Stars

A **star** is a sphere of hot gases that gives off light and heat. The only star you can observe during the daytime is the Sun. The Sun is the closest star to Earth. Other stars are much farther away. Throughout the universe, stars are found in large groups called galaxies. Our Sun is near the edge of a galaxy with billions of other stars. You may know this galaxy as the Milky Way. Our galaxy's nearest neighbor is the Andromeda Galaxy.

Star Colors and Temperature

Stars are different colors. These colors occur because of the surface temperature of each star. Think about the flames of a bonfire. Different parts of the fire are different temperatures. Cooler areas are red. The hottest areas are orange-yellow. This same relationship between color and temperature applies to stars. The Sun's temperature makes it look yellow. Cooler stars are red or orange. Warmer stars are white or blue.

Like the Milky Way, the Andromeda Galaxy is shaped like a spiral. It is wider than our own Milky Way Galaxy.

Star Distances

The Sun is about 150 million km (93 million mi) from Earth. It takes about eight minutes for its light to reach Earth. Most stars are much farther away. The Sun appears to be the brightest star because it is the closest star to Earth. Other stars may be brighter but are much farther away. After the Sun, the next closest star to Earth is Proxima Centauri. This star is about 40 trillion km (24.8 trillion mi) away. Because stars are so far from Earth, writing their distance in kilometers or miles becomes awkward.

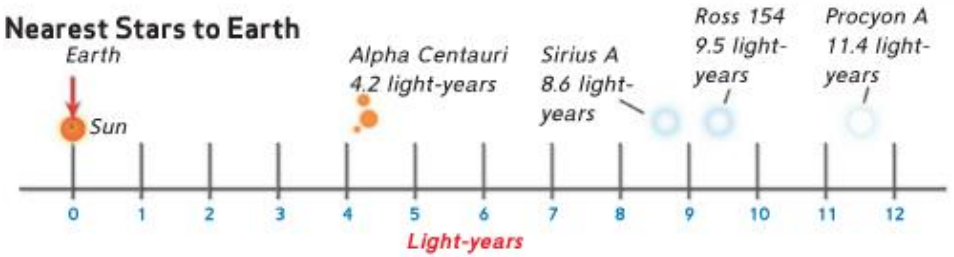
To simplify the writing of such large distances, astronomers use a unit called a light-year. A **light-year** is the distance light travels in one year, which is nearly 10 trillion km (6 trillion mi). Proxima Centauri is 4.2 light-years from Earth.

When you observe a distant star, you are seeing what it looked like in the past. A star you observe today may have stopped glowing millions of years ago. However, its light is still making its way through space. The light we see from the Proxima Centauri system left there about 4.2 years ago.

SKILL BUILDER

Read a Diagram
In this diagram, Earth is right next to the Sun at 0. Count the light-years from Earth-Sun to Alpha Centauri.

Nearest Stars to Earth



FACT CHECKER

A light-year is not a measure of time, but of distance.

Star Cycles

Stars form when matter comes together and starts to give off energy. Stars go through stages, or cycles, between their beginning and ending. Different kinds of stars have different cycles. The cycle of a star depends on how much hydrogen the star contains. A star's cycle ends when it stops giving off energy.

A star forms out of a nebula. A **nebula** is a huge cloud of gases and dust. Gravity pulls the mass of the nebula, most of which consists of hydrogen gas, closer together. As hydrogen atoms move closer, they collide with one another. These collisions produce heat, and the temperature in the cloud rises. When the temperature reaches at least 10,000,000° Celsius (18,000,000° Fahrenheit), hydrogen atoms begin combining to form a new gas, helium. This process gives off tremendous amounts of heat and light. The nebula becomes a protostar, or beginning star. The protostar continues to gain mass because of its gravitational pull. Its heat makes it glow.

The Sun, and other stars like it, started with a medium amount of hydrogen. That hydrogen is the fuel that produces energy in the Sun. For a few billion years, hydrogen atoms continue combining to form helium, and the star increases in temperature.

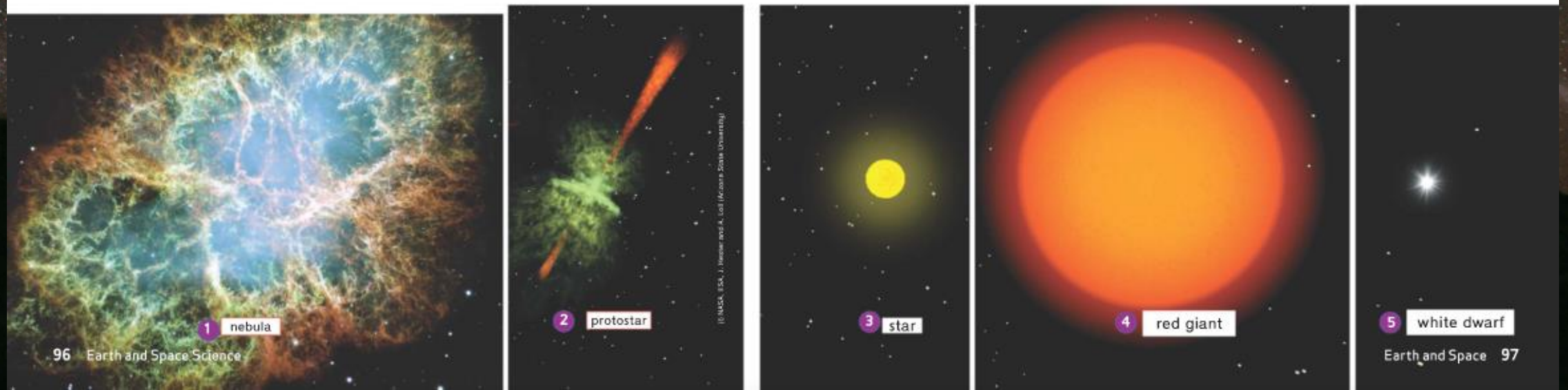
Eventually the heat forces the hydrogen on the edge of the star to expand into space. As the expanding hydrogen moves farther from the center of the star, it cools and turns red. At this stage in its cycle, the star has become a red giant. A red giant is many times larger than the original star. In the star's core, the temperature has risen to about 100,000,000°C (180,000,000°F). Helium atoms now combine to form atoms of carbon.

When all the helium is gone, the star can no longer combine helium to form carbon. Now the star begins to cool and shrink, becoming a white dwarf. A **white dwarf** is a small and very dense star that shines with a cooler white light. The white dwarf stage is the end of a medium-sized star's cycle.

About 10 billion years pass during this cycle. Because the Sun is approximately 5 billion years old, it is about halfway through the cycle.

SKILL BUILDER

Read a Diagram
Follow the numbers to better understand the stages of a medium-sized star. The Sun is in stage 3 of this cycle.



Star Cycles of Larger Stars

Stars that start off with greater amounts of hydrogen end their cycle differently. After they become red giants, the temperature of the core of these stars increases to about 600,000,000°C (1,080,000,000°F). At this temperature, their atoms combine to form atoms of iron.

Eventually the iron core produces more energy than gravity can hold together, and the star explodes. The exploding star is called a **supernova.** Supernovas shine brightly for days or weeks and then fade away. A supernova will form a new nebula.

If a star is very massive, it may end its cycle as a black hole. A **black hole** is an object that is so dense and has such powerful gravity that nothing can escape from it, not even light.

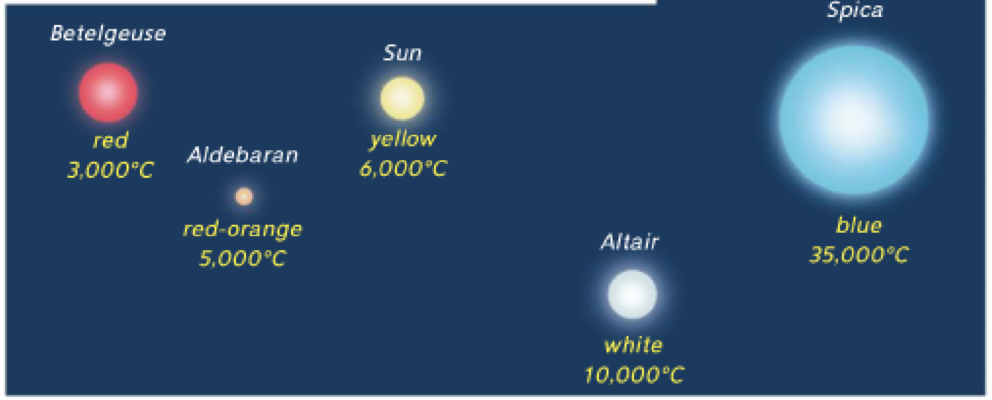
SKILL BUILDER

Read a Diagram
Look for a pattern between temperature and color in these different stars.

Star Classification

Stars are characterized by their size, color, and temperature. The Sun is a medium-sized yellow star with a surface temperature of about 6,000°C (11,000°F). Giant stars have diameters that are 10 to 100 times that of the Sun. Super giants may have diameters that are 1,000 times that of the Sun. Neutron stars are the smallest stars and are 60,000 times smaller than the Sun.

Color and Surface Temperatures of Stars



The Milky Way and Other Galaxies

Our solar system is part of a larger region of space called a galaxy. A galaxy contains billions of stars, dust, and gas that are held together by gravity. Our galaxy is known as the Milky Way.

The Milky Way contains more than 200 billion stars. The dust and gas in the galaxy is enough material to make billions more stars. Even so, the Milky Way is not the largest galaxy. A galaxy known as IC1101 includes more than 100 trillion stars. It is approximately 60 times larger than the Milky Way Galaxy! The smallest known galaxy is called M60-UCD1 and is approximately 300 times smaller than the Milky Way.

Spiral Galaxies These galaxies are shaped like disks. They contain gas, dust, and young stars in their arms. Some spirals arms are long and symmetrical, while others are short and stubby. The Milky Way is a spiral galaxy.

Elliptical Galaxies These galaxies do not have an internal structure. Some are spheres, like basketballs, while others resemble footballs. Elliptical galaxies contain older, redder stars than spiral galaxies do. They also contain little or no gas and dust.

Irregular Galaxies These galaxies are oddly shaped and contain large amounts of gas and dust. They have the highest rate of star formation of any galaxy type. These galaxies do not have bright centers.

Our solar system is in one of the arms of the Milky Way Galaxy.

Spiral Galaxy

Elliptical Galaxy

Irregular Galaxy

Constellations

When people in ancient cultures looked at the night sky, they saw patterns in the stars. These patterns are called **constellations.** They were named after animals, fictional characters, or objects.

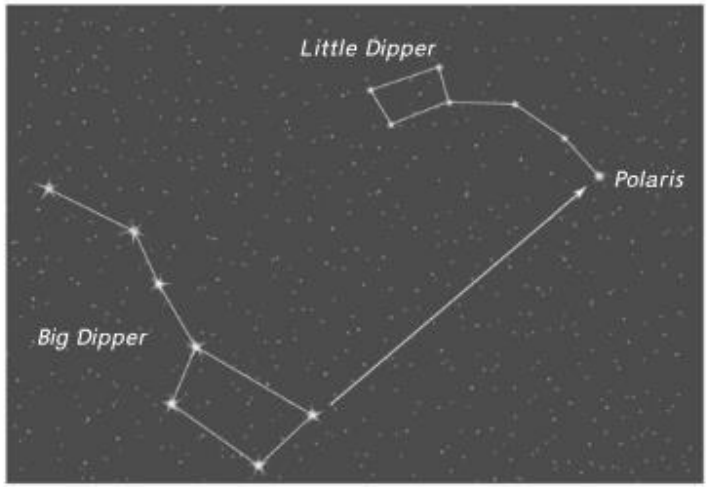
Star patterns have been useful to ancient and modern travelers. For example, if you can see either the Big Dipper or the Little Dipper in the night sky, you can use them to easily find Polaris, the North Star. If you travel in the direction of Polaris, you willbe moving north.

The ancient Greeks divided the sky into 12 sections and named some constellations after characters from Greek myths, such as the hunter Orion and the hero Hercules. The ancient Chinese divided the sky into four major regions. The name of each region included a color, an animal, and a direction. For example, the western region was called the White Tiger of the West.

Today, astronomers divide the sky into 88 constellations. Many of the ancient names for constellations are still used today. Modern astronomers have named constellations visible in the Southern Hemisphere, which could not be seen by Ancient Greeks and Romans.

SKILL BUILDER

Read a Diagram
To find Polaris, first find the stars in the bowl of the Big Dipper.



X_PHOTOCREDIT_TK

Apparent Motion

The stars in the northern sky seem to circle around Polaris. The stars appear to move because of Earth's rotation. Although the stars appear to change position, their positions within constellations do not change.

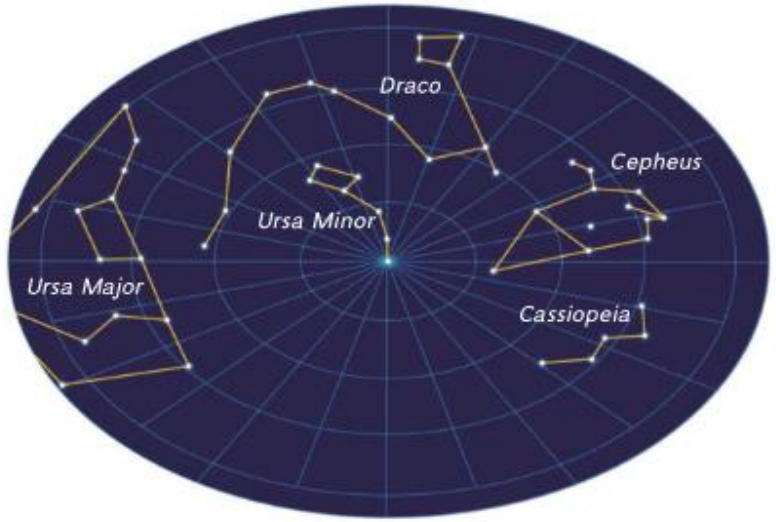
As Earth revolves around the Sun, different constellations are visible to an observer on Earth. For example, Orion is a winter constellation in the Northern Hemisphere. It can be seen rising in the eastern sky on winter evenings. As the season changes, Orion sets earlier and earlier each night. In May, Orion disappears from the night sky in the Northern Hemisphere. In June, the constellation Scorpius, the scorpion, becomes visible.

These seasonal changes are caused by Earth's orbit around the Sun. Each night, the position of most stars shifts slightly to the west. Soon the stars once visible in the west cannot be seen, and other stars appear in the east.

WORD STUDY

The word *circumpolar* comes from two words. *Circum* means "around," and *polar* means "of the poles."

A star map shows the locations of constellations in the night sky.



X_PHOTOCREDIT_TK

There are three main types of galaxies;

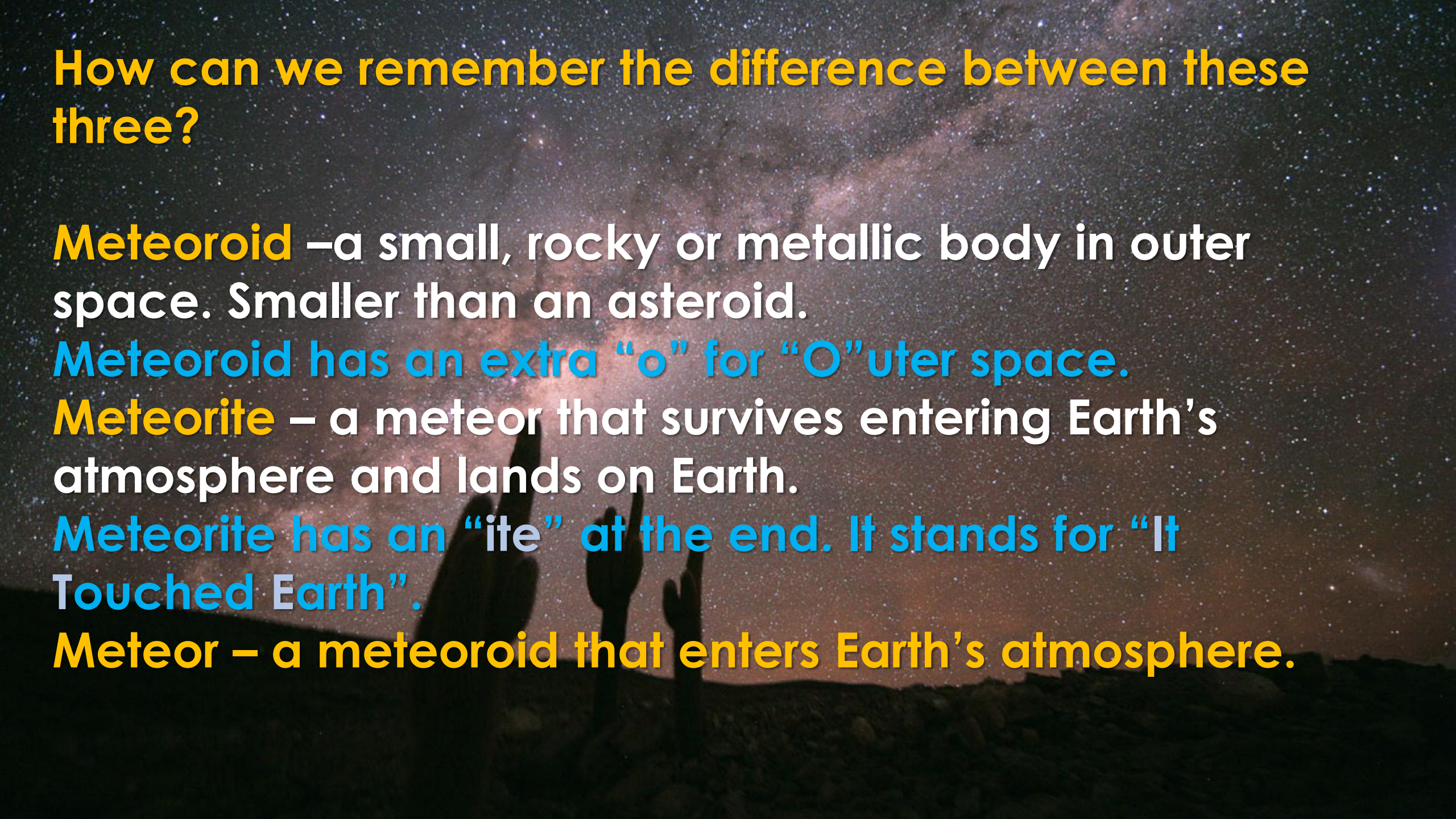
Spiral Galaxies These galaxies are shaped like disks. They contain gas, dust, and young stars in their arms. Some spirals arms are long and symmetrical, while others are short and stubby. The Milky Way is a spiral galaxy.

Elliptical Galaxies These galaxies do not have an internal structure. Some are spheres, like basketballs, while others resemble footballs. Elliptical galaxies contain older, redder stars than spiral galaxies do. They also contain little or no gas and dust.

Irregular Galaxies These galaxies are oddly shaped and contain large amounts of gas and dust. They have the highest rate of star formation of any galaxy type. These galaxies do not have bright centers.

- Our galaxy itself contains five hundred billion stars.
- It's a hundred thousand light years side to side.
- It bulges in the middle, six thousand light years thick,
- But out by us it's just a thousand light years wide.
- We're thirty thousand light years from galactic central point.
- We go round every two hundred million years,
- And our galaxy is only one of millions of billions
- In this amazing and expanding universe.

Video Galaxies 101

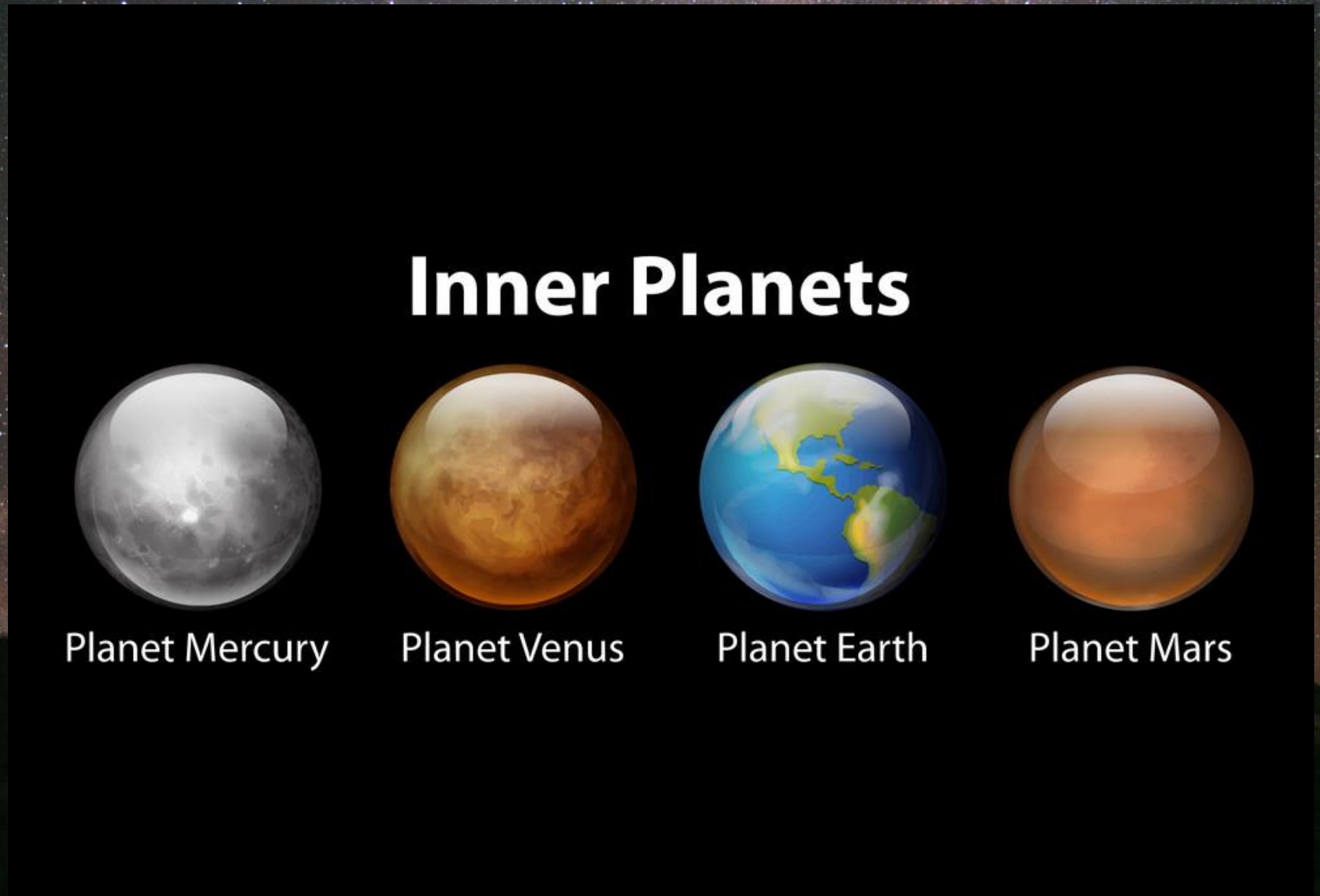


How can we remember the difference between these three?

Meteoroid –a small, rocky or metallic body in outer space. Smaller than an asteroid.
Meteoroid has an extra "o" for "O"uter space.
Meteorite – a meteor that survives entering Earth's atmosphere and lands on Earth.
Meteorite has an "ite" at the end. It stands for "It Touched Earth".
Meteor – a meteoroid that enters Earth's atmosphere.


Solar System 101
Perseid Meteor Shower
Chelyabinsk Meteor

Inner Planets – Terrestrial Planets - Rocky



Inner Planets of the Solar System

The four planets closest to the Sun are called the *inner planets*. They are also called the terrestrial, or rocky, planets because they are made mostly of rock. Evidence suggests that each has a core of iron. They have relatively similar sizes and closely spaced orbits. They have few, if any, moons. All the inner planets rotate relatively slowly and none of them have rings. Despite these similarities, each planet has its own unique features.

Mercury Mercury is the closest planet to the Sun. That closeness makes it very hot. It has almost no water and very little air. The surface has many craters, like Earth's Moon. A *crater* is a hollow area or pit in the ground. Craters form when large space rocks crash into other space objects. Mercury is the smallest inner planet. At its equator, it is less than half the size of Earth.

Venus Venus is the second closest planet to the Sun. It has a thick atmosphere that is made mostly of carbon dioxide, with atmospheric pressure 90 times greater than that of Earth. The atmosphere does not allow heat to easily escape. This atmosphere makes Venus the hottest planet. There are many volcanoes on Venus, and its surface is covered in lava flows.

DID YOU KNOW

Mercury's Sun-facing side is hot enough to melt zinc. However, on the night side of the planet, temperatures can drop to -170°C (-274°F).

Distance to the Sun: 58 million km
Diameter: 4,880 km
Fast Fact: Mercury's surface is covered with craters.

Distance to the Sun: 108 million km
Diameter: 12,100 km
Fast Fact: Temperatures on Venus can reach 500°Celsius (932°Fahrenheit).

(t) ©Dvele Images/Alamy; (r) NASA Jet Propulsion Laboratory (NASA/JPL)

Earth Earth is unique in our solar system. It has oxygen and liquid water. Earth is the only planet known to support life. Earth's atmosphere keeps temperatures from getting too hot or too cold to sustain life as we know it. It is the largest of the inner planets.

Mars Of all the planets, Mars is the most like Earth. It has two small moons and a thin atmosphere. Mars has volcanoes, but they are no longer active. The surface has many features that show evidence of erosion by floods and rivers. Today, Mars is much colder than Earth. Its water is frozen in ice caps near both poles. NASA has sent probes to Mars and hopes to send astronauts to the red planet one day.

DID YOU KNOW?

The largest asteroid in the asteroid belt is about one fourth the diameter of Earth's moon.

Beyond the Inner Planets

Beyond the orbit of Mars is a belt of space rocks called **asteroids.** These are rocky or metallic objects that orbit the Sun. Scientists have accumulated a great deal of information about asteroids in recent years. Space probes have sent back information that provides pictures of these orbiting objects.

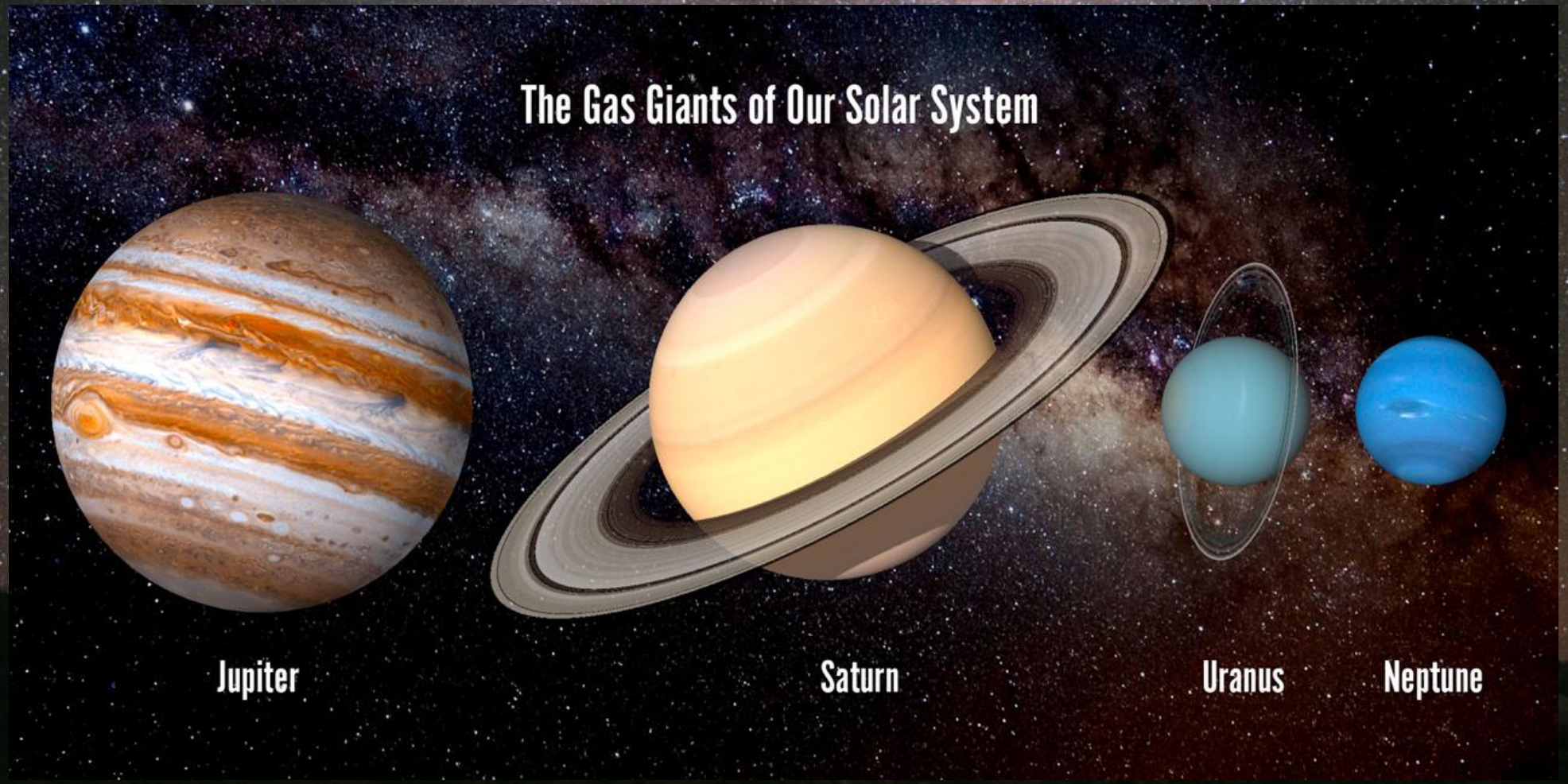
Ida is a heavily cratered, irregularly shaped asteroid.

Distance to the Sun: 150 million km
Diameter: 12,756 km
Fast Fact: Earth's atmosphere makes it suitable for life.

Distance to the Sun: 228 million km
Diameter: 6,794 km
Fast Fact: Iron oxide, or rust, gives Mars its reddish color.

(l) NASA/JPL; (r) Stocktrek/Getty Images; Digital Vision

Outer Planets - Jovian Planets – Gas Giants



Outer Planets of Earth's Solar System

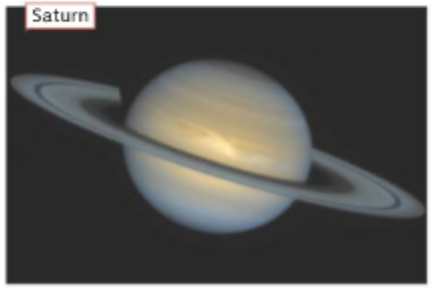
The four planets beyond Mars are called the *outer planets*. They are also called *gas giants* because they are huge compared with the inner planets, and because they consist mostly of gases. The largest gas giant, Jupiter, is five times farther from the Sun than Earth is.

The gas giants do not have solid surfaces. They are made mostly of the gases hydrogen and helium. Scientists have evidence that they may have some rock and ice at their cores. Each has a ring system, although most are difficult to see. They also have many moons and some have atmospheres.

Jupiter This planet's atmosphere is divided into bands of strong winds. The winds in each band blow in directions opposite the bands on either side of it. One band has a large red spot the size of Earth. The red spot is a storm that has been blowing for over 400 years. The storm is known as The Great Red Spot. One of Jupiter's moons, Ganymede, is the largest moon in the solar system. Another, Europa, may have an ocean of water beneath its icy crust. The moon named Io has active volcanoes.

Saturn Saturn is the second largest planet. It is famous for its system of rings. The rings are made of pieces of ice and rock. Most of these pieces are less than a couple meters in diameter. Saturn has at least 34 moons. The largest is named Titan.

Distance to the Sun: 778 million km
Diameter: 143,000 km
Fast Fact: Jupiter's four largest moons were first observed by Galileo in 1610.



Distance to the Sun: 1 billion, 429 million km
Diameter: 120,536 km
Fast Fact: Winds on Saturn can blow at 500 meters per second.

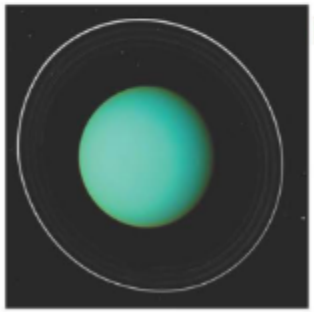
(t) NASA-JPL; (b) Reta Beebe (New Mexico State University), D. Gilmore, L. Borgonoi (STScI), and NASA

Uranus Uranus is sometimes known as the "sideways" planet. The axis is tilted so much that it rotates on its side. An *axis* is an imaginary line down an object's center that it appears to rotate around. Uranus's tilted axis means that one pole faces the Sun during parts of Uranus's orbit. The unusual blue-green color of this planet is due to gases in its upper atmosphere, including methane. Uranus has at least 27 moons. One of its moons, Miranda, looks as though it broke apart and the pieces clumped back together several times as it formed.

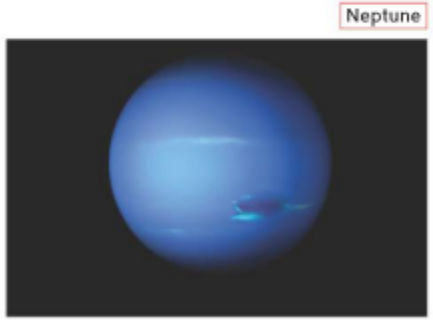
Neptune Neptune is the farthest gas giant from the Sun. Winds on Neptune can blow at speeds of 2,000 kilometers (1,200 miles) per hour. Its atmosphere, like that of Uranus, is mostly hydrogen, helium, and methane. There may be an ocean underneath Neptune's clouds. Scientists have observed 13 moons orbiting Neptune. Triton is the largest moon. Triton is known to have "ice volcanoes" that shoot material up to 8 km (5 mi) high.

Beyond the Outer Planets

Beyond Neptune's orbit lie the Kuiper Belt and the Oort Cloud. Both of these regions are composed of small, icy bodies and are the origin of comets. Scientists hypothesize that the bodies that make up these regions are the remnants from the formation of the solar system.



Distance to the Sun: 2 billion, 871 million km
Diameter: 51,118 km
Fast Fact: The axis of Uranus is tilted toward the Sun.



Distance to the Sun: 4 billion, 504 million km
Diameter: 49,528 km
Fast Fact: Neptune takes 165 Earth years to orbit the Sun.

(t) Voyager 2, NASA; (r) ©Erwin Images/Wang

Compare & Contrast

Inner Planets & Outer Planets

Which one has . . .

- **Fewer moons?** Inner
- **Thick atmospheres?** Outer
- **Shorter years?** Inner
- **Revolve around the Sun?** Both
- **Made mostly of rock?** Inner
- **Made mostly of gas?** Outer

Вене́ра (Venera) 13, 1 March 1982, Surface of Venus

Other Objects in the Solar System

Other than the Sun, planets and moons are the largest objects in the solar system. The next largest objects are dwarf planets. However, many smaller objects are also found in our solar system.

Meteoroids A *meteoroid* is a small, rocky or metallic object that orbits the Sun in both the inner and outer regions of the solar system. The craters on the Moon were formed by meteoroids colliding with its surface.

Meteors A *meteor* is a meteoroid that enters Earth's atmosphere. It appears as a bright streak in the sky. If a meteor does not break apart and burn up in the atmosphere, it can hit Earth's surface. You may have heard meteors called shooting stars. Some evenings you can observe many meteors in the night sky. These events are called meteor showers.

Meteorites A meteor that strikes Earth's surface is called a meteorite. Many places on Earth show evidence of meteorite impacts. One such place is Meteor Crater in Arizona. About 50,000 years ago, a large meteorite crashed there, forming a crater that is as wide as 11 football fields.

DID YOU KNOW

Many meteoroids are no bigger than grains of sand.

This is a meteorite.

A meteorite caused this crater when it collided with Earth's surface.

(t) NASA/JPL-Caltech/Cornell University (b) Photo by David J. Roddy, USGS, Branch of Astrogeology

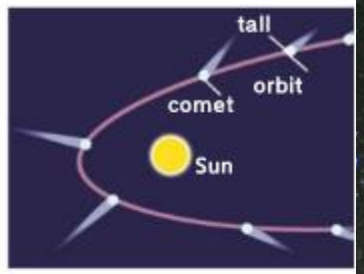
Comets

A **comet** is a mixture of frozen gases, ice, dust, and rock that moves in an elliptical orbit around the Sun. Comets are thought to be bits of material left over from the formation of the solar system about 4.6 billion years ago.

When a comet is farther away from the Sun, the gases and ice in the comet are frozen. As the comet moves toward the Sun, the core, or nucleus, of the comet warms up. Some of the ice and dust in the nucleus form a cloud or coma around the nucleus. Together, the coma and the nucleus make up the head of the comet.

As the comet gets closer to the Sun, heat from the Sun's rays pushes some of the coma away from the comet. This material forms a glowing tail that may stretch millions of kilometers behind the head. Sometimes two tails will form. One tail is made of ice, and one is made of gases.

Heat moves out from the Sun in every direction. As a comet moves around the Sun, the head stays closest to the Sun and the tail trails out behind it. No matter where the comet is in its path around the Sun, the comet's tail always points away from the Sun.



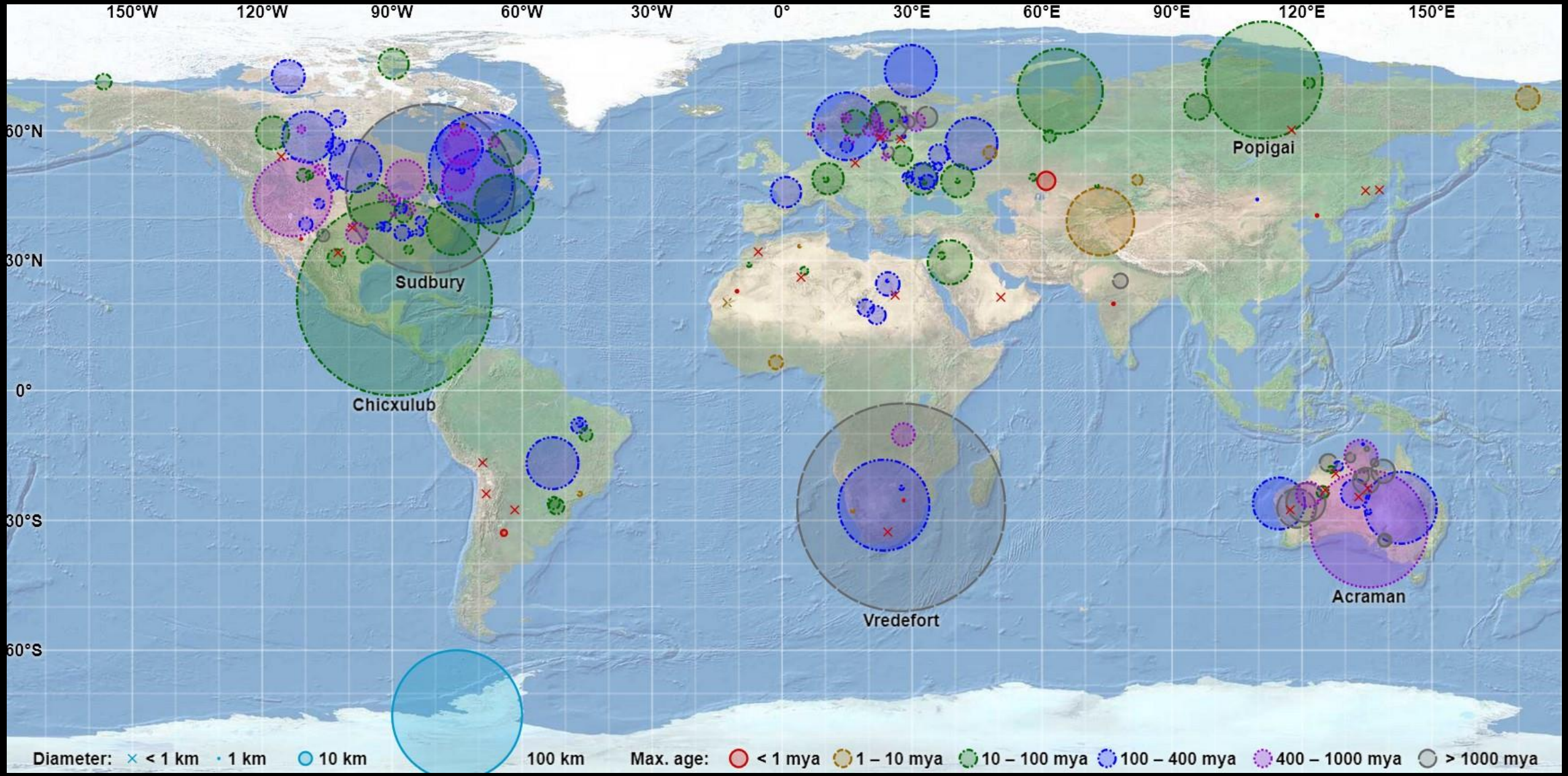
Comets have tails of ice and gases.

Stocktrek/Getty Images

Meteor Crater Natural Landmark

Northern Arizona

50,000 years ago


150°W
120°W
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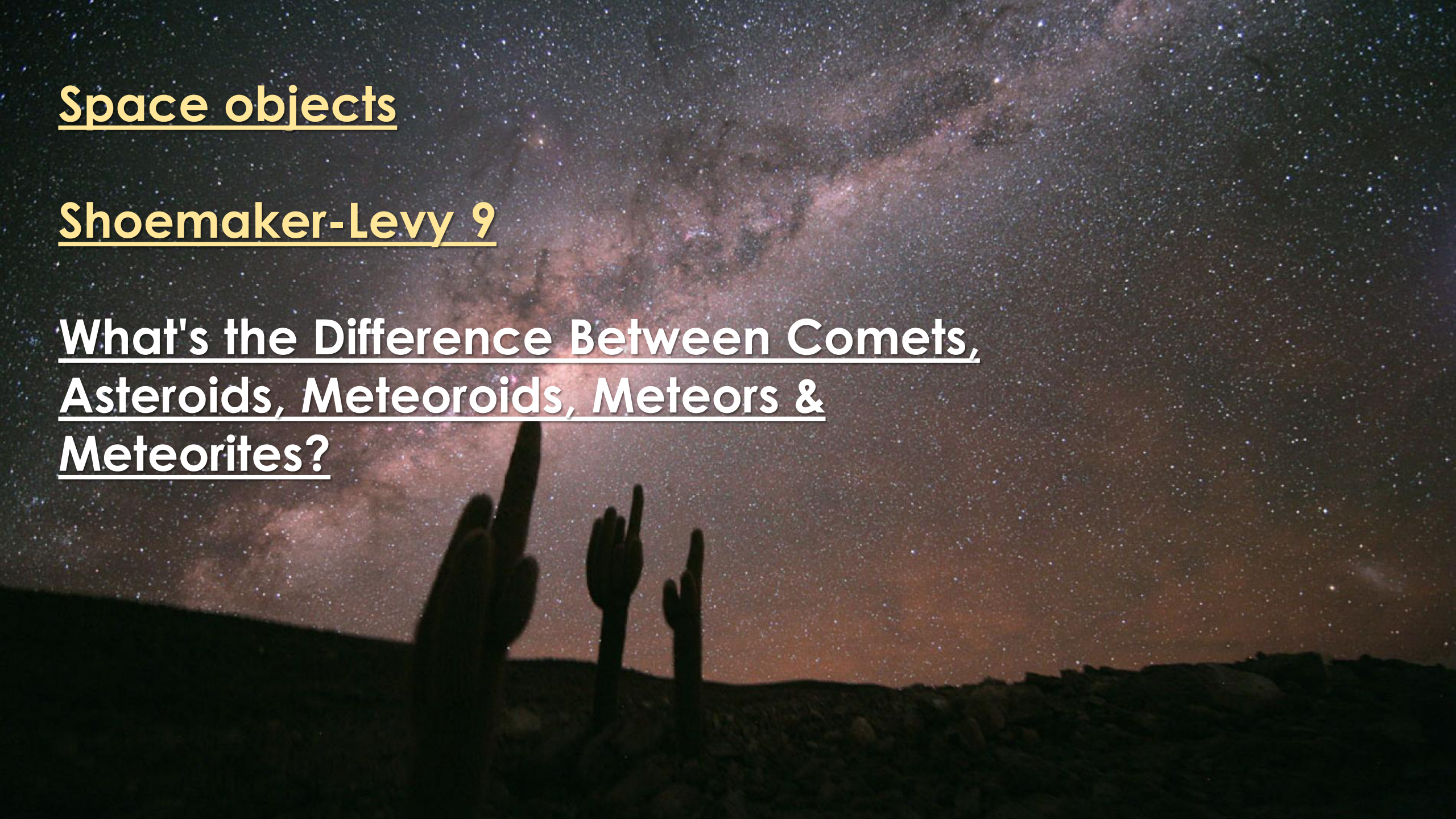
30°E
60°E
90°E
120°E
150°E
60°N
30°N
0°
30°S
60°S
Sudbury
Chicxulub
Popigai
Vredefort
Acraman
Diameter:
< 1 km
1 km
10 km
100 km
Max. age:
< 1 mya
1 – 10 mya
10 – 100 mya
100 – 400 mya
400 – 1000 mya
> 1000 mya


Space objects
Shoemaker-Levy 9
What's the Difference Between Comets, Asteroids, Meteoroids, Meteors & Meteorites?

Mini Lesson: Life*

*All phrases may as well have "as we know it" at the end

For LIFE to exist we need:

- Oxygen - an atmosphere that contains O_2 for breathing and/or converting into Carbon Dioxide CO_2
- Carbon – because Carbon is the base element for all life. Organic molecules must contain Carbon.
- Liquid water – The Earth is the only place we know that has water in gas, solid and liquid form.
- The right distance from the Sun – enough heat and light. Habitable Zone
- Gravity must be not too strong or not too weak.

EXTRA CREDIT

Use online resources or a book from the library; solarsystem.NASA.gov
https://kids.nationalgeographic.com/

Choose one planet to research, either one Inner (terrestrial) planet or one Outer (Jovian) planet. Create a visual. Use the ones on my "Future Scientists" board as exemplars. I have color copy paper and color card stock you can have. Use your creativity to make a visual of the planet. You can draw, paint a Styrofoam ball, or use whatever your artistic talents may lead you. But you *must include* the following information in the corner of your visual for full credit:

REQUIRED

- Where does its name originate from?
- How far away is it from the Sun?
- What is it made of; mostly rock or mostly gas?
- Does it have an atmosphere and what gases make up the atmosphere?
- How long is a year on your planet? How long is a day?
- How many moons? Name one or two important moons.
- Include one random fact that you find interesting about your planet.

Be sure to put a title, your name and section number on it.
Due 9/29. A maximum of 5 assessment bonus points and a 100 classwork grade will be applied to projects that meet the requirements.