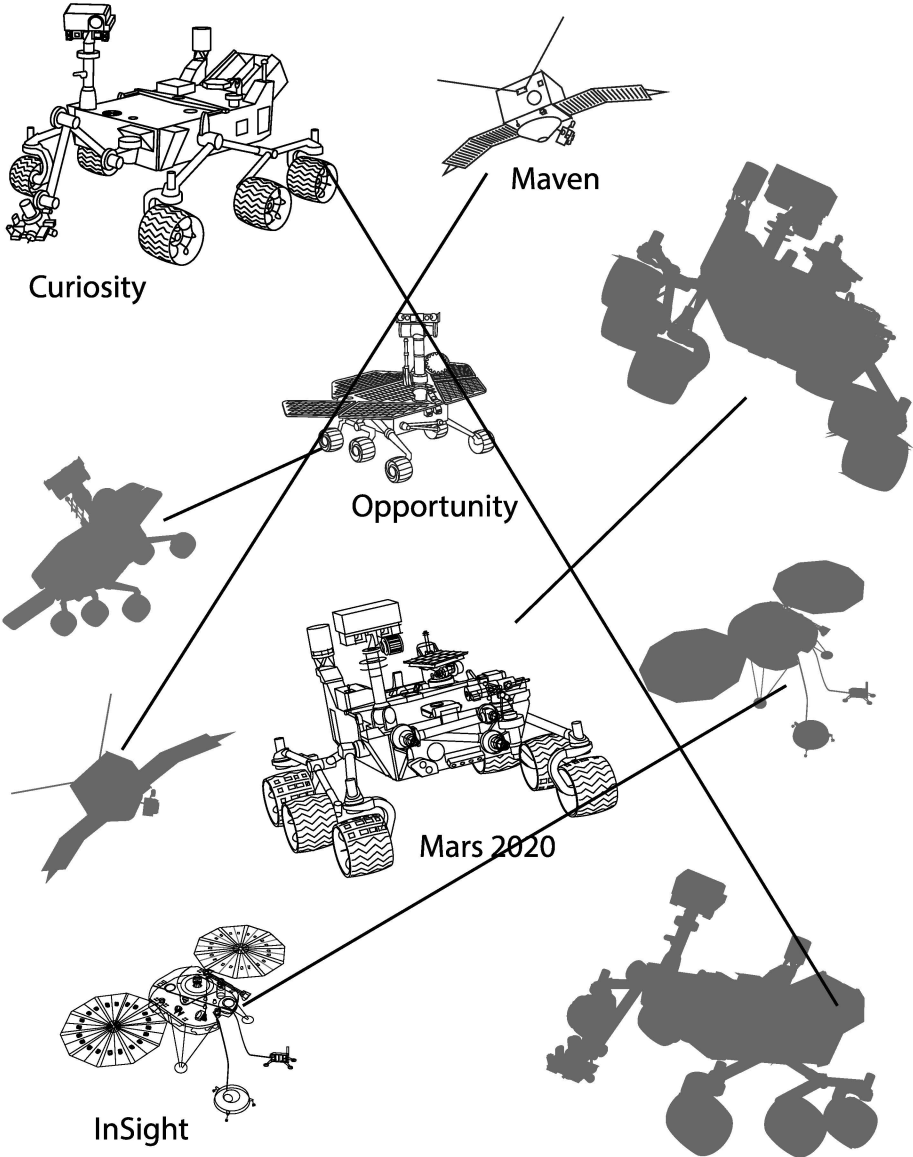
(Activity continues on page 35.)

B	E →	F	P
R	D	G	M
C	B	J	H
A	E	I	K

I	N	S	I	G	H	T

Satellites, Rovers, and Lander

Match each Mars observer to its shadow.



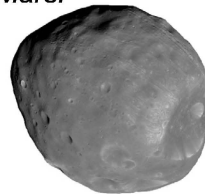
Two Moons of Mars

Fill in the numbers 1 through 9 so that each equation is correct. Use each number only once.

4	+	I 8	÷	D 2	= 8
+		÷		X	
7	+	O 1	X	E 5	= 12
—		—		—	
B 9	÷	S 3	+	6	= 9
= 2		= 5		= 4	

Match the letter in each box to the code below to reveal the names of the two moons of Mars.

P	H	O	B	O	S
4	7	1	9	1	3



13.8 miles



7.8 miles

D	E	I	M	O	S
2	5	8	6	1	3



Be a Martian!

Use the code to reveal a message from NASA.

M A R S
☎ ▶ 😊 ✈

E X P L O R E R S
⊕ * ⚠ ⚡ ⬠ 😊 ⊕ 😊 ✈

W A N T E D
😞 ▶ ⚠ 🪐 ⊕ ⊕

A = ▶	F = ☉	K = 🛡	P = ⚠	U = ▬	Z = ▶
B = ○	G = ✓	L =	Q = □	V = ☒	
C = ⚙	H = ☀	M = ☎	R = 😊	W = 😞	
D = ⊕	I = ↑	N = ⚠	S = ✈	X = *	
E = ⊕	J = ⊗	O = ⬠	T = 🪐	Y = 👁	

Mars needs YOU!

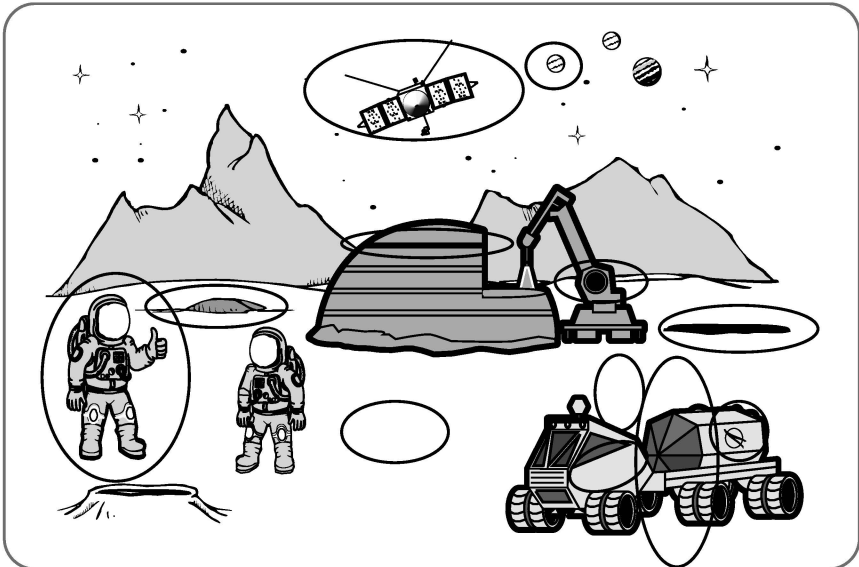
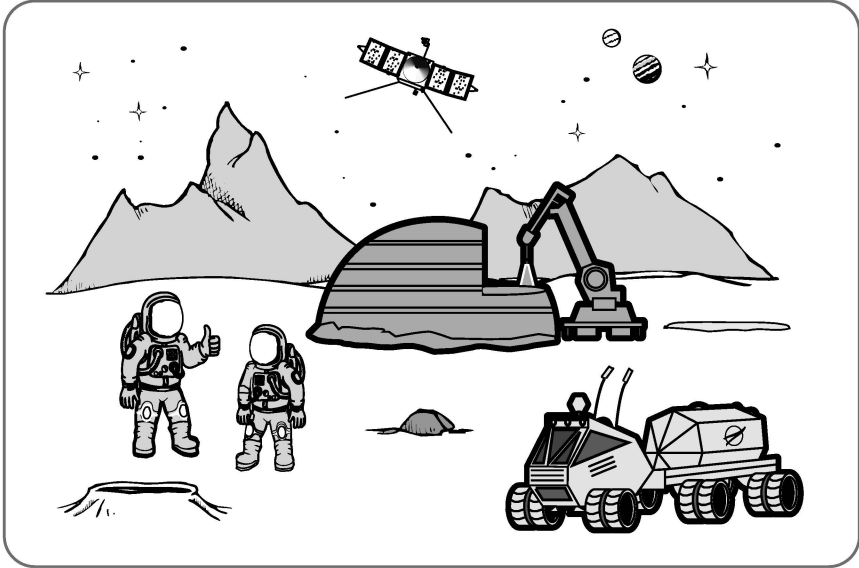
Mars will need all kinds of explorers, scientists, technologists, engineers, mathematicians, artists, designers, programmers, and teachers--

but most of all, Mars will need YOU!



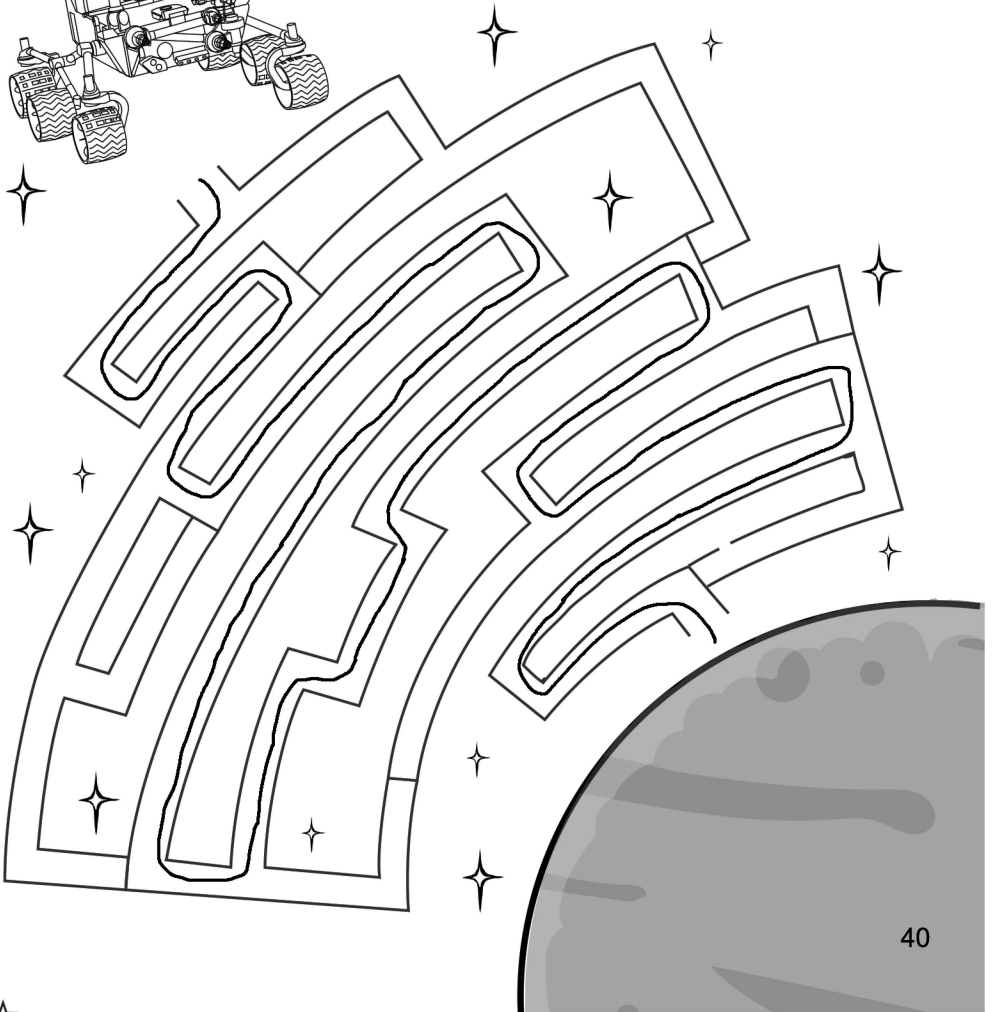
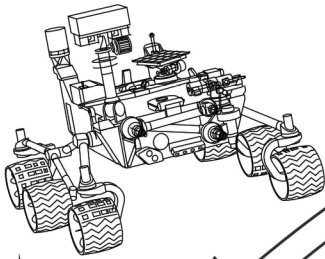
Life on Mars

Find and mark 12 differences in the two pictures.



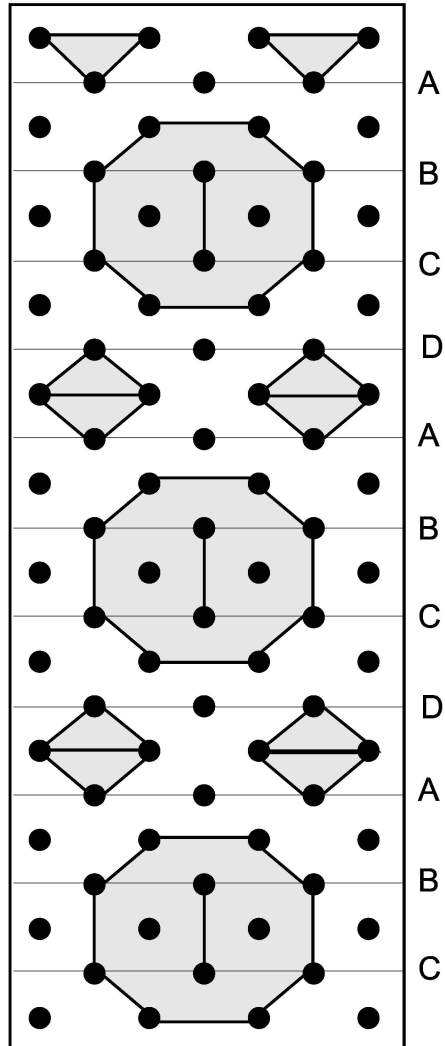
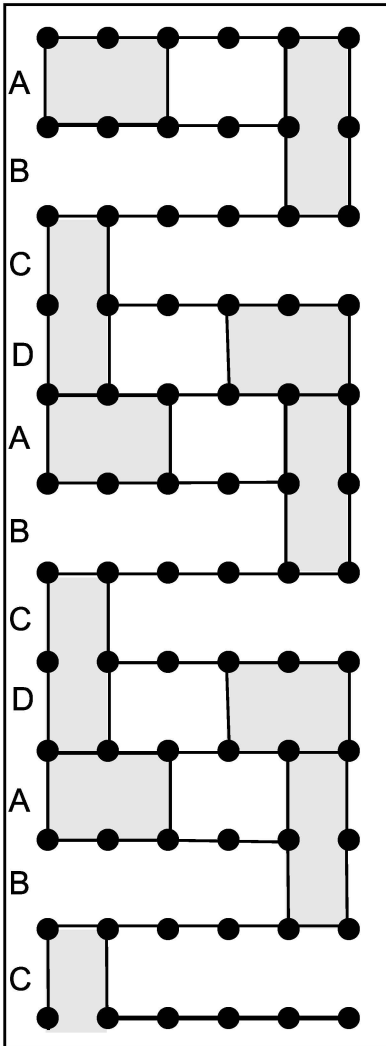
Land on Mars

Help the Mars 2020 rover safely land on Mars.



Complete the Pattern

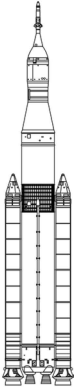
Complete shading the boxes below by continuing the patterns that have been started for you.



Scientists and engineers look for patterns to make sense of observations.

What Do You Think?

Circle your response for each question. **Objects are not to scale.**



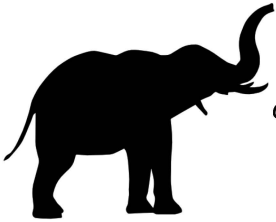
Which is taller?

Space Launch System Crew

OR

Statue of Liberty

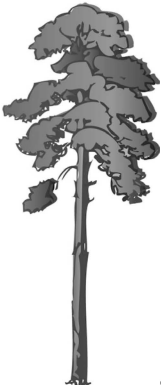
The SLS Crew will stand at 322 feet tall. The Statue of Liberty is 305 feet tall.



How many elephants?

About how many elephants could fit in the cargo area of the first SLS Crew rocket?

1-2 10-12 100-120



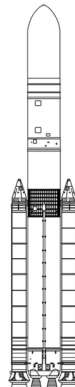
Which is taller?

Hyperion, the worlds tallest known Redwood tree

OR

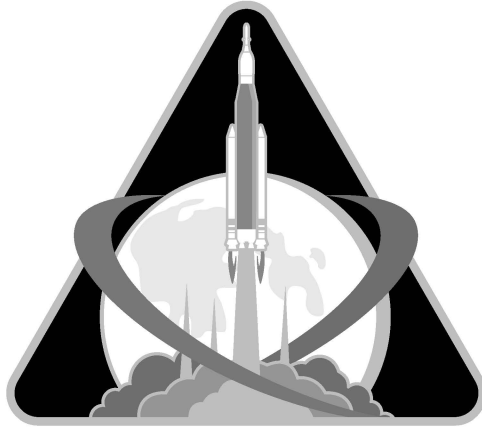
the first SLS Cargo rocket

Hyperion is 379.1 feet tall.
SLS Block 1 Cargo will be 313 feet tall.
Later versions of SLS will extend to 365 feet tall.



Small Steps to Giant Leaps

Unscramble the tiles to reveal a message.



e p s .	G i a	p s	o f
a	s t	b u	n t
i e s	s e r	i l t	a l l
a r e	o n	l e a	s m

G i a n t l e a p s
a r e b u i l t o n
a s e r i e s o f
s m a l l s t e p s .

Create Your Own Stanza

Finish "Moving Forward to the Moon" on the opposite page by adding seven more lines. Have the second, fourth, and sixth lines end in rhyming words. Be sure to include humans traveling to Mars since that is the next giant leap.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____



Moving Forward to the Moon

We're moving forward to the Moon
To build a colony
Fifty years of exploration
And more we'd like to see
We will unite the world through space
To stretch our boundaries
As we all move forward to explore the Moon.

We'd like to show the world the Moon
In ways they've never seen
And declare our honor to the LEM
Based at Tranquility
We'd like to probe the universe
In ways that will be key
As we all move forward to explore the Moon.

We'd like to use all our STEM
To search the galaxy
Exploring both time and space -
Seek new realities
We'd like to fill the cosmos with
Peace and humanity
As we all move forward to explore the Moon.

We're building a new Gateway
It is our destiny
A new frontier that we'll explore
Like Eagle in history
That one small step for man still stands
A new giant leap is in the plans
As we all move forward to explore the Moon

- Rebecca Strong

EXPLORE
MOON to MARS



... and on to Mars!

STEM Engagement:

nasa.gov/stem

Apollo Program:

nasa.gov/apollo50th

Explore Moon to Mars:

nasa.gov/moon2mars

Short Rocket Science Videos:

nasa.gov/nosmallsteps

Forward to the Moon with Artemis

Explorer Activities and Answer Key:

nasa.gov/exploreraactivities

nasa.gov

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