

National Aeronautics and Space Administration



# POWER & PROPULSION ELEMENT ACTIVITY BOOK

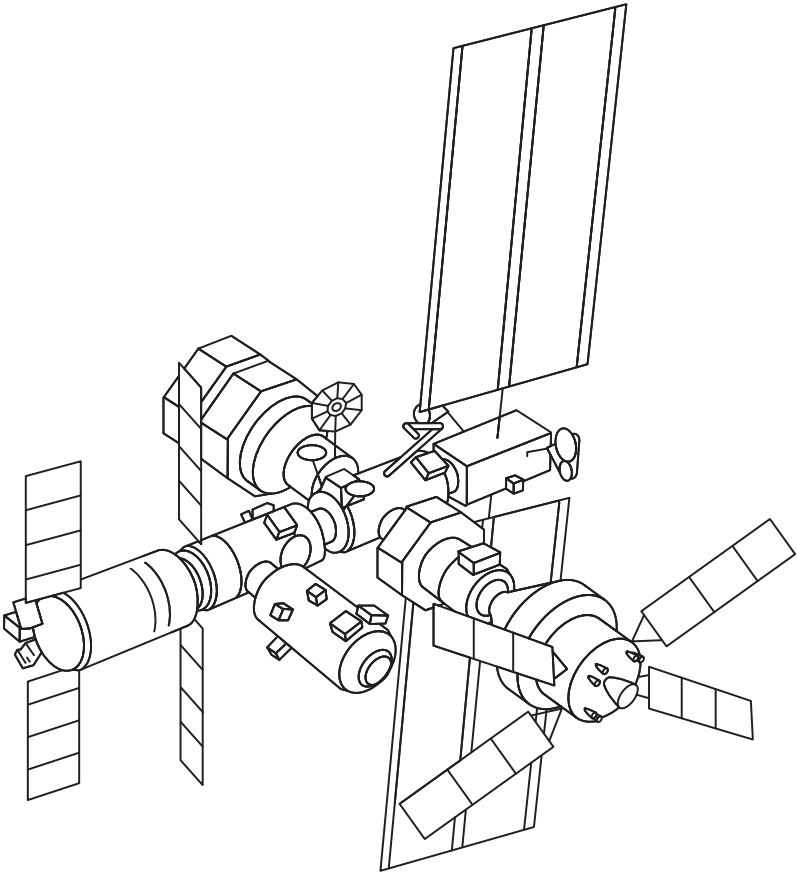


**THIS BOOK BELONGS TO:**

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# GATEWAY

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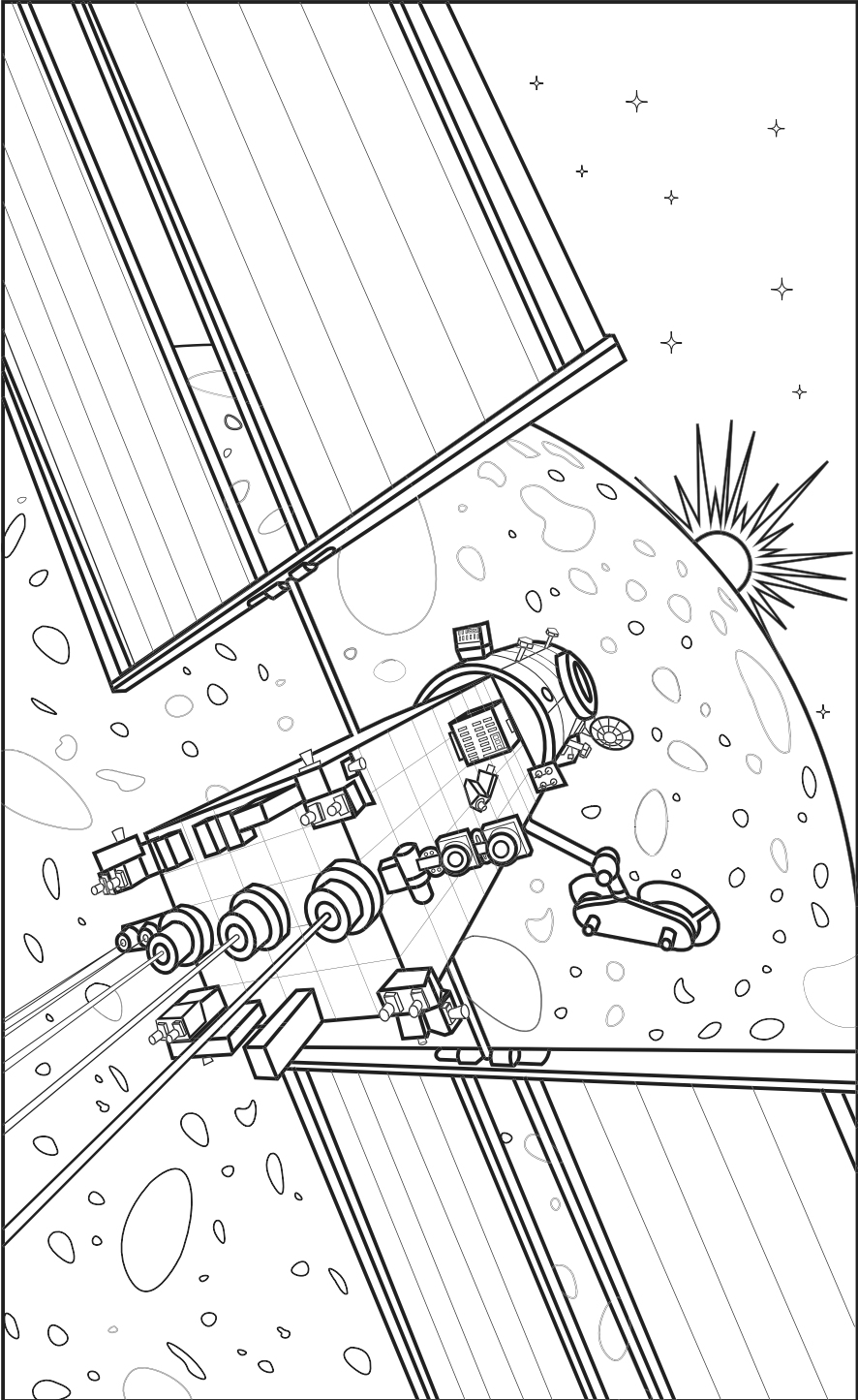


## **What is Gateway?**

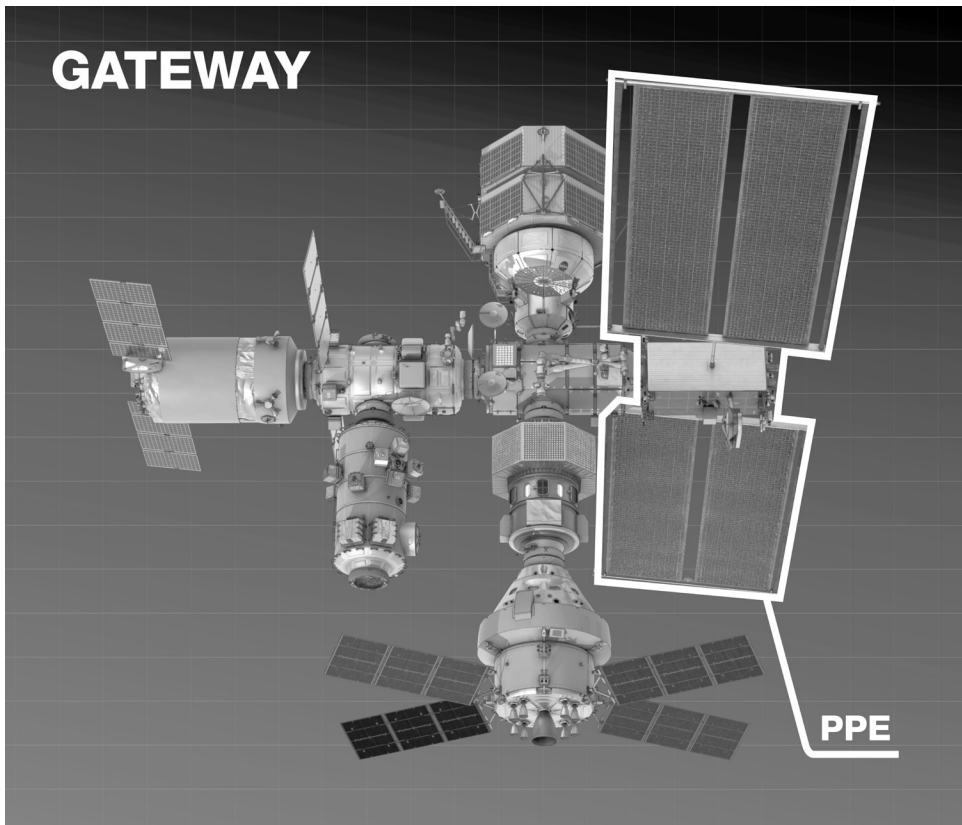
The Artemis Program will land the first woman and person of color on the Moon for scientific discovery and to enable human missions to Mars. An important part of Artemis is NASA's lunar-orbiting station called Gateway. Gateway is where astronauts from many countries will eat, sleep, rest, conduct science experiments, and get ready for their trips to the lunar surface.

The first two pieces of Gateway are the Power and Propulsion Element, or PPE, and the Habitation and Logistics Outpost, or HALO, where astronauts will live. PPE and HALO will launch together from Earth to lunar orbit.

# POWER & PROPULSION ELEMENT



# POWER & PROPULSION ELEMENT



*Pictured: The Gateway space station with PPE highlighted (Credit: NASA)*

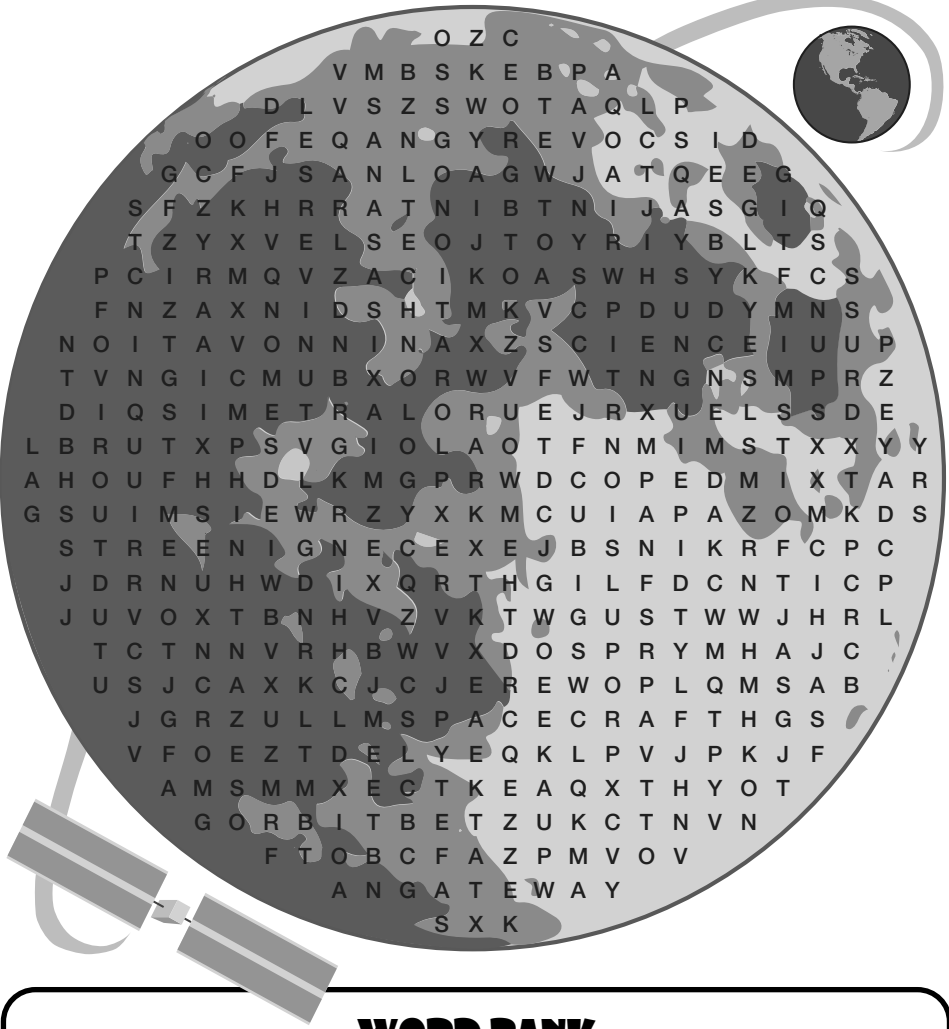
## **What is the PPE?**

The Power and Propulsion Element (PPE) is the powerhouse for the Gateway space station.

PPE will provide the lunar outpost with power to keep its computers running and to stay in its orbit around the Moon. PPE will also provide communications so that people on Earth can talk to astronauts on the surface of the Moon. It will also be a flying laboratory where computers and astronauts will conduct science experiments to better understand the solar system that we live in.

# SPACE WORD SEARCH

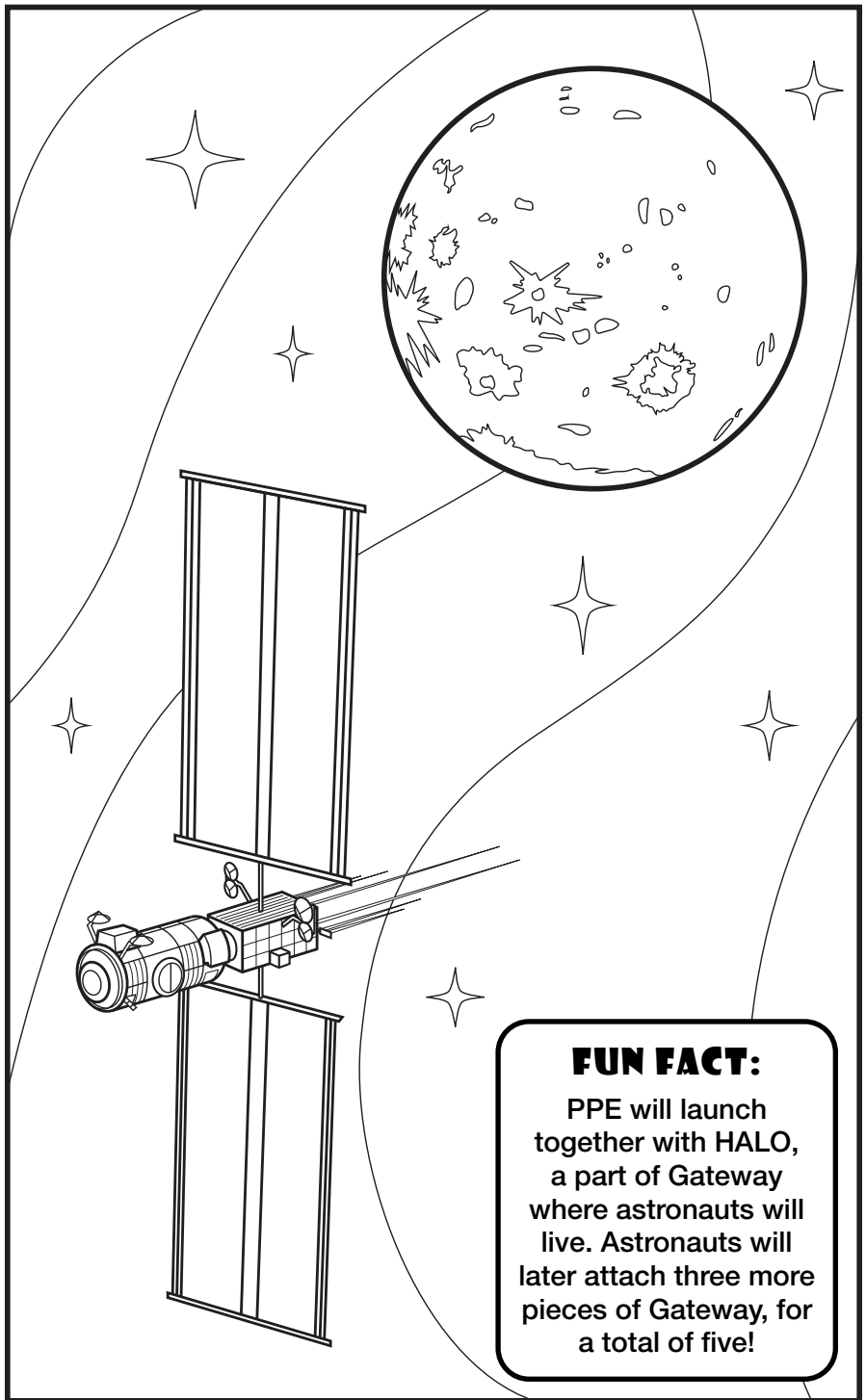
Can you find all the hidden space words?



## WORD BANK

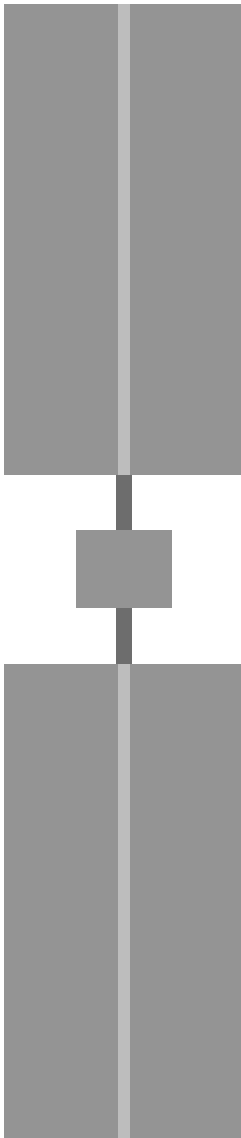
- |            |         |               |            |             |
|------------|---------|---------------|------------|-------------|
| Safety     | Power   | Propulsion    | Orbit      | Moon        |
| Artemis    | Sun     | Earth         | Spacecraft | Exploration |
| Engineer   | Flight  | Communication | Astronaut  | Rocket      |
| Innovation | Science | Technology    | Universe   | Discovery   |
|            | NASA    | Gateway       |            |             |

# GATEWAY & THE MOON



# SOLAR POWER

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## **FUN FACT:**

From tip to tip of the solar arrays, the PPE is about as long as half of a football field!

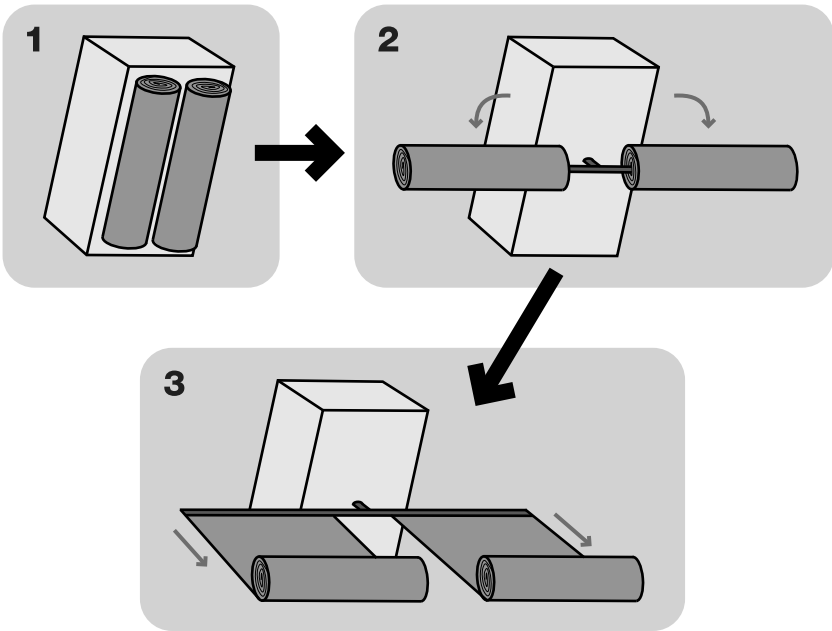
**Roll-Out Solar Arrays**

## **How is the PPE powered?**

Two large roll-out solar arrays, or ROSAs, will absorb the sun's energy to power Gateway.



# ROLL-OUT SOLAR ARRAYS



*Pictured: They're called "roll-out solar arrays" because they roll themselves out, kind of like a rug!*

## **What makes ROSAs different from solar panels on Earth?**

You might already know about solar panels. Your own home may even have solar panels on the rooftop. They do the same thing as ROSAs, capturing solar energy and turning it into electricity. However, to be used in space, you need ROSAs because they are lightweight and can fit inside of a rocket for launch.

For the PPE, the flexible ROSAs are rolled up for launch and then rolled out once they're in space. ROSAs are already used on the International Space Station, and they may be used on future spacecraft to Mars and beyond!

# CONNECT THE DOTS

## Solar Array

long panels of solar cells that change sunlight into electricity

## Antenna

captures and sends radio signals between the Earth and Moon

## Thruster

creates force that moves Gateway through space

## Star Tracker

takes pictures of star patterns and uses them as a map so Gateway knows where it is around the Moon

## PPE

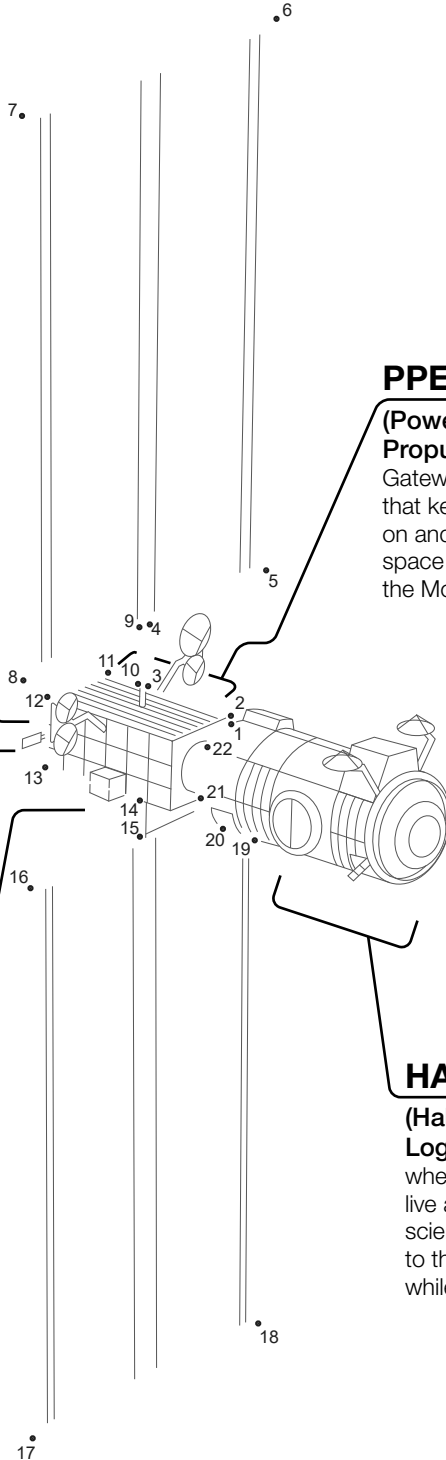
### (Power and Propulsion Element)

Gateway's powerhouse that keeps the lights on and helps the small space station fly around the Moon

## HALO

### (Habitat and Logistics Outpost)

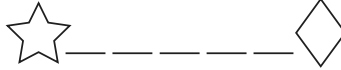
where astronauts will live and prepare for science expeditions to the Moon's surface while visiting Gateway



# SPACE WORD SCRAMBLE

Unscramble the letters to make space related words!

GVRATYI



STOTAIN



SAEITLLET



MNOO



SAEPC



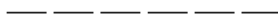
STASR



DTAA



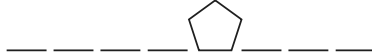
LCHUNA



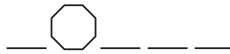
MSISINO



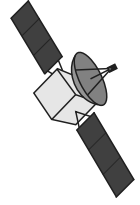
SOEFWTRA



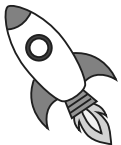
ETHRA



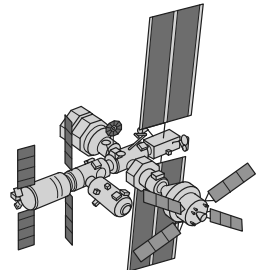
RCEKTO



Write in the special shape letters to find the final word:  
What is the name of the space station that will orbit the Moon?



**HINT:**  
Want some clues? Look at the pictures on this page!



# GATEWAY'S POLAR ORBIT

Gateway will take one week to fly around the Moon in what is known as a “polar orbit,” because Gateway will travel over both the Moon’s North and South Poles.

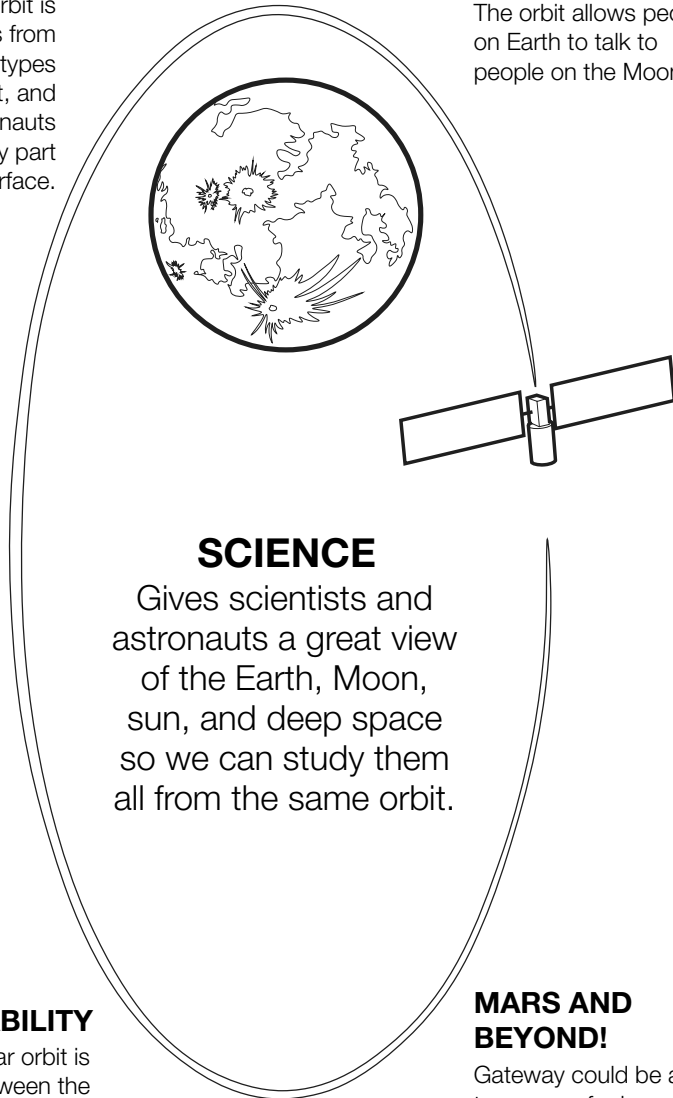
Why was it chosen?

## ACCESS

Gateway’s orbit is easy to access from Earth by many types of spacecraft, and will allow astronauts to land on every part of the lunar surface.

## COMMUNICATIONS

The orbit allows people on Earth to talk to people on the Moon!



## SCIENCE

Gives scientists and astronauts a great view of the Earth, Moon, sun, and deep space so we can study them all from the same orbit.

## STABILITY

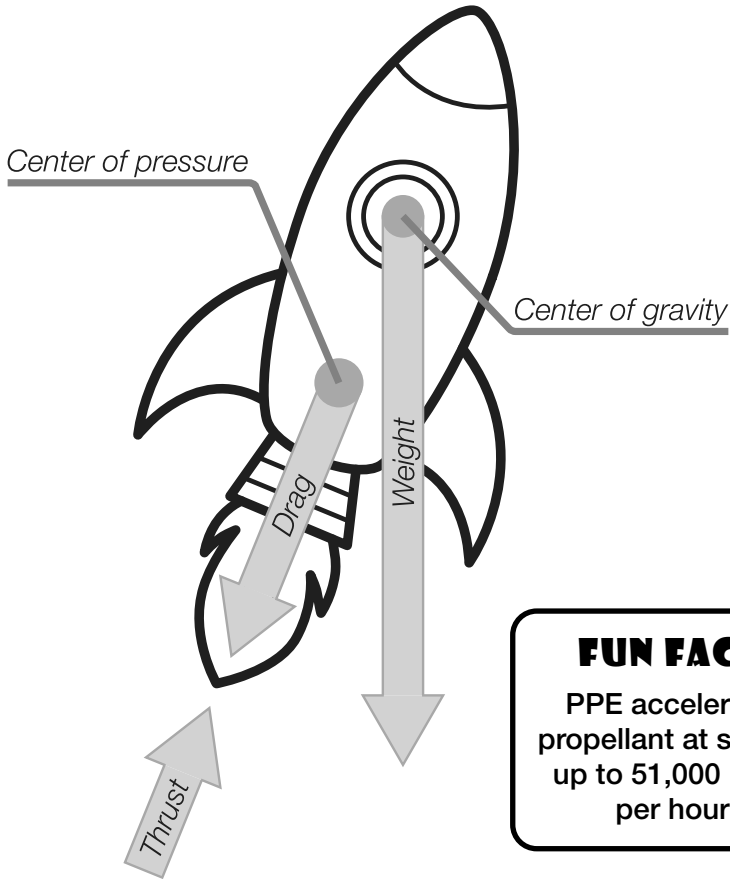
Gateway’s polar orbit is balanced between the gravity of the Earth and Moon, making it easy to fly with less energy!

## MARS AND BEYOND!

Gateway could be a place to prepare for human missions to Mars and beyond!

# PROPULSION

## Forces Acting on a Rocket



### **FUN FACT:**

PPE accelerates propellant at speeds up to 51,000 miles per hour!

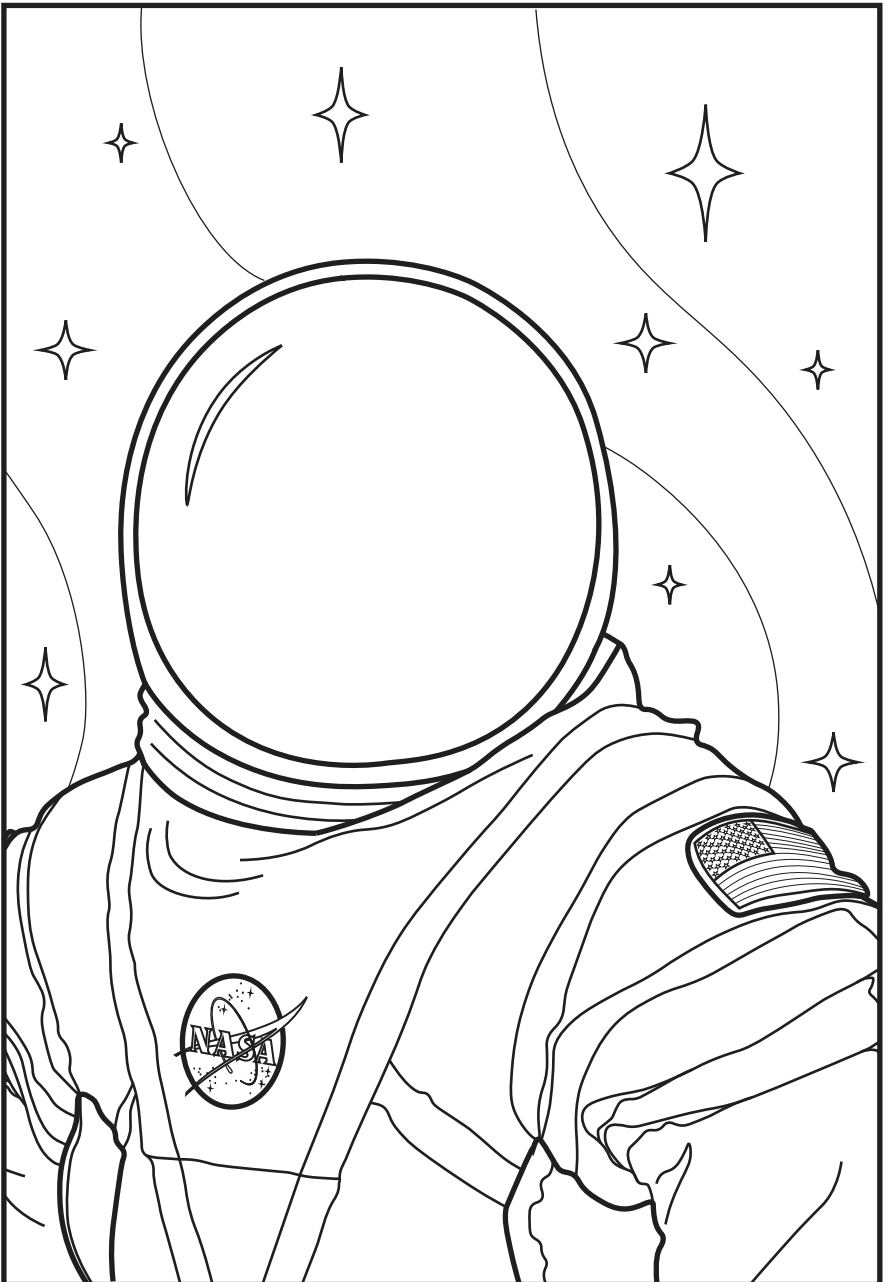
### **How does the PPE move Gateway?**

PPE stands for Power and Propulsion Element. Propulsion means to push forward, or drive an object forward. As Gateway's propulsion system, the PPE's job is to produce thrust, or the force that moves things through space. This thrust is generated when PPE combines the Sun's energy collected by the solar arrays with a xenon plasma, creating an electric propulsion that produces the thrust to propel the spacecraft.

# A NEW GENERATION OF ASTRONAUTS

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Gateway will support long-term science and human exploration on and around the Moon. Can you draw yourself as an astronaut on a lunar mission?



# YOUR LUNAR MISSION STORY

Fill in the words to make your own story!

In the future year \_\_\_\_\_, you'll be invited by NASA to embark on a mission into space! You'll travel to the lunar space station with a team of \_\_\_\_\_ astronauts for the \_\_\_\_\_ mission, and step foot on the Moon! They picked you because you're really good at \_\_\_\_\_. On this mission, you'll study \_\_\_\_\_, and send information back to your team on Earth at \_\_\_\_\_.



You'll get to the lunar space station by riding on the \_\_\_\_\_ rocket. It will be powered by \_\_\_\_\_ and travels at \_\_\_\_\_ miles per hour! Your crew is coming with you, including your best friend \_\_\_\_\_. To keep yourself entertained, you'll pack \_\_\_\_\_ and play \_\_\_\_\_ with your friend. You'll bring \_\_\_\_\_ to remember Earth while you're away. While in space, you'll see \_\_\_\_\_!

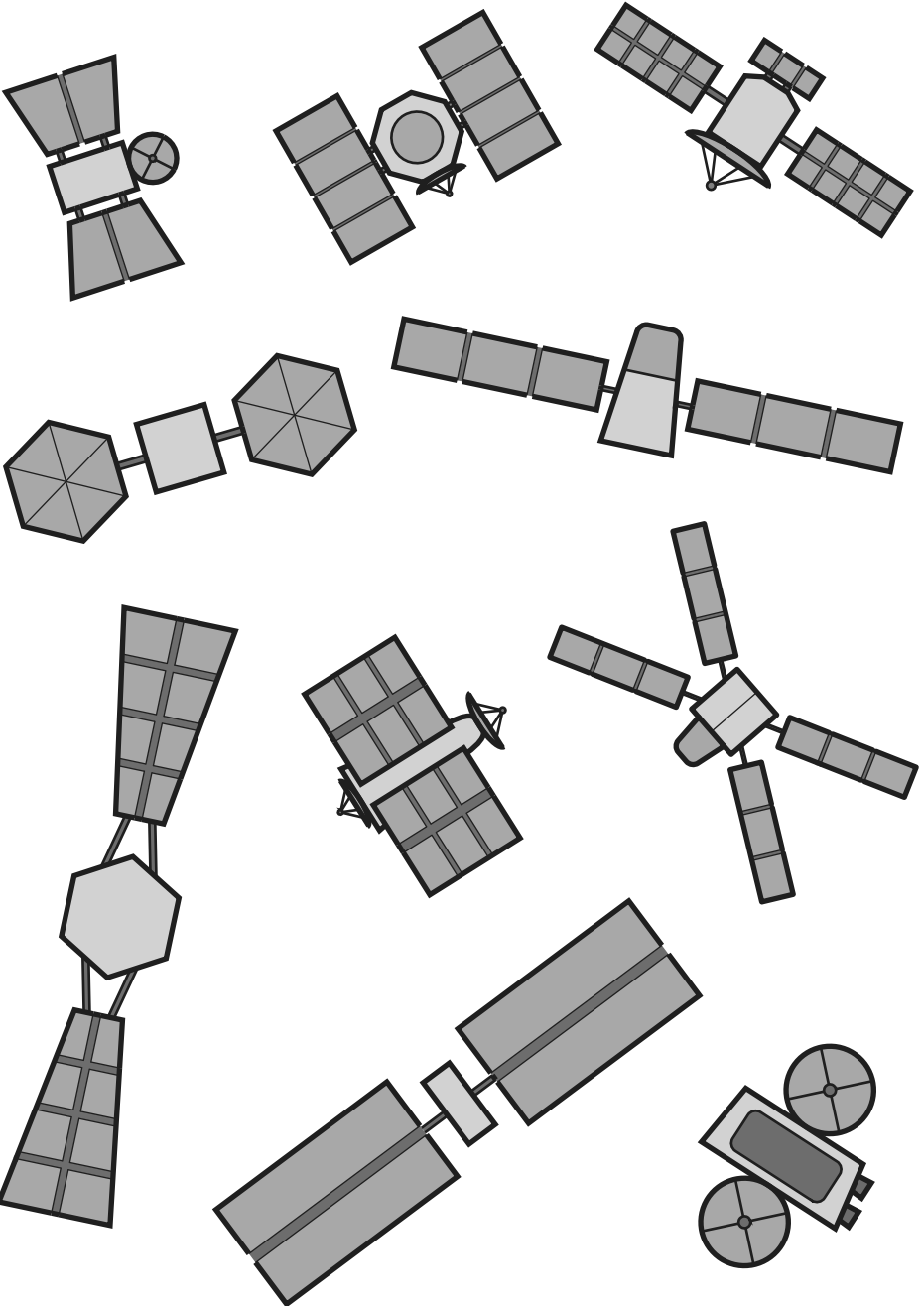


You'll live in space for \_\_\_\_\_ months. You'll wear a \_\_\_\_\_ spacesuit that looks \_\_\_\_\_, and bring \_\_\_\_\_ and \_\_\_\_\_ to eat and drink. When you visit the Moon's surface, you'll stay there for \_\_\_\_\_ and travel using a \_\_\_\_\_. Your studies on \_\_\_\_\_ will benefit \_\_\_\_\_ and help scientists learn how to travel to \_\_\_\_\_!



# PICK OUT THE PPE

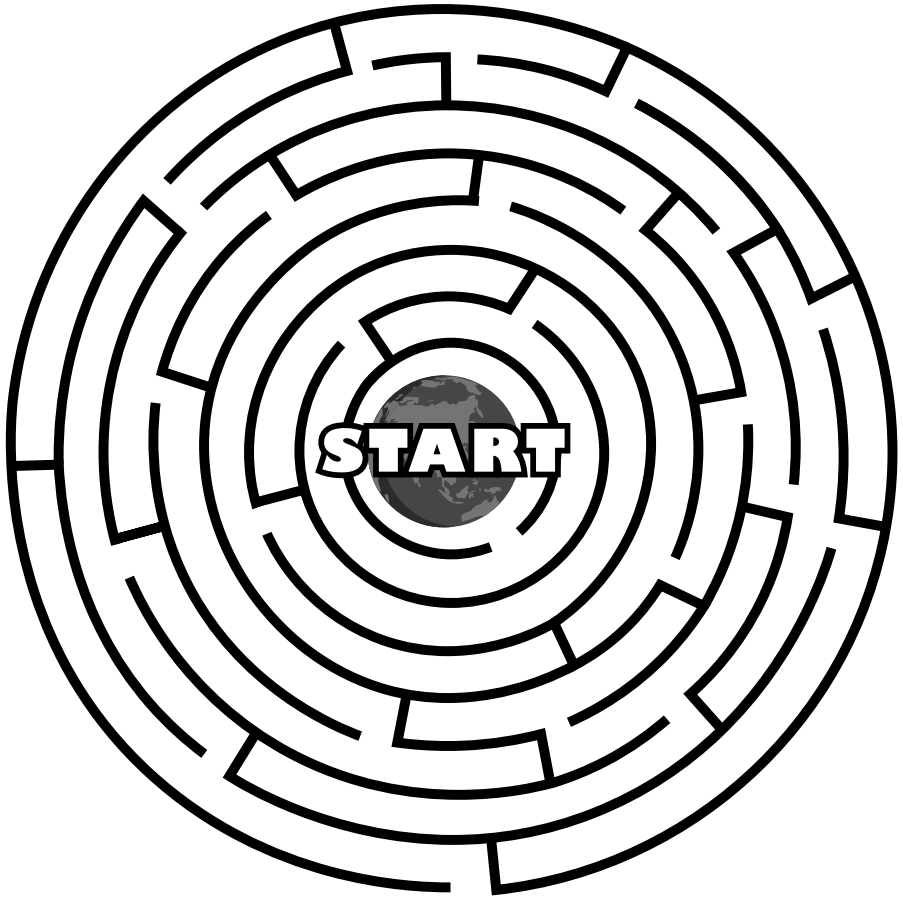
Can you find the PPE? It has a rectangular body and two large rectangular solar arrays.





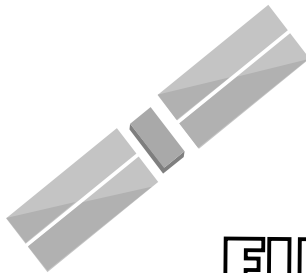
# POWER & PROPULSION ELEMENT MAZE

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## **FUN FACT:**

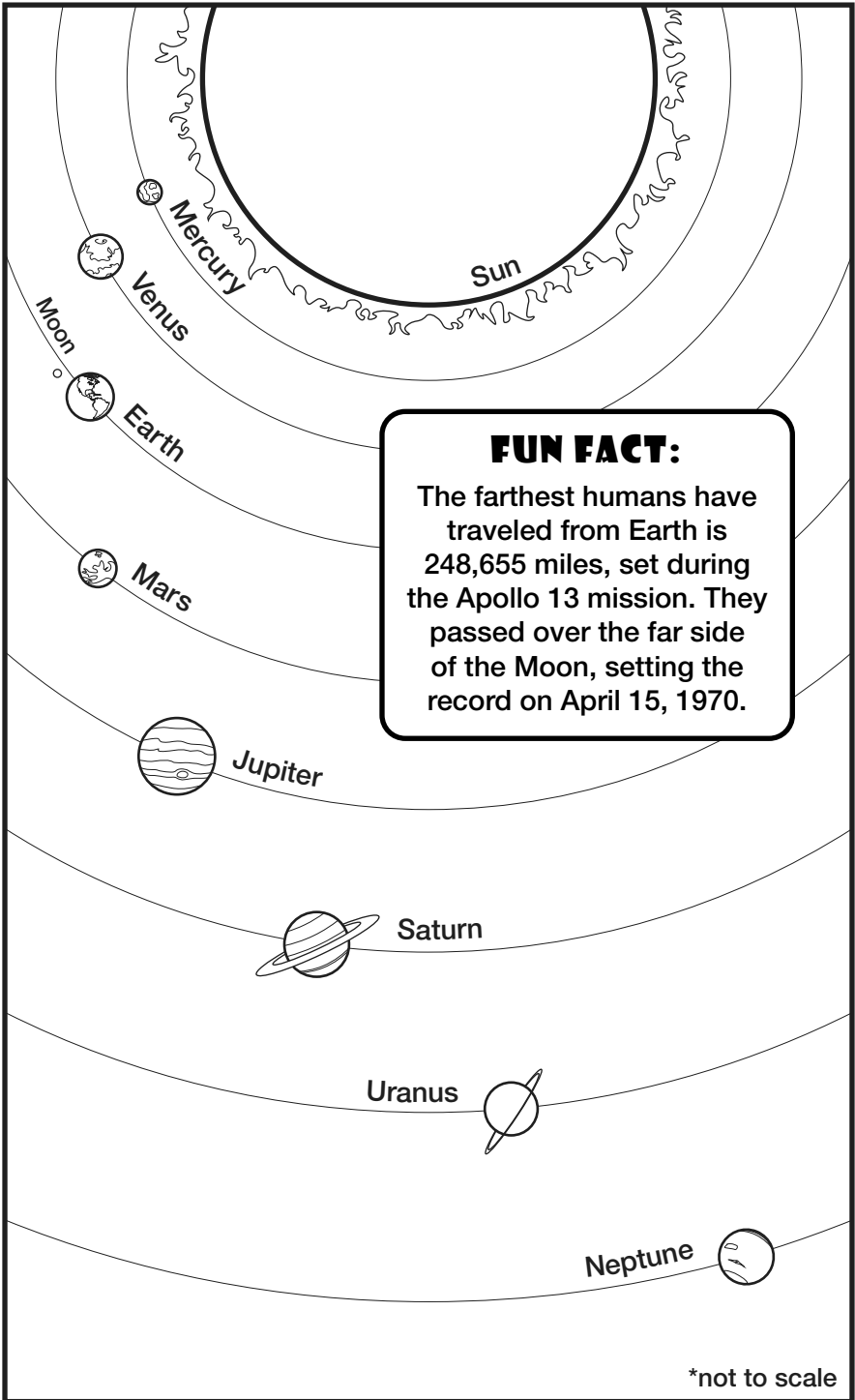
PPE provides Gateway with power, communications, and steering for deep space travels!



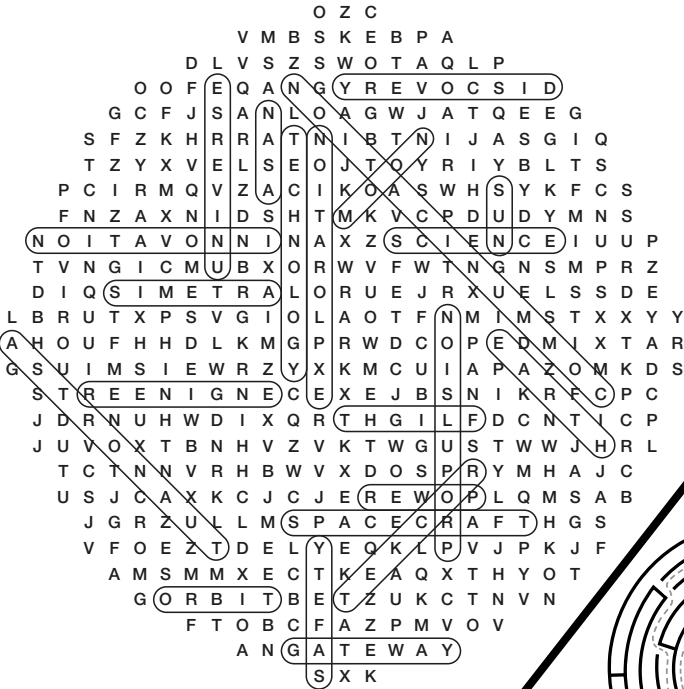
## **FINISH**



# OUR SOLAR SYSTEM

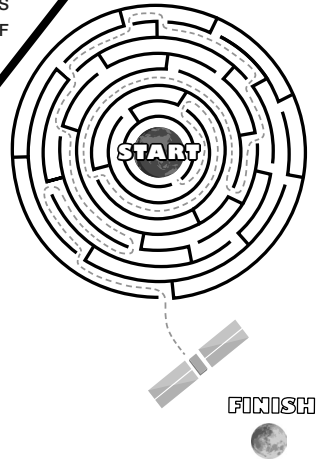


# ANSWER KEY



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## Page 11

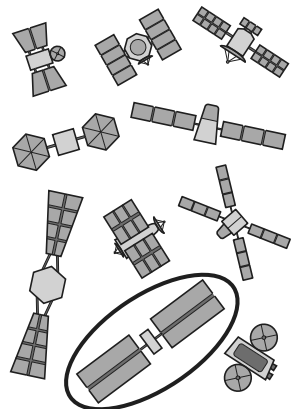
**HINT:** Want some clues? Look at the pictures!

- |           |           |
|-----------|-----------|
| GVRATYI   | ☆GRAVITY◇ |
| STOTAIN   | STATION   |
| SAEITLLET | SATELLITE |
| MNOO      | MOON      |
| SAEPC     | SPACE     |
| STASR     | STARS     |
| DTAA      | DATA      |
| LCHUNA    | LAUNCH    |
| MSISINO   | MISSION   |
| SOEFWTRA  | SOFTWARE  |
| ETHRA     | EARTH     |
| RCKETO    | ROCKET    |

Write in the special shape letters to find the final word:  
What is the name of the space station that will orbit the Moon?

☆GATEWAY◇

## Page 16



The background of the entire page is a dark blue space scene with a starry field. A large, curved, light blue shape, possibly representing a celestial body or a spacecraft component, arcs across the top and left. On the right side, a portion of a solar panel array is visible, showing a grid of yellow lines on a dark surface. The text and icons are centered in the middle of the page.

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