



# Module 3 – Nautical Science

## Unit 4 – Astronomy

### Chapter 15 - The Planets

#### Section 2 – Mars & Jupiter



# What You Will Learn to Do

Demonstrate understanding of astronomy and how it pertains to our solar system and its related bodies: Moon, Sun, stars and planets



# Objectives

1. Describe the major features of Mars
2. Identify the principal characteristics of Jupiter



# Key Terms



CPS Key Term  
Questions 1 - 5



# Key Terms

**Nix Olympica** - Snow of Olympus

**Galilean satellites** - The four largest and brightest moons of Jupiter: Io, Europa, Ganymede and Callisto; discovered by Galileo in 1610

**Prograde motion** - The counter-clockwise direction of celestial bodies around the Sun as seen from above the north pole of the Sun; in the sky it is from west to east



# Key Terms

**Retrograde motion -**

The clockwise direction of celestial bodies around the Sun; in the sky it is from east to west

**Rotational axis -**

The straight line through all fixed points of a rotating rigid body around which all other points of the body move in circles



# Opening Question



Discuss what types of exploration missions have occurred on Mars.

1.

2.

3.

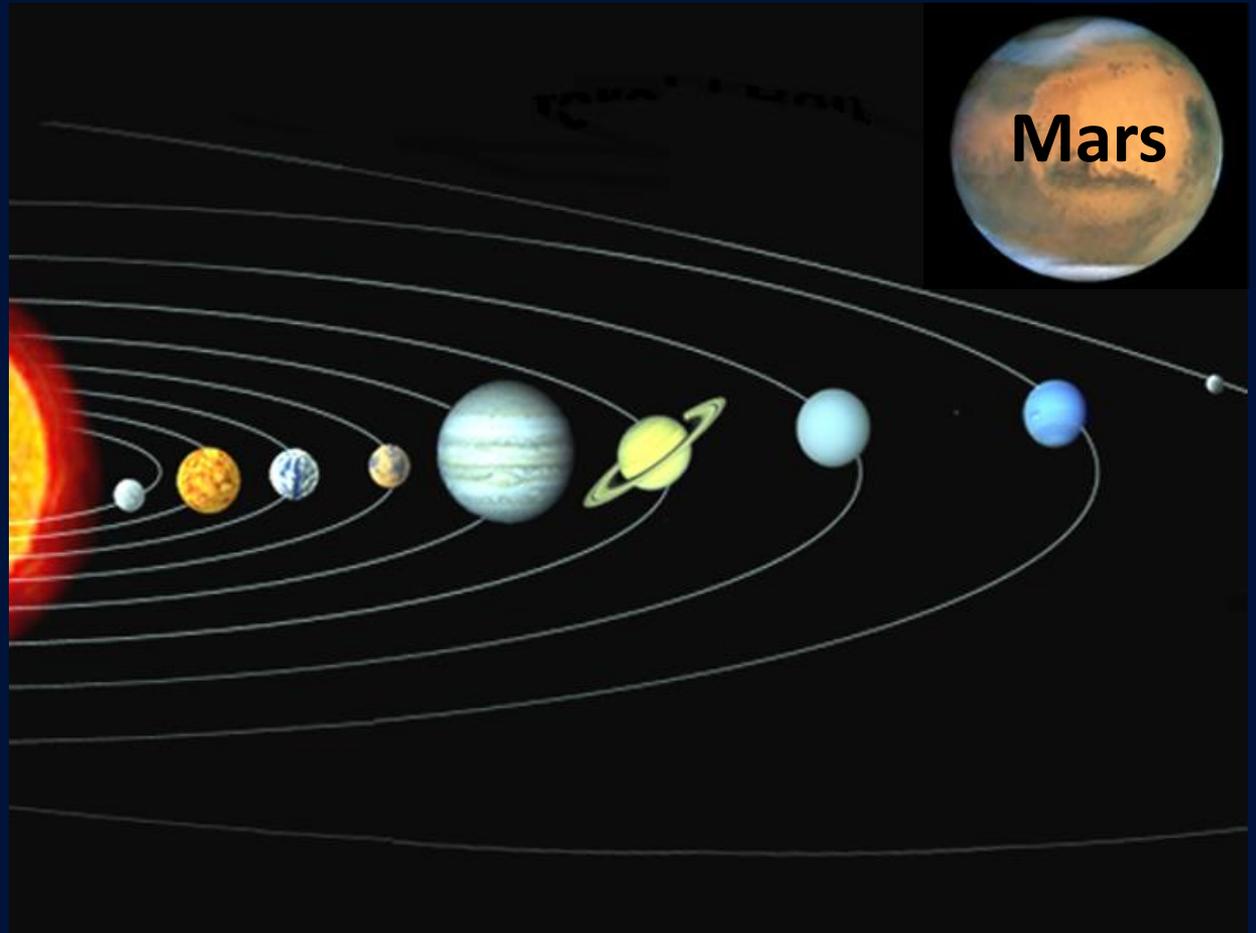
(Use CPS "Pick a Student" for this question.)





# Mars

Fourth from the Sun and the next planet beyond Earth, Mars has aroused the greatest interest.





# Mars





# Mars



Ares  
(Roman Mars)

Mars

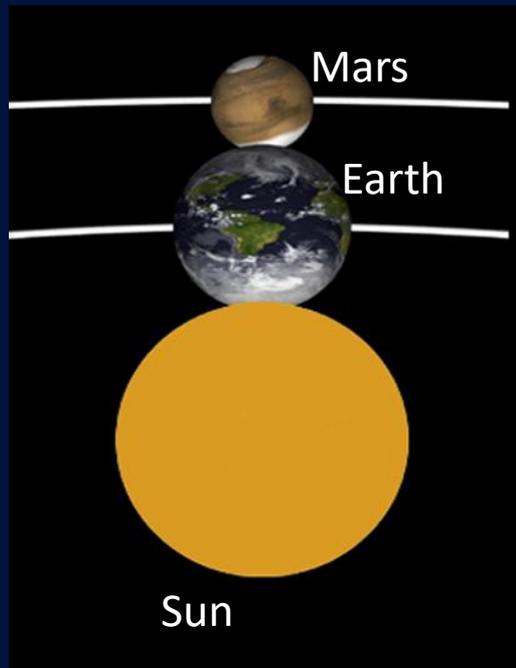


Named for the Roman god of war, it is often called the “red planet.”



# Mars

Mars' red color and its rapid movement from west to east among the stars make it stand out in the sky.



The best time to see Mars is when it is nearest to Earth in August and September, when the Earth is between the Sun and Mars.



# Mars

In 1877, Italian astronomer Giovanni Schiaparelli discovered a series of intersecting lines on the Martian surface and called them **canali** – **channels** or **canals**.



Giovanni Schiaparelli



# Mars



*Mariner*



*Viking*

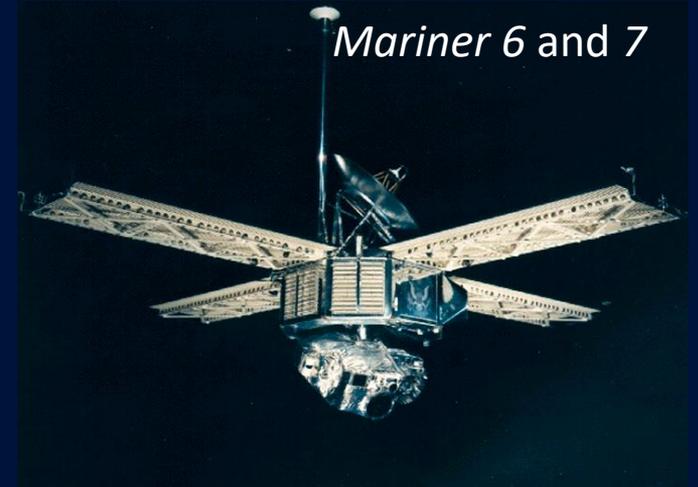


Early astronomers thought that the canali were either man- or water-made. *Mariner* and *Viking* series photography has proven the canali to be an illusion.



# Mars

*Mariner 6 and 7* made 6-month journeys and found no sign of living things or an environment that could support them.



*Mariner 6 and 7*



*Mariner 9*

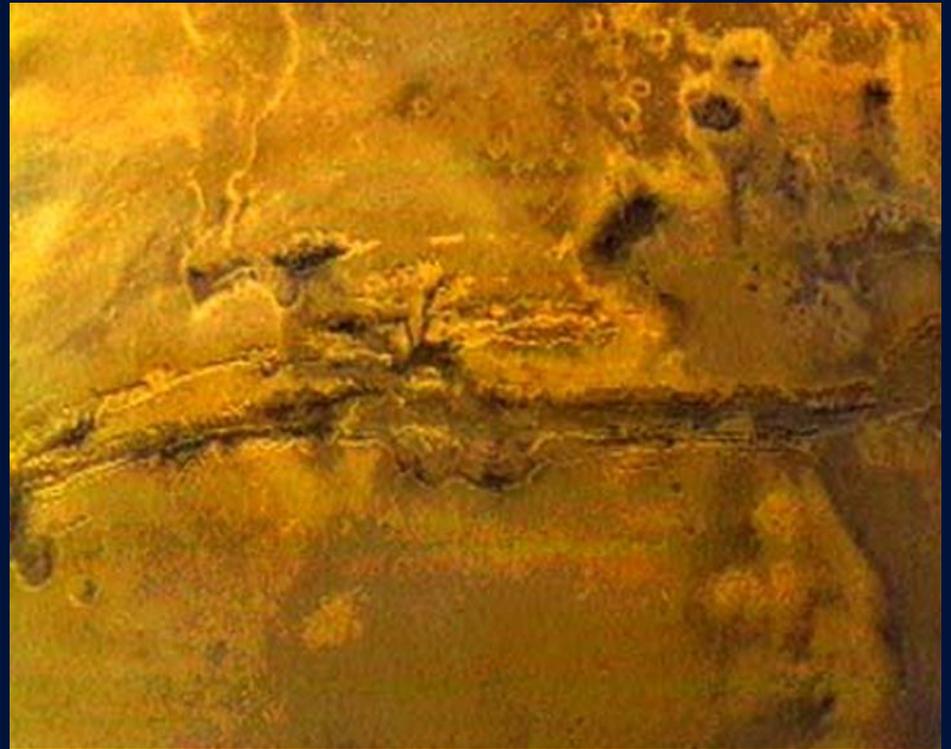
Mariner 9 photographs of the Martian surface found evidence that large amounts of water at one time existed on Mars.



# Mars

Torrential rains may have caused Martian canyons.

Variations in the planet's orbit around the Sun occur on a 50,000-year cycle.





# Mars

The Martian atmosphere contains small amounts of oxygen and water vapor, but not enough to sustain life, being mostly carbon dioxide.

## Mars' present atmosphere

- Atm. surface pressure 5.6 mbar
- Mean surface air temperature 218 K
  - full sunlight 240 K
  - night 170 K

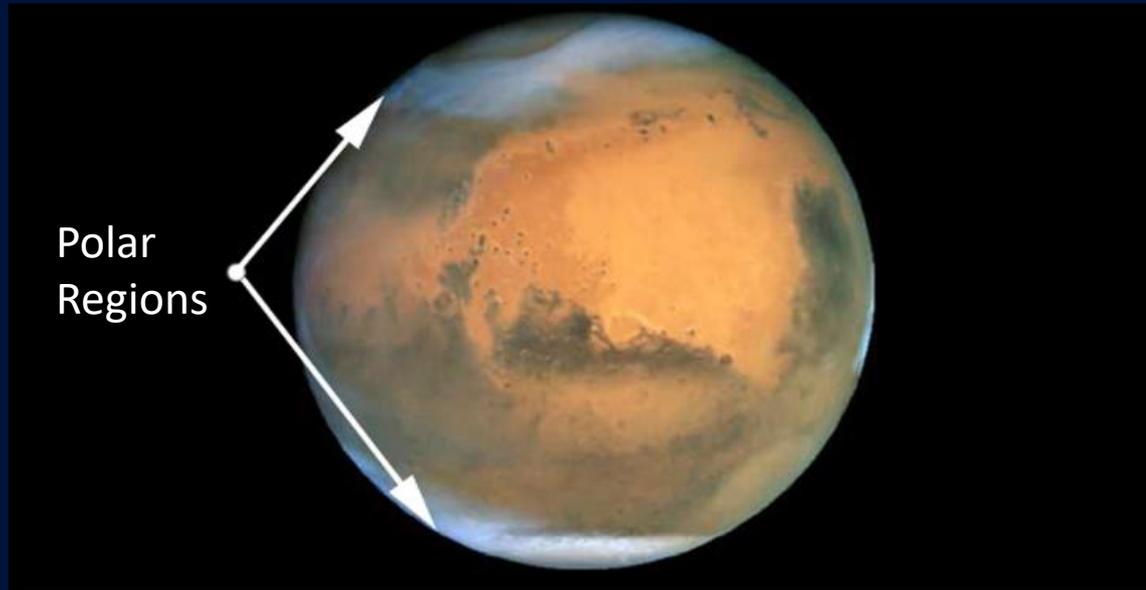
- Composition by number

CO <sub>2</sub>	95.32 %
N <sub>2</sub>	2.8 %
Ar	1.6 %
O <sub>2</sub>	0.13 %
CO	0.07 %
H <sub>2</sub> O	0.03 %





# Mars

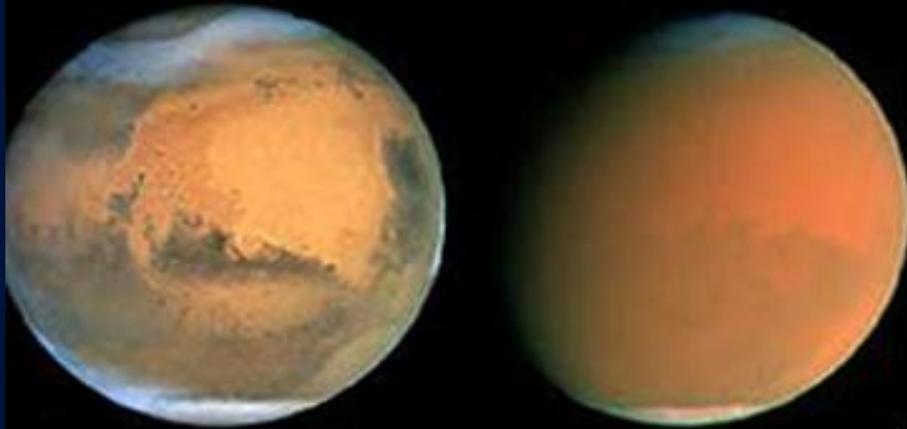


A veil of haze rises above each polar region during winter seasons, where the ice is thought to be composed of frozen carbon dioxide and frozen water vapor.



# Mars

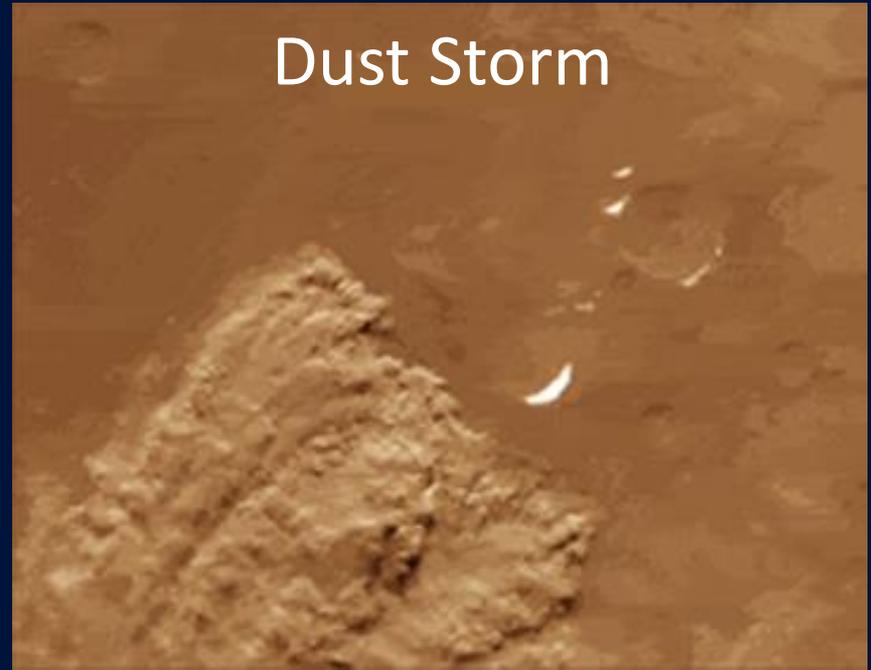
Sandstorm



June  
2001

September 2001

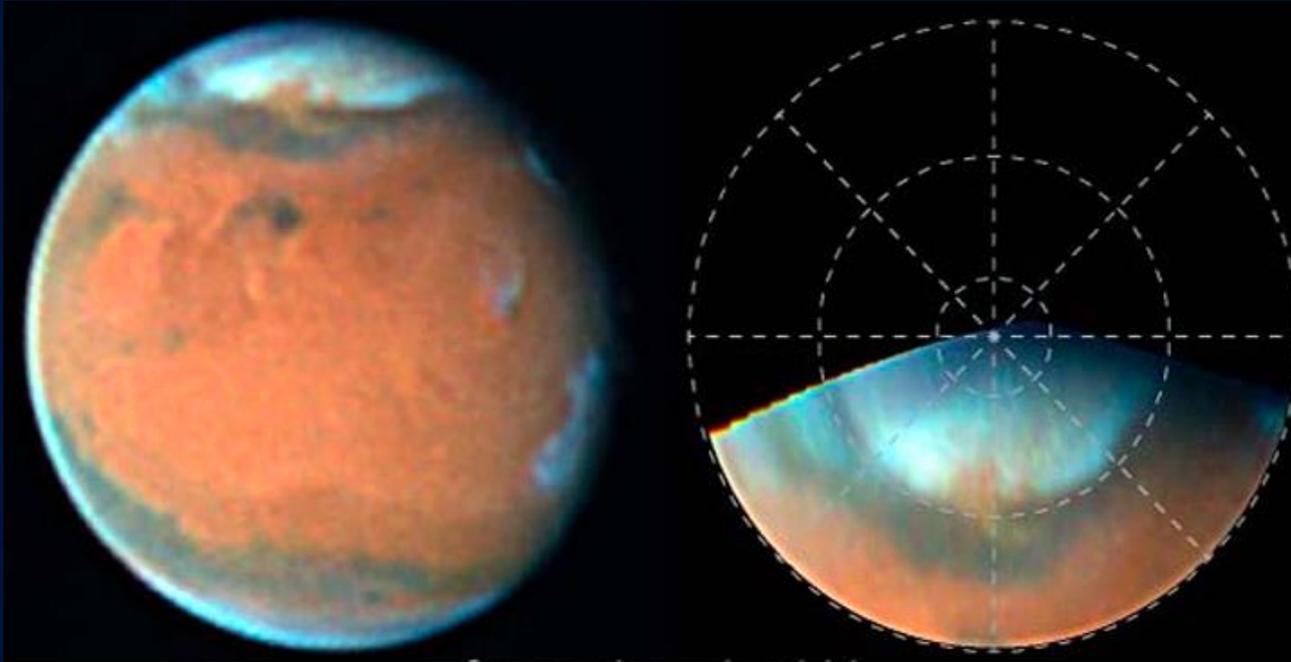
Dust Storm



Fierce seasonal Martian winds whip up huge dust storms of the pinkish-colored iron oxide that covers three-fourths of the surface.



# Mars



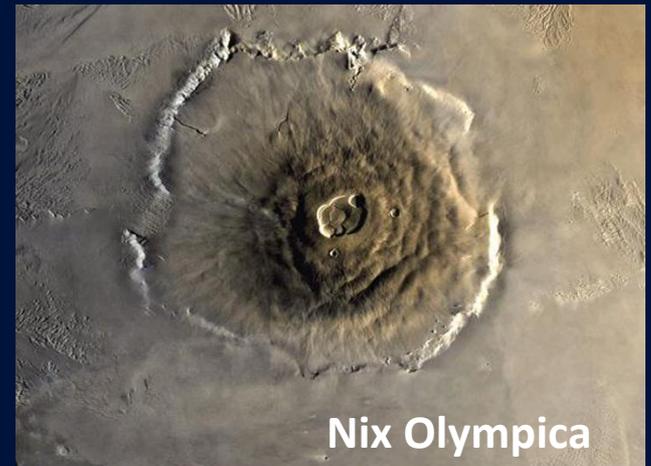
Windstorms may rage for months at speeds up to 300 mph.  
Dust is sometimes carried 35 miles above the surface.



# Mars

**Nix Olympica** is roughly the size of Nebraska.

It rises 15 miles above the surrounding terrain, and has a main crater 40 miles in diameter.



Nix Olympica



Volcano South Spot

**South Spot** has the largest volcanic crater measuring 75 miles across.

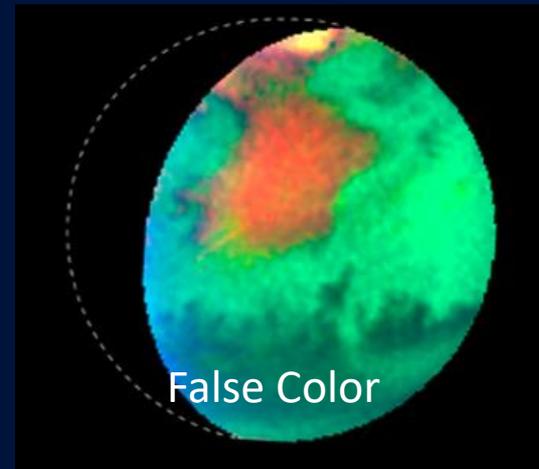


# Mars

Temperatures on Mars range from 32 °F to -135 °F.

Due to the thin atmosphere, the air a few feet above the ground may be as much as **80° cooler** than the surface itself.

The polar regions keep a steady -190 °F.



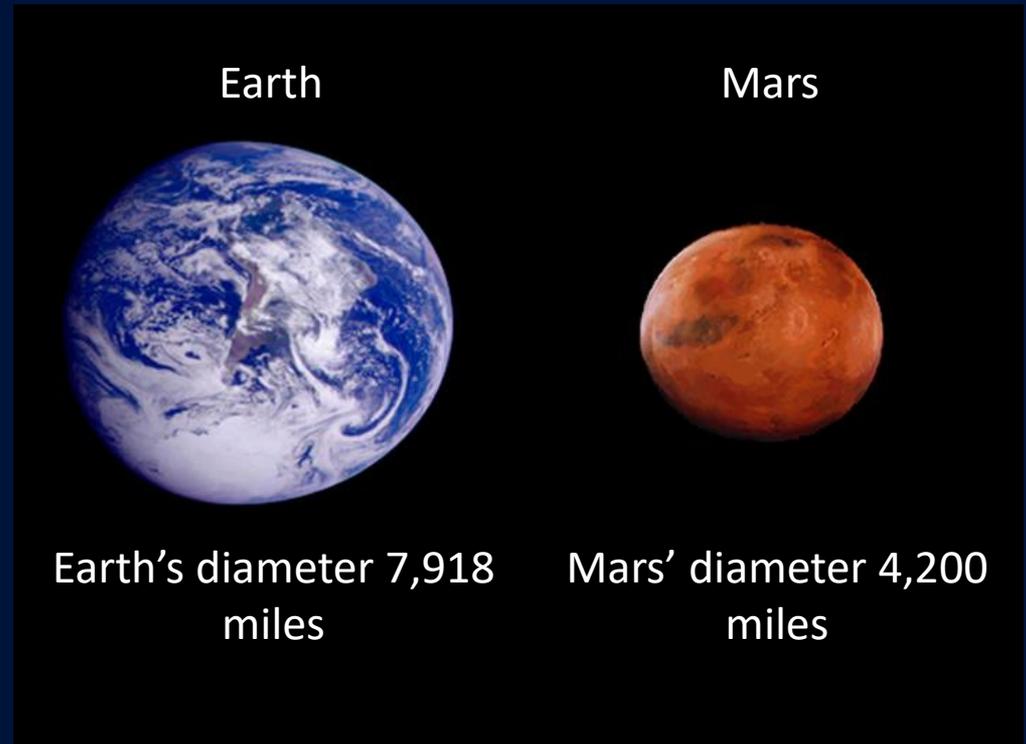


# Mars

Mars is about  $\frac{1}{2}$  the size of Earth.

Mars' gravity is only about  $\frac{1}{3}$  of Earth's.

That means a person weighing 150 pounds on Earth would weigh only about 57 pounds on Mars.



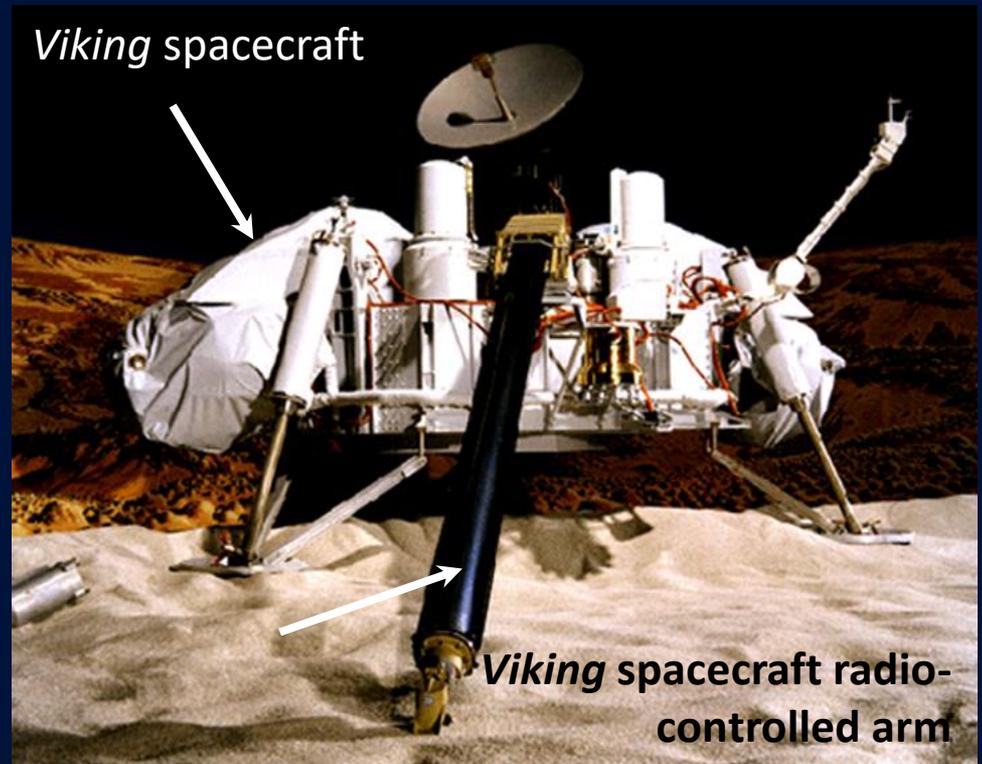


# Mars

Two NASA *Viking* spacecraft landed safely on Mars in 1976 carrying sensors and equipment.

One *Viking* spacecraft retrieved and analyzed rock and soil in a series of onboard chemical tests in a search for life.

So far, results are inconclusive.





# Mars

In 1996, NASA scientists discovered an Antarctic meteorite that originated on Mars some **3 billion** years ago.

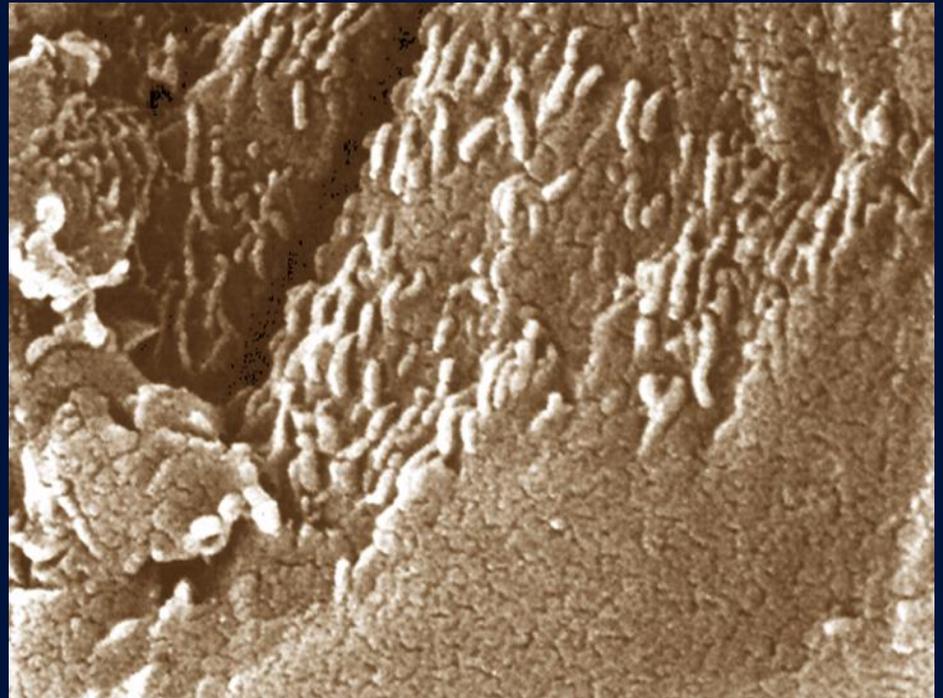




# Mars

The meteorite was analyzed and fossilized evidence of Martian bacteria was discovered.

However, other scientists disputed these claims, stating that the alleged “bacteria” were in fact products of chemical reactions.





# Mars

Launched in December 1996, *Pathfinder* made a cushioned landing on Mars on July 4, 1997. It carried the *Sojourner*.



*Mars Pathfinder*  
spacecraft





# Check On Learning Questions

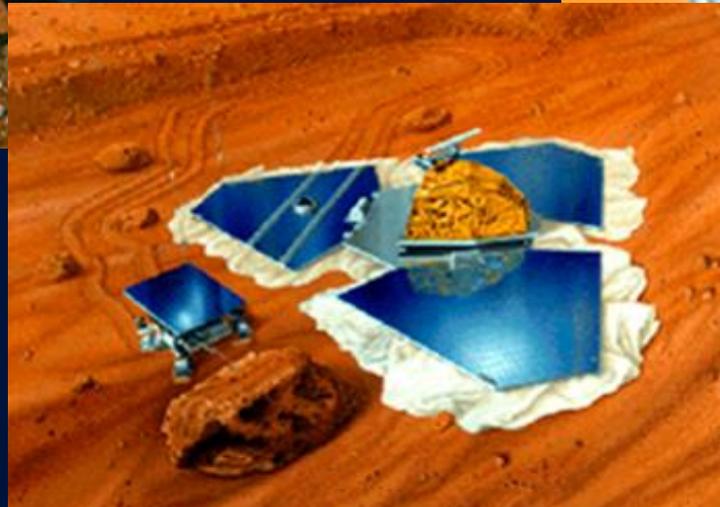


## CPS Lesson Questions 3 - 4



# Mars

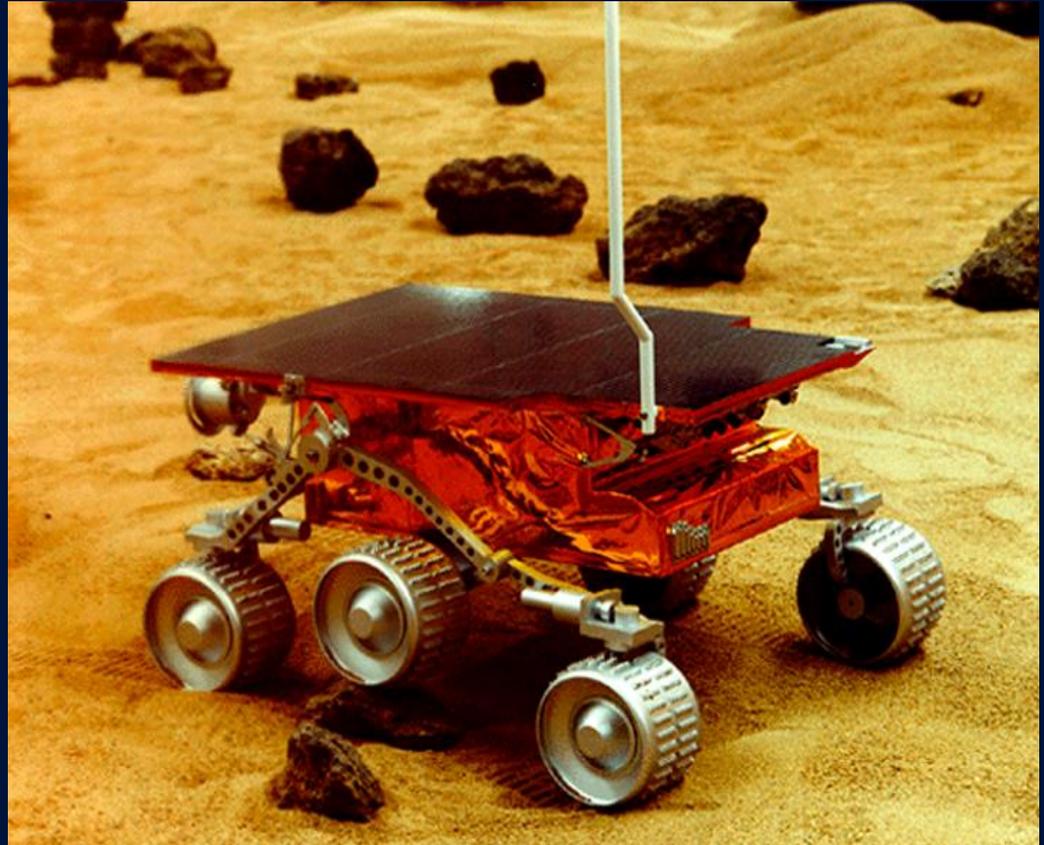
## *Pathfinder* Landing





# Mars

At 22 pounds and solar powered, *Sojourner* roamed the surface of Mars to collect and send information through black and white and color photos, and an alpha proton x-ray spectrometer.



*Sojourner*



# Mars

## Mars Exploration Rover Mission

*Spirit and Opportunity*



Rovers *Spirit* and *Opportunity* were even more successful than *Pathfinder*.



# Mars

*Spirit* found more evidence of igneous rocks extensively altered by ancient exposure to water.

*Opportunity* found layered bedrock at its location bearing geological evidence of an ancient body of shallow water.

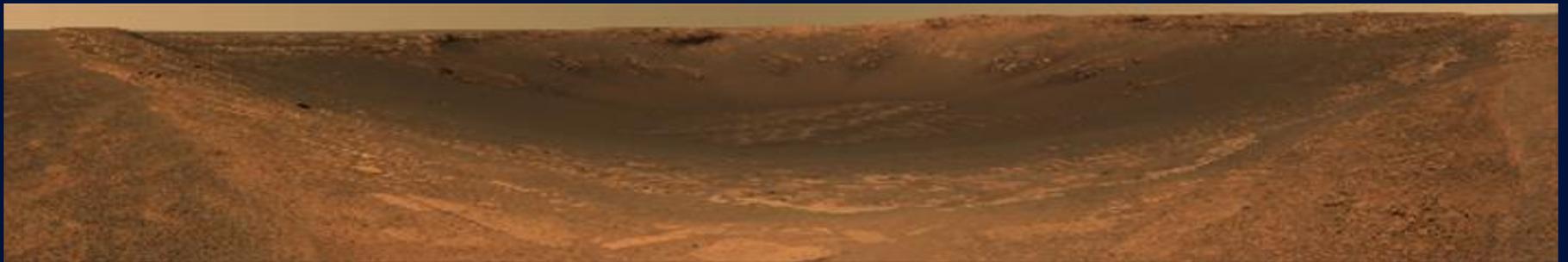
Both sent back hundreds of detailed photographs, many showing their tracks through the Martian terrain.





# Mars

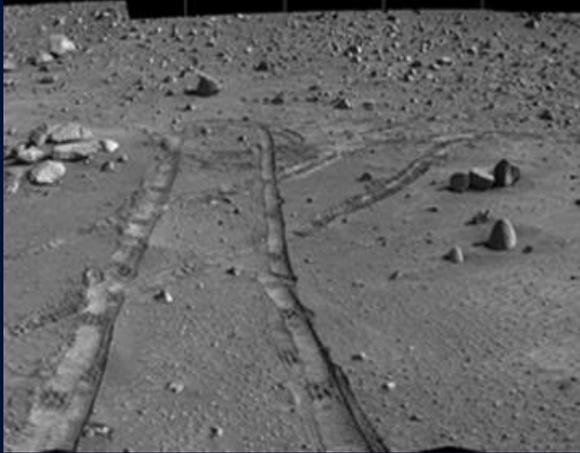
## Rover *Opportunity* photos





# Mars

## Rover *Spirit* photos

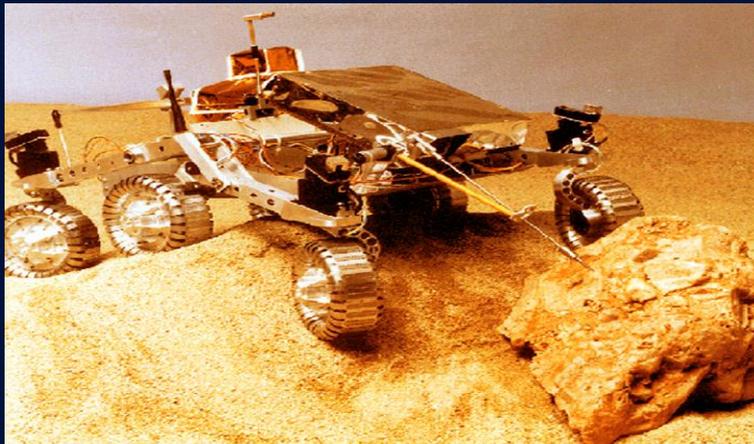




# Mars

Additional missions have been planned for the next several years.

A mission sending astronauts to Mars may be a possibility sometime thereafter.



Later missions will settle the question of life on Mars.

Do you believe there was life on Mars?



# Jupiter

Search

2-6

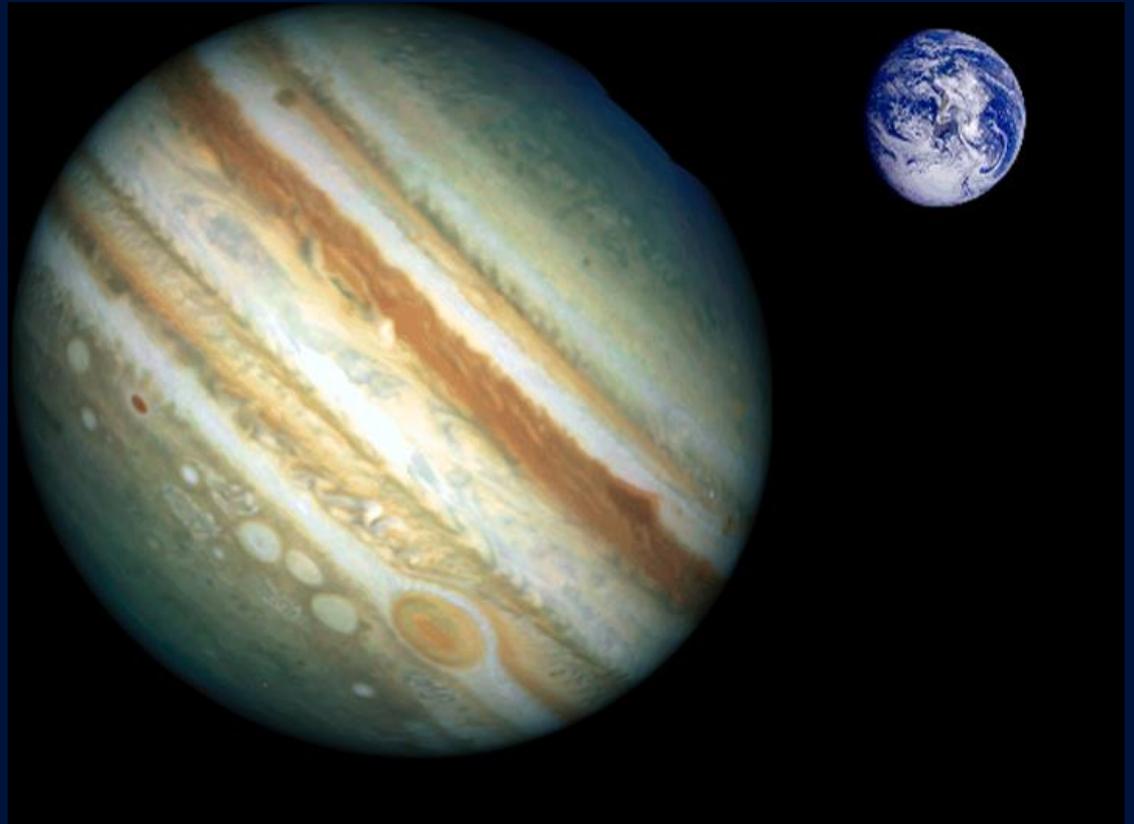
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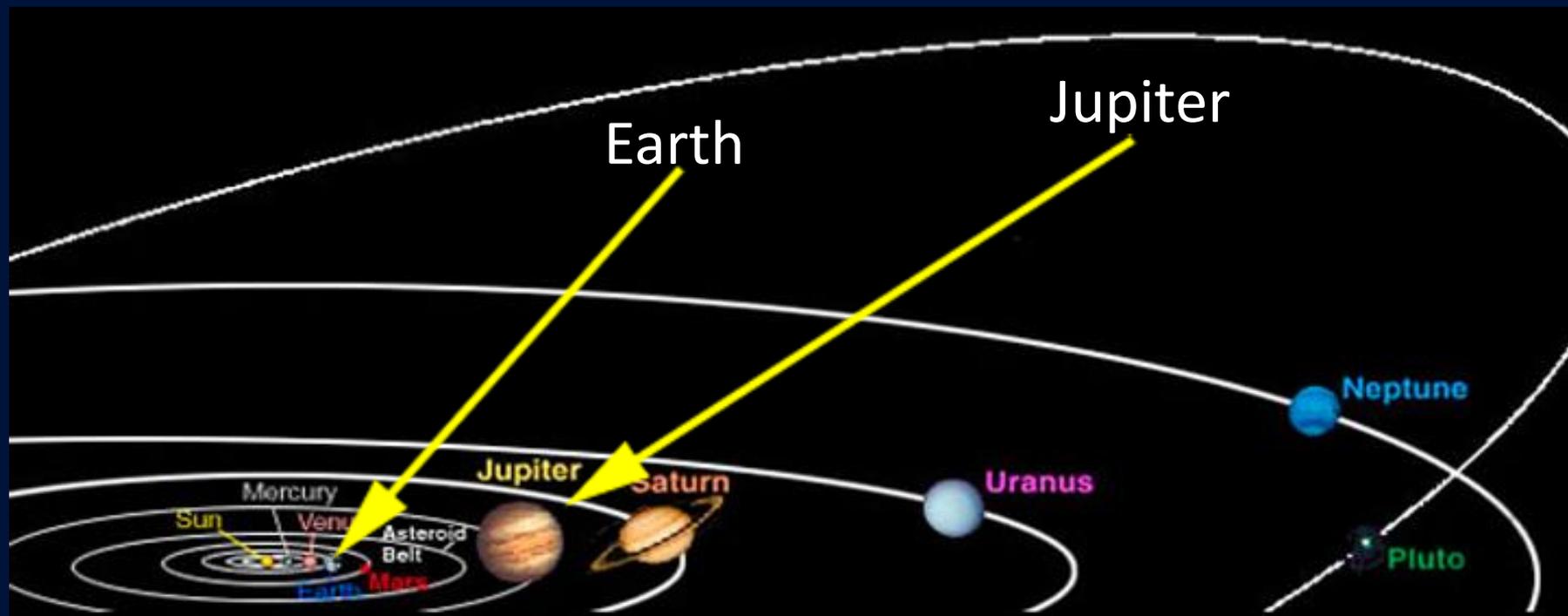
# Jupiter

Jupiter is larger than all the other planets put together and ten times the size of Earth.





# Jupiter

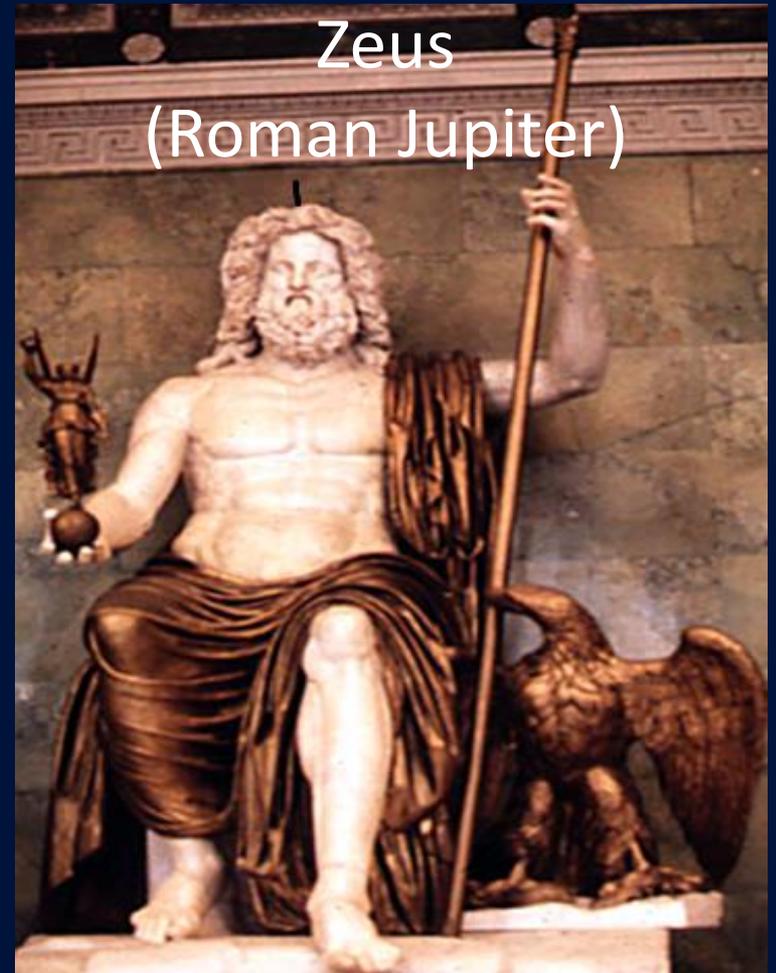
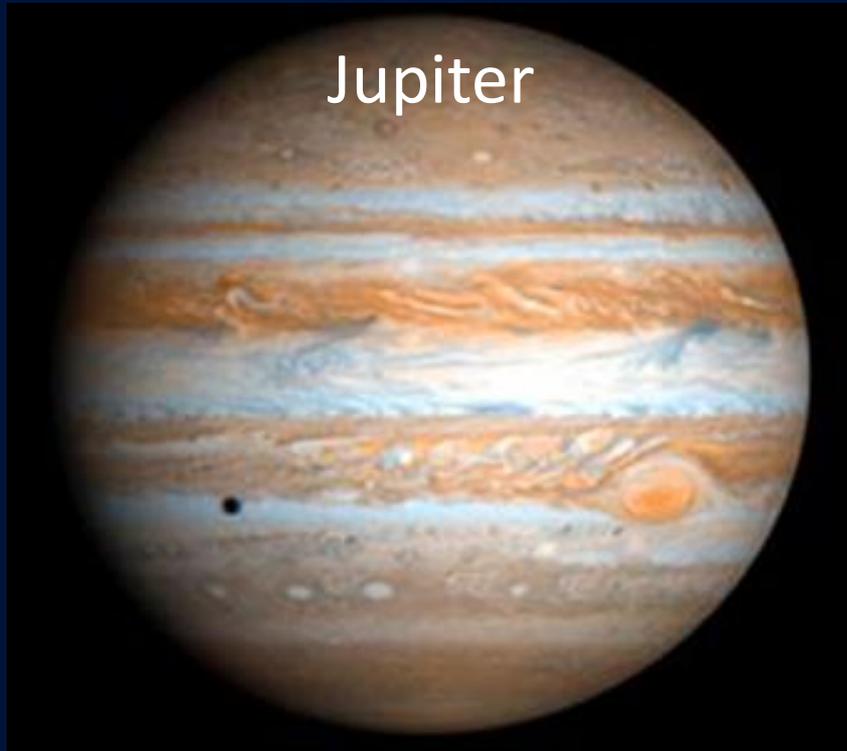


Jupiter orbits 484 million miles from the Sun and never comes closer than 367 million miles to Earth.



# Jupiter

Jupiter is named for the king of Roman gods.





# Jupiter

Until *Pioneer 10* in 1973 and *Pioneer 11* in 1974 passed close to Jupiter, it remained a mystery.





# Jupiter

The *Voyager* provided many superb color pictures of Jupiter and her moons in March and July of 1979.





# Jupiter

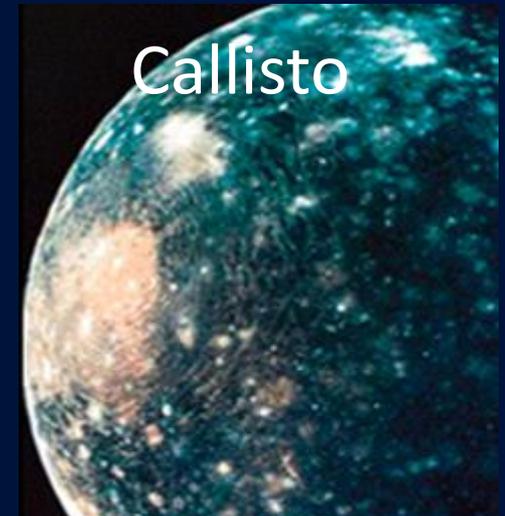
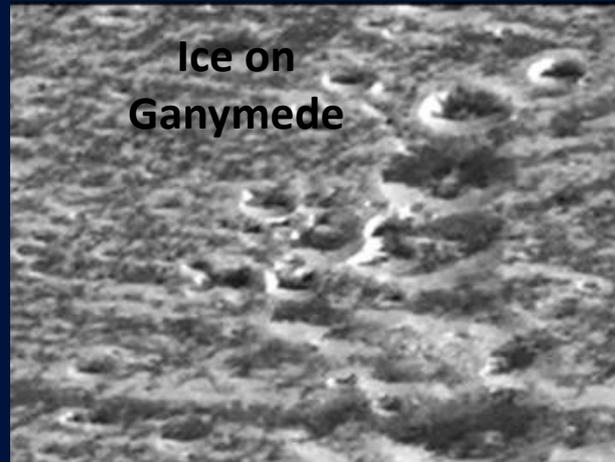
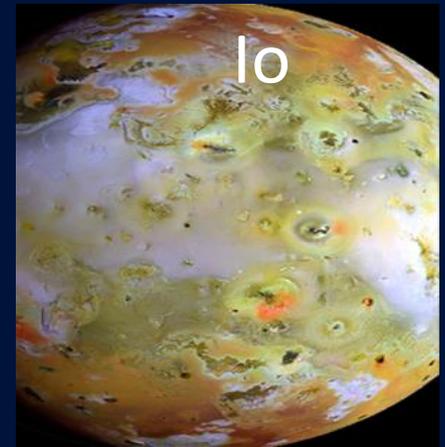
## Galilean Moons of Jupiter





# Jupiter

Sulfur and sulfur dioxide volcanism were found on Io.



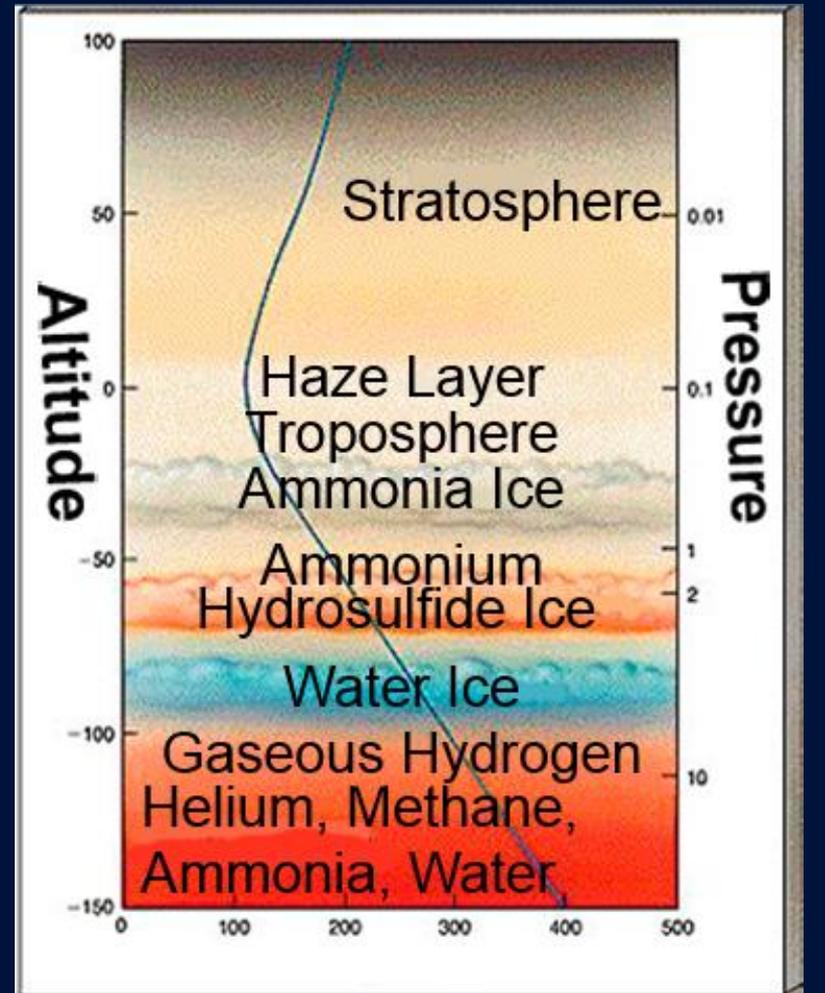
Water ice was discovered on Callisto and Ganymede.



# Jupiter

Jupiter retains all kinds of gases in its atmosphere, especially hydrogen and helium.

The planet rotates so fast that a day is only 10 hours long.





# Jupiter

Manned travel to Jupiter is beyond today's technology.

Some problems include:

1. It would take 21 months to arrive, surpassing current life support system capabilities
2. Communications would have a 45-minute lag...





# Jupiter

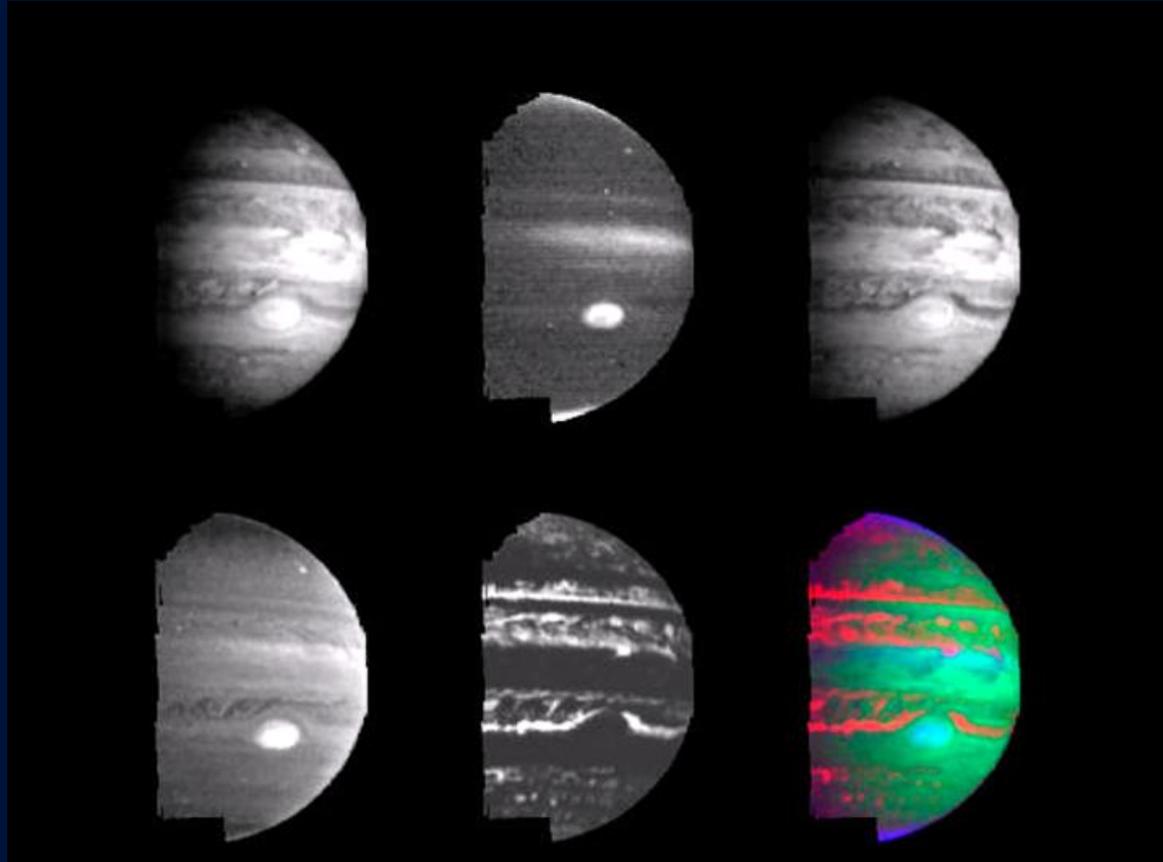
3. Temperatures are intolerable
4. Its radiation belt gives off lethal doses





# Jupiter

## Jupiter's Outer Atmosphere

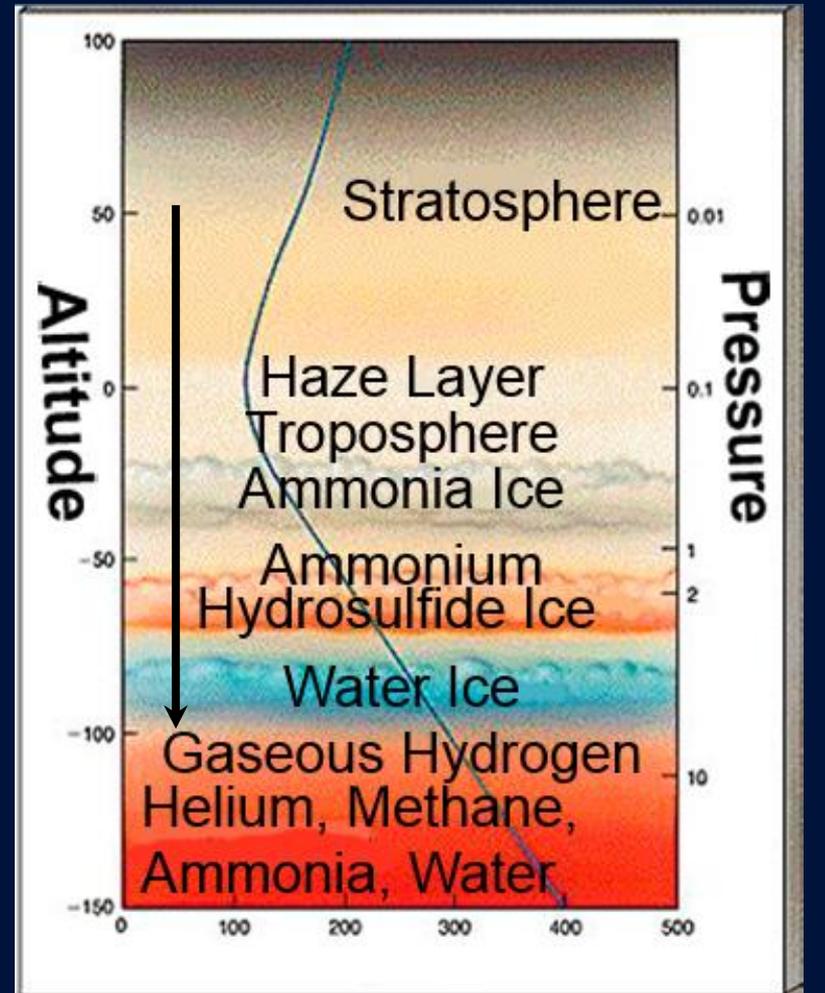




# Jupiter

The atmosphere of Jupiter is made up mostly of hydrogen and helium, with small but extremely important amounts of methane, ammonia, and water.

Wide circling bands of white, yellow, brown and gray make up much of Jupiter's face.

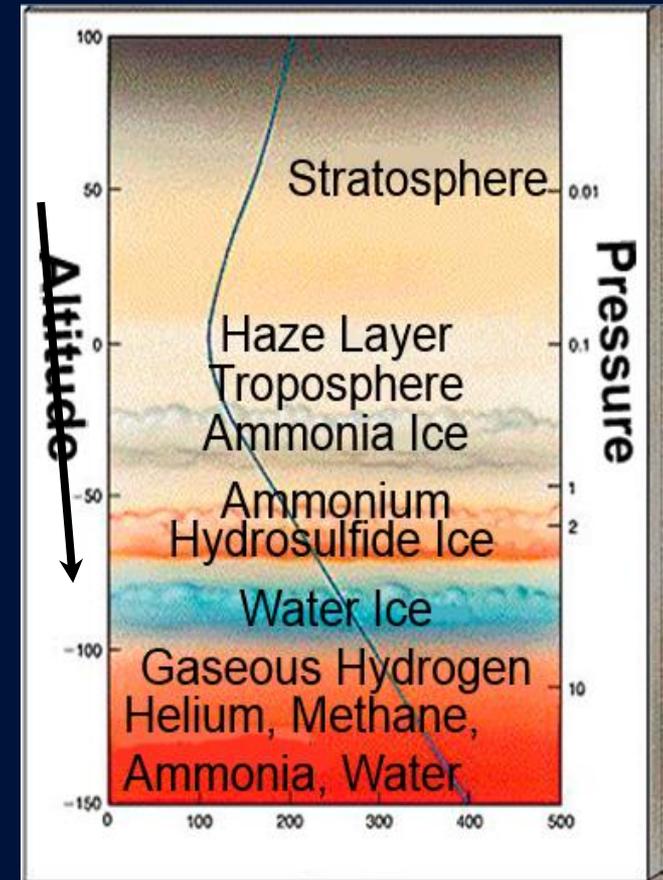




# Jupiter

Farther in, there is a darker cloud deck made up of dark yellow, orange, and brown clouds, consisting mainly of **icy particles** of ammonium hydrosulfide.

Jupiter's innermost layer of clouds is a massive, thick stratum of liquid-water droplets suspended in the hydrogen-helium atmosphere, with ice crystalline, cirrus like clouds on top.





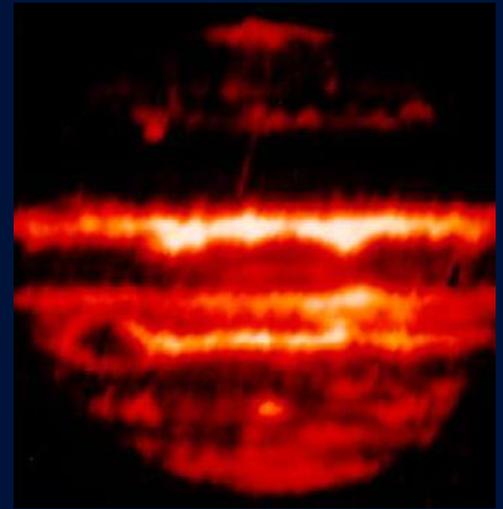
# Jupiter

Beneath this cloud deck, temperatures can reach 800 °F.

According to current theory, there is no solid surface as on other planets.

Instead, the hydrogen is gradually squeezed into a dense, hot fluid under increasing pressure.

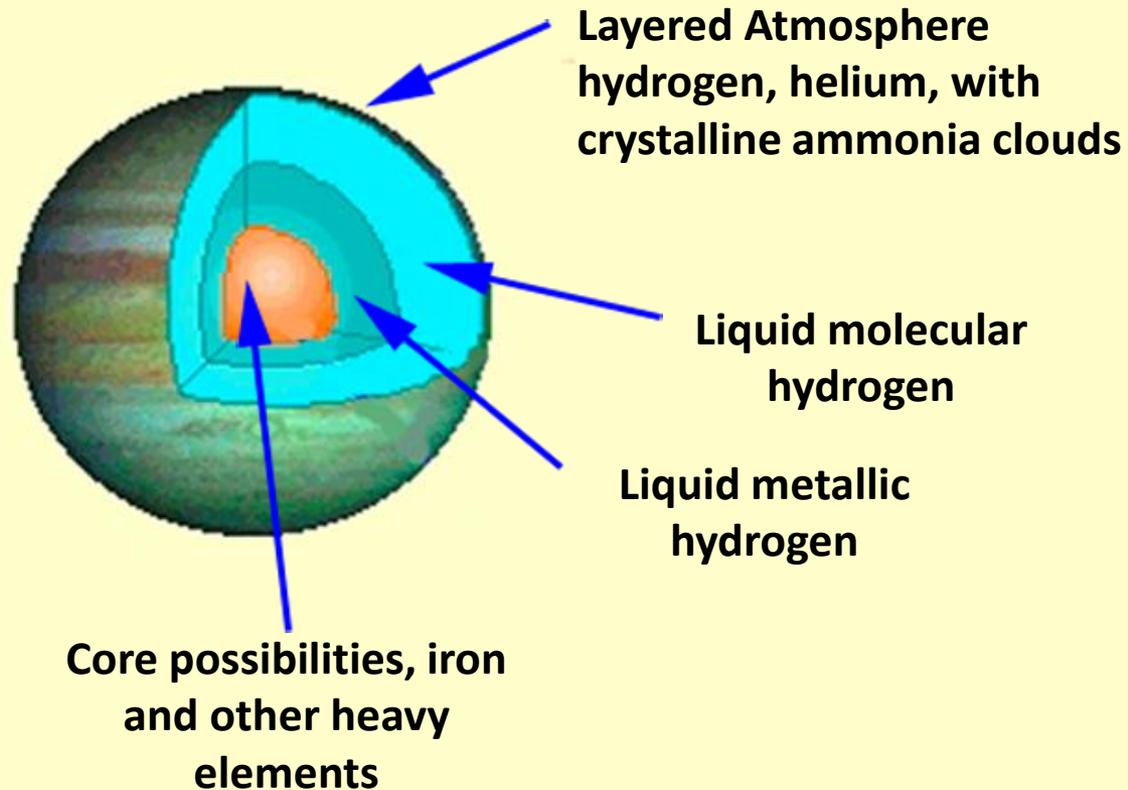
Temperatures may reach 18,000 °F.





# Jupiter

## Inside Jupiter





# Check On Learning Questions

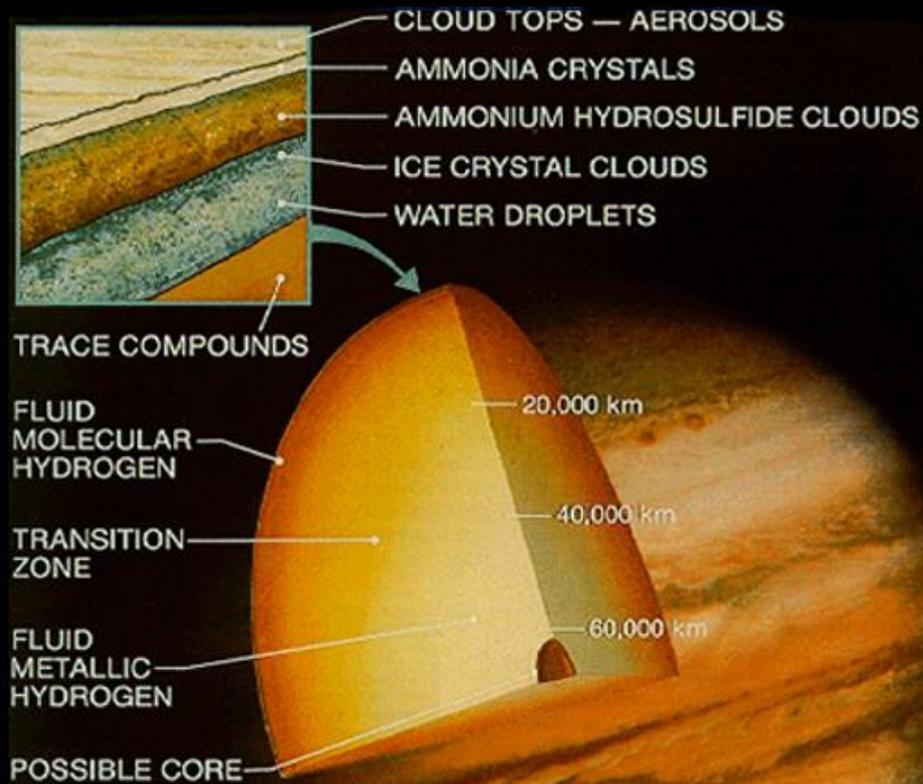


CPS Lesson  
Questions 5 - 6



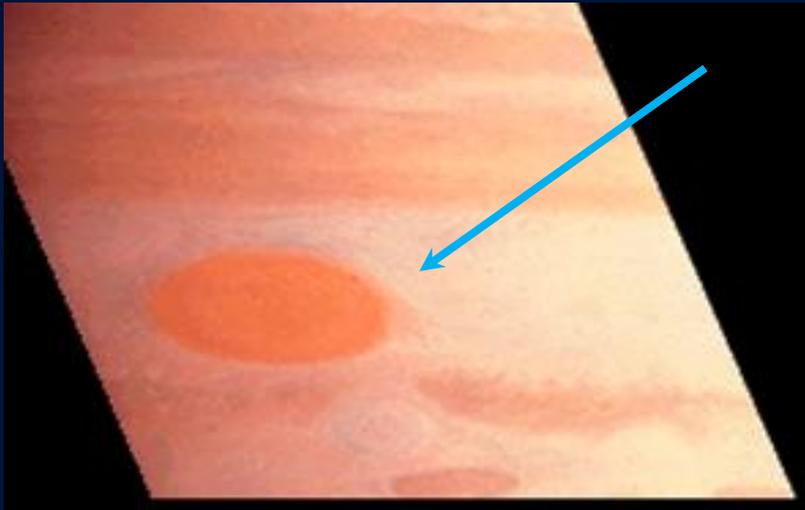
# Jupiter

## Jupiter





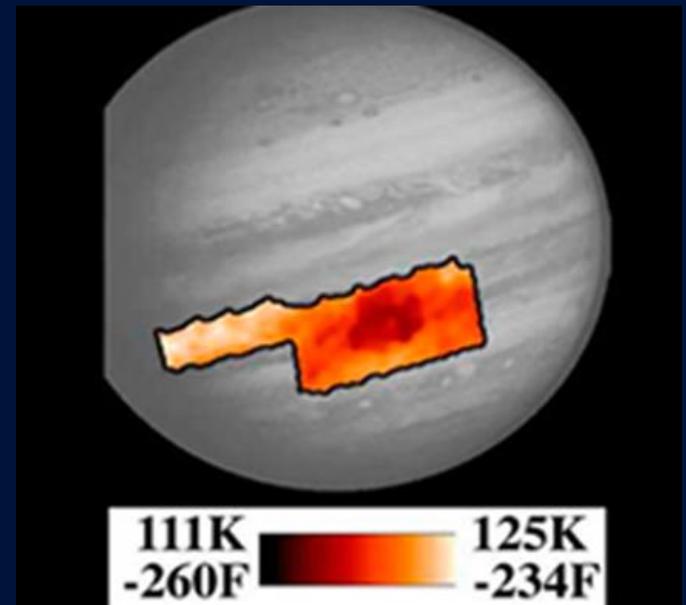
# Jupiter



## Great Red Spot of Jupiter

- It is 17,000 miles long by 8,500 miles wide.

- Its color sometimes fades to gray and then returns to its red-orange state.





# Jupiter

It is a storm that may eventually die.

It is characteristic of the gases of Earth's primordial atmosphere.



## Great Red Spot of Jupiter





# Jupiter

In October 1989,  
*Atlantis* launched  
the *Galileo*  
spacecraft.

Its mission was to  
launch an  
exploratory probe  
that would explore  
Jupiter for 2 years.



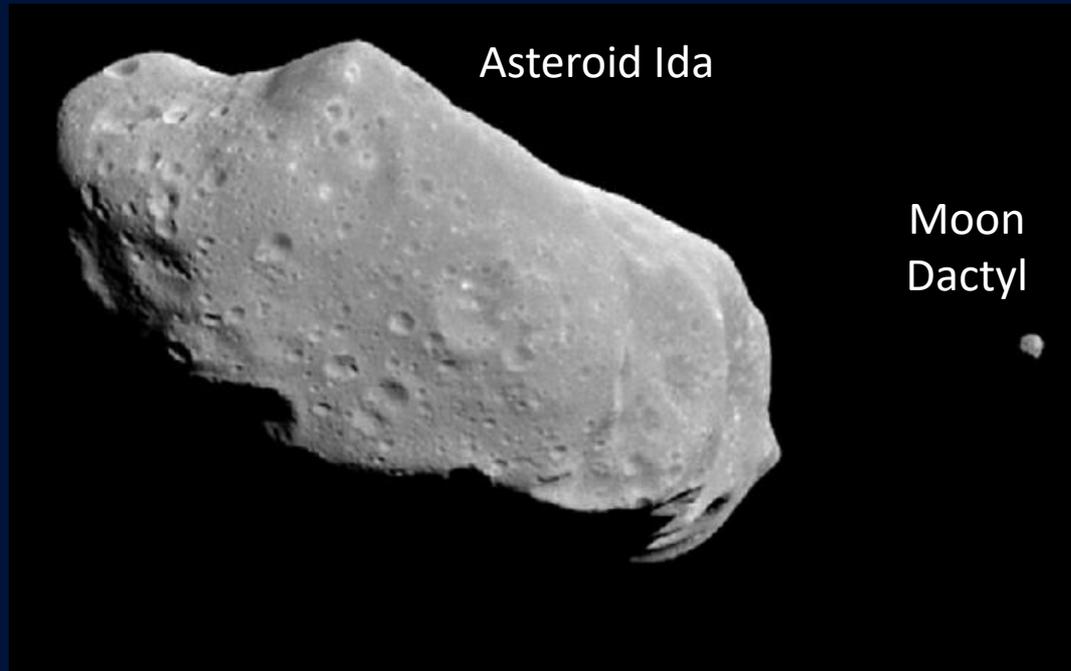


# Jupiter





# Jupiter



While, en route to Jupiter, the *Galileo* spacecraft photographed asteroids and discovered a moon circling one of them.

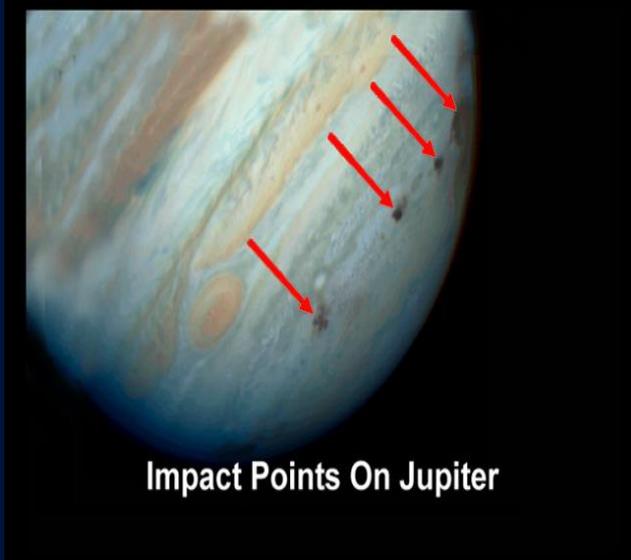


# Jupiter

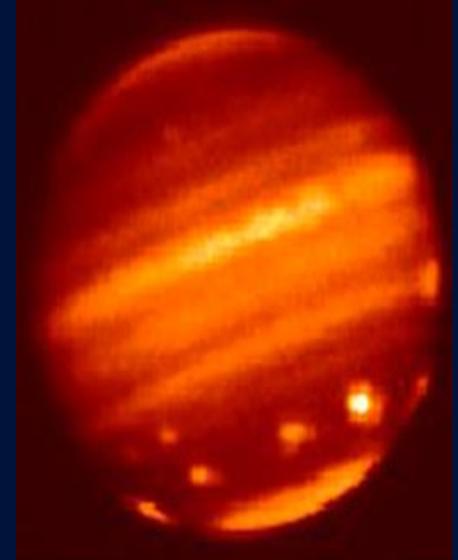
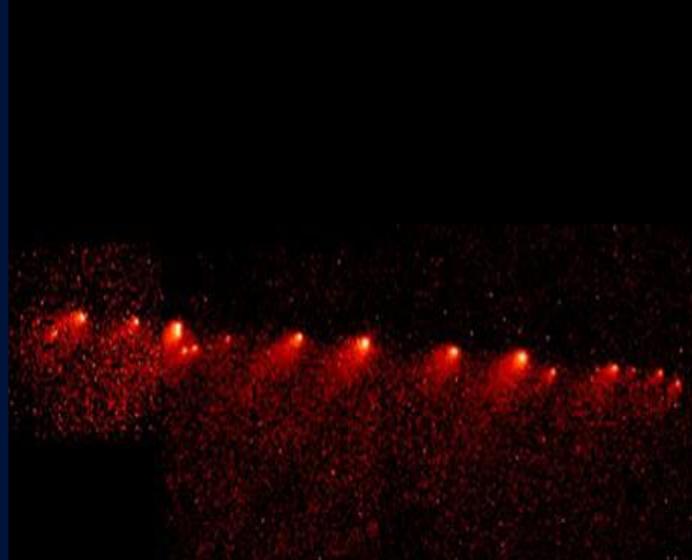




# Jupiter



Impact Points On Jupiter



In July 1994, *Galileo* took a spectacular series of photos when the comet *Shoemaker-Levy* struck Jupiter.



# Jupiter

The *Hubble Space Telescope* and probes *Ulysses* and *Voyager 2* also took photos of fragments striking Jupiter at **130,000 miles per hour**.

Huge fireballs and plumes of dust and gas resulted.





# Jupiter

## *Galileo* Orbiter and Probe

Galileo's probe incorporated experiments to:

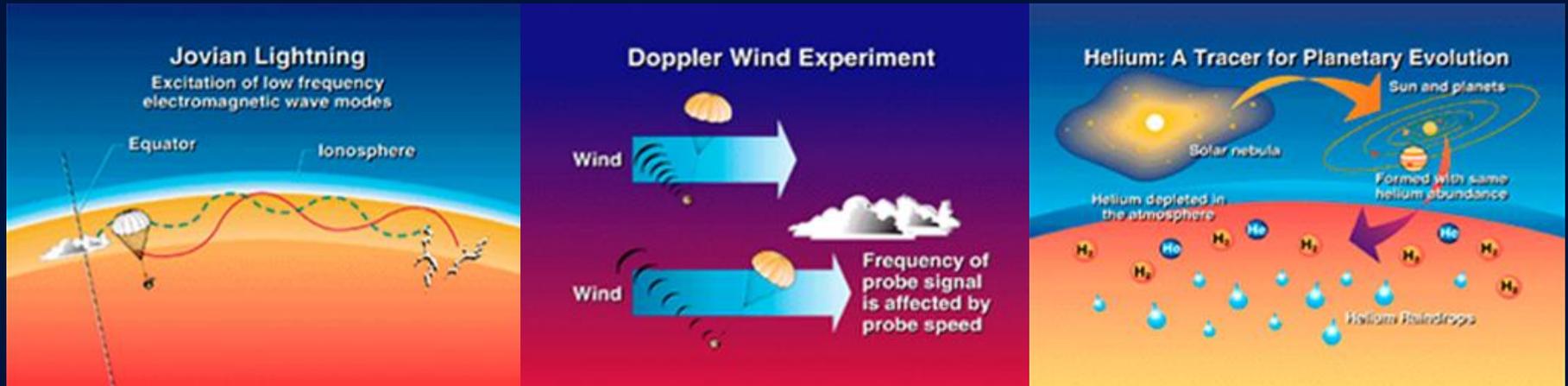
- Measure temperature and pressure along the descent path
- Locate major cloud decks
- Analyze the chemistry of atmospheric gases
- Attempt to detect and study **Jovian** lightning





# Jupiter

## New discoveries by the *Galileo* orbiter:



- Jovian Lightning
- Doppler Wind Experiment
- Helium: A Tracer for Planetary Evolution



# Jupiter

Jovian wind speeds in excess of 400 mph

## Doppler Wind Experiment



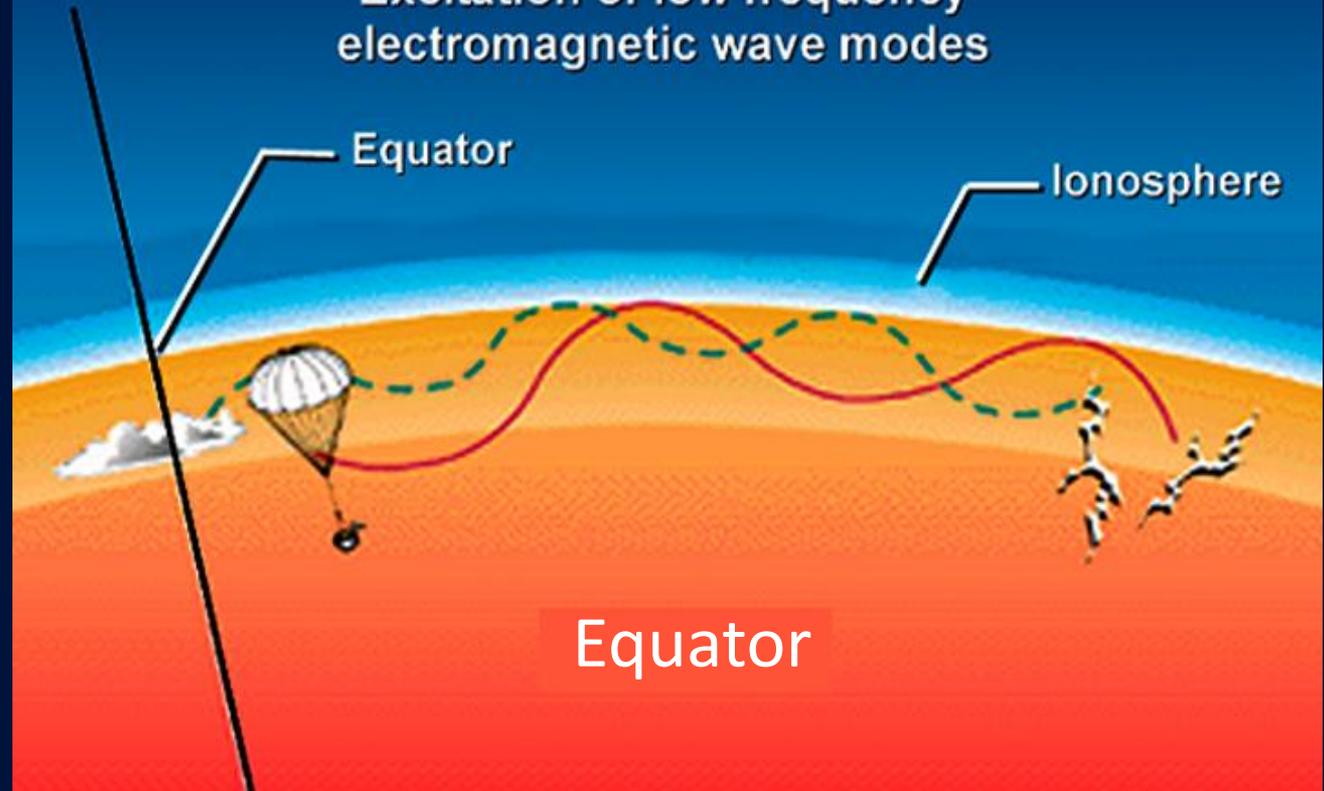


# Jupiter

Far less lightning activity than anticipated

## Jovian Lightning

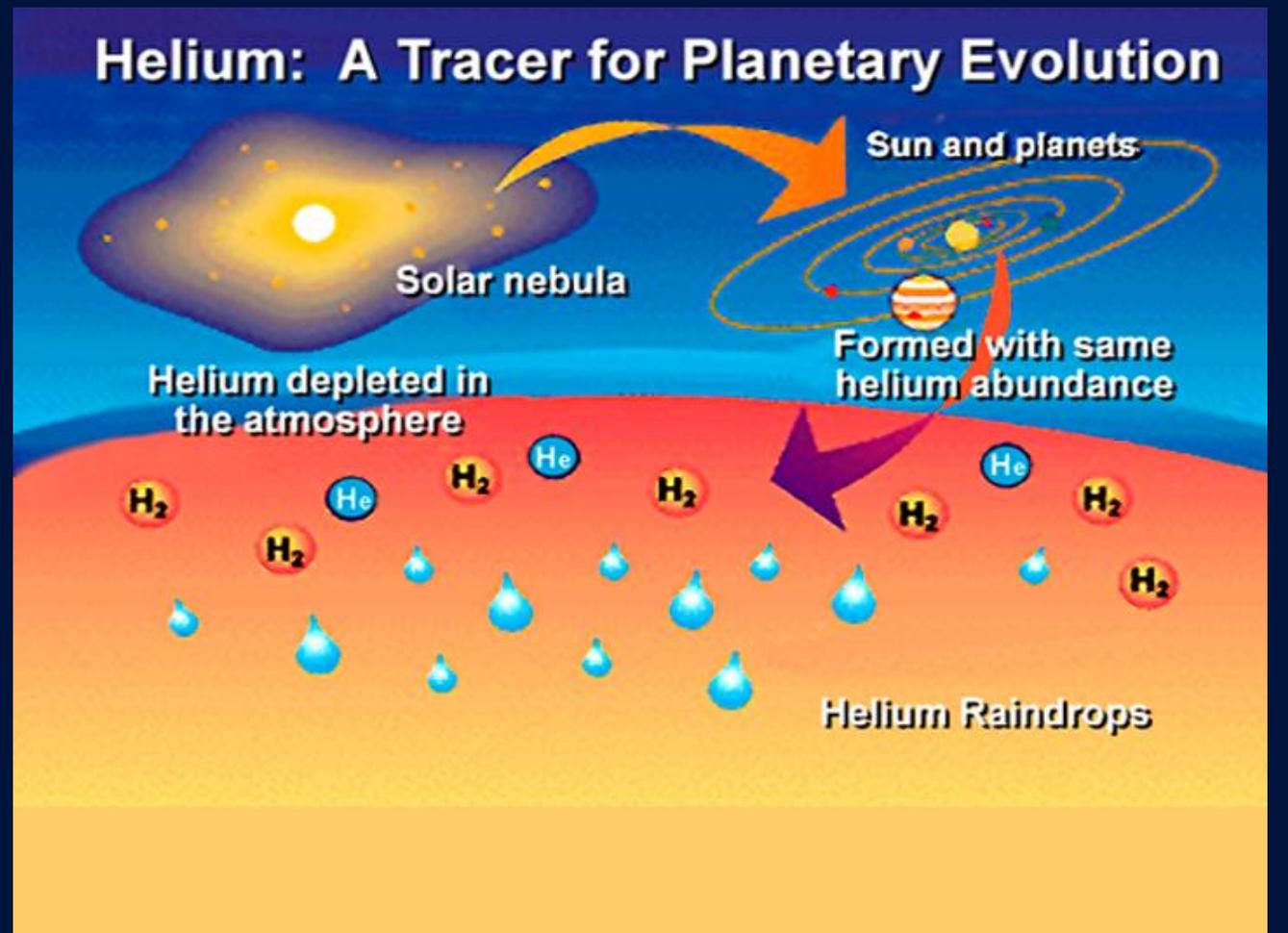
Excitation of low frequency electromagnetic wave modes





# Jupiter

Helium abundance very near that of the Sun





# Jupiter

*Galileo's* mission was originally planned to last only two years.

However it ultimately explored Jupiter and its moons for a total of **eight years** until it was sent on a final plunge into the Jovian atmosphere in September 2003.

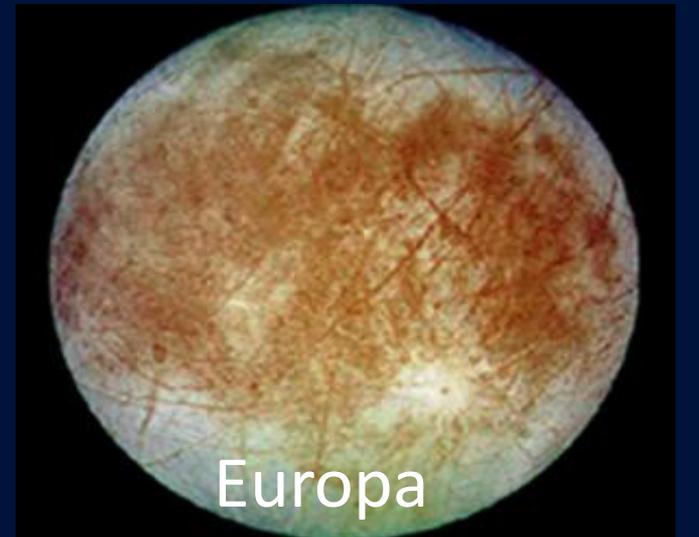




# Jupiter

New discoveries made by the *Galileo* orbiter:

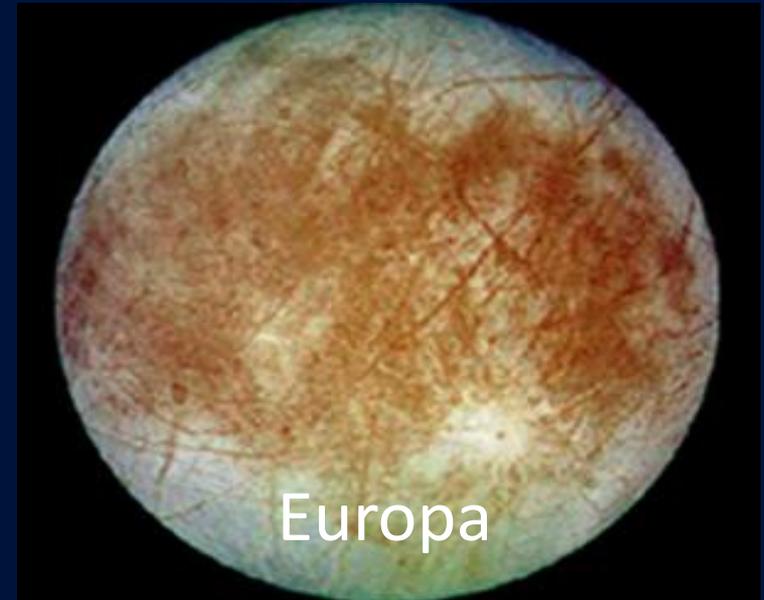
- Extensive resurfacing of the moon Io due to continued volcanic activity
- Evidence of liquid water beneath the moon Europa's frozen surface





# Jupiter

If Europa does indeed have liquid water, it would be the first place other than Earth in the solar system known to have it.



Ice

Microscopic life may exist.

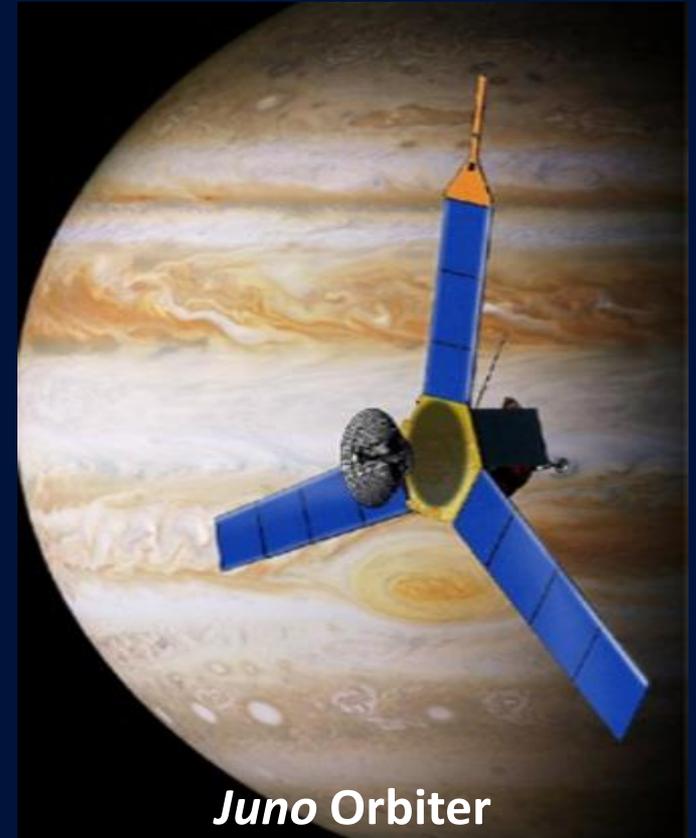


# Jupiter

The possibility of some life forms on Jupiter has excited scientists.

In 2011, the probe *Juno* was launched by NASA.

Upon arrival in 2016, it will be placed in polar orbit above Jupiter, where it will attempt to learn more about the planet's origin and structure.



*Juno* Orbiter



# Review Question



Describe and discuss Jupiter's structure, atmosphere, and temperature.

1.

2.

3.

(Use CPS "Pick a Student" for this question.)





# Closing Questions



CPS Lesson  
Questions 7 - 8



# Questions?

