

Where do we live?

**How are the other planets
compared to Earth?**

S6E1



What is the universe?

All of space & everything in it!

How does *science* explain how the **UNIVERSE** came to be?

- 15-20 billion years ago all matter was compressed into a hot, dense, tiny dot that exploded called the **BIG BANG** theory.



THE BIG BANG THEORY

TIME
BEGINS

ONE
SECOND

PRESENT
DAY

Time	10^{-43} sec.	10^{-32} sec.	10^{-6} sec.	3 min.	300,000 yrs.	1 billion yrs.	15 billion yrs.
Temperature		10^{27}°C	10^{13}°C	10^8°C	$10,000^{\circ}\text{C}$	-200°C	-270°C

1 The cosmos goes through a superfast "inflation," expanding from the size of an atom to that of a grapefruit in a tiny fraction of a second.

2 Post-inflation, the universe is a seething, hot soup of electrons, quarks and other particles.

3 A rapidly cooling cosmos permits quarks to clump into protons and neutrons.

4 Still too hot to form into atoms, charged electrons and protons prevent light from shining: the universe is a superhot fog.

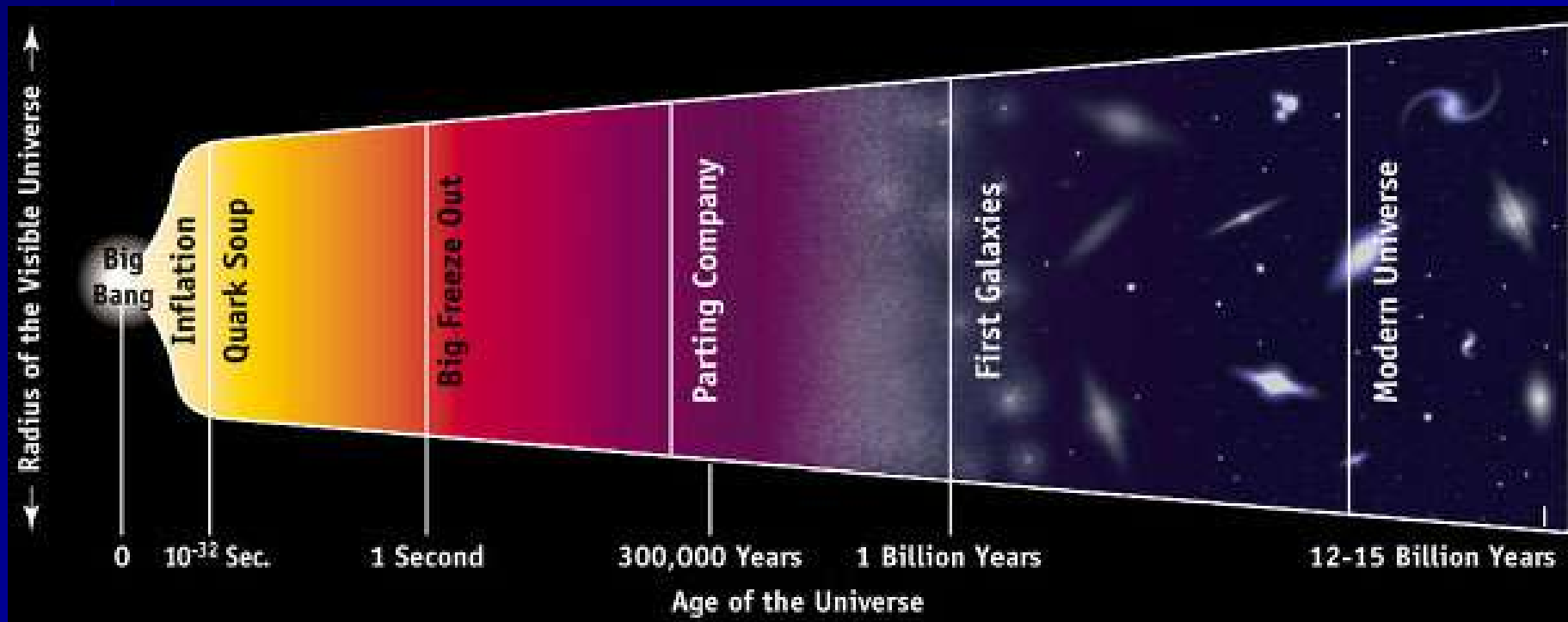
5 Electrons combine with protons and neutrons to form atoms, mostly hydrogen and helium. Light can finally shine.

6 Gravity makes hydrogen and helium gas coalesce to form the giant clouds that will become galaxies; smaller clumps of gas collapse to form the first stars.

7 As galaxies cluster together under gravity, the first stars die and spew heavy elements into space; those will eventually turn into new stars and planets.



The Universe began in an instant and has been expanding ever since.



The universe has many galaxies.

What is a galaxy?

**A huge group of stars,
singles stars, star clusters,
dust & gas bound (held)
together by gravity**

What is the name of our galaxy?

THE MILKY WAY GALAXY

Just one
of billions
of
galaxies
in the
Universe.



How is the shape of our galaxy described?



SPIRAL – looks like a pinwheel with arms.

Why can't we see this spiral shape from Earth?

Because we are on the side, IN an arm.

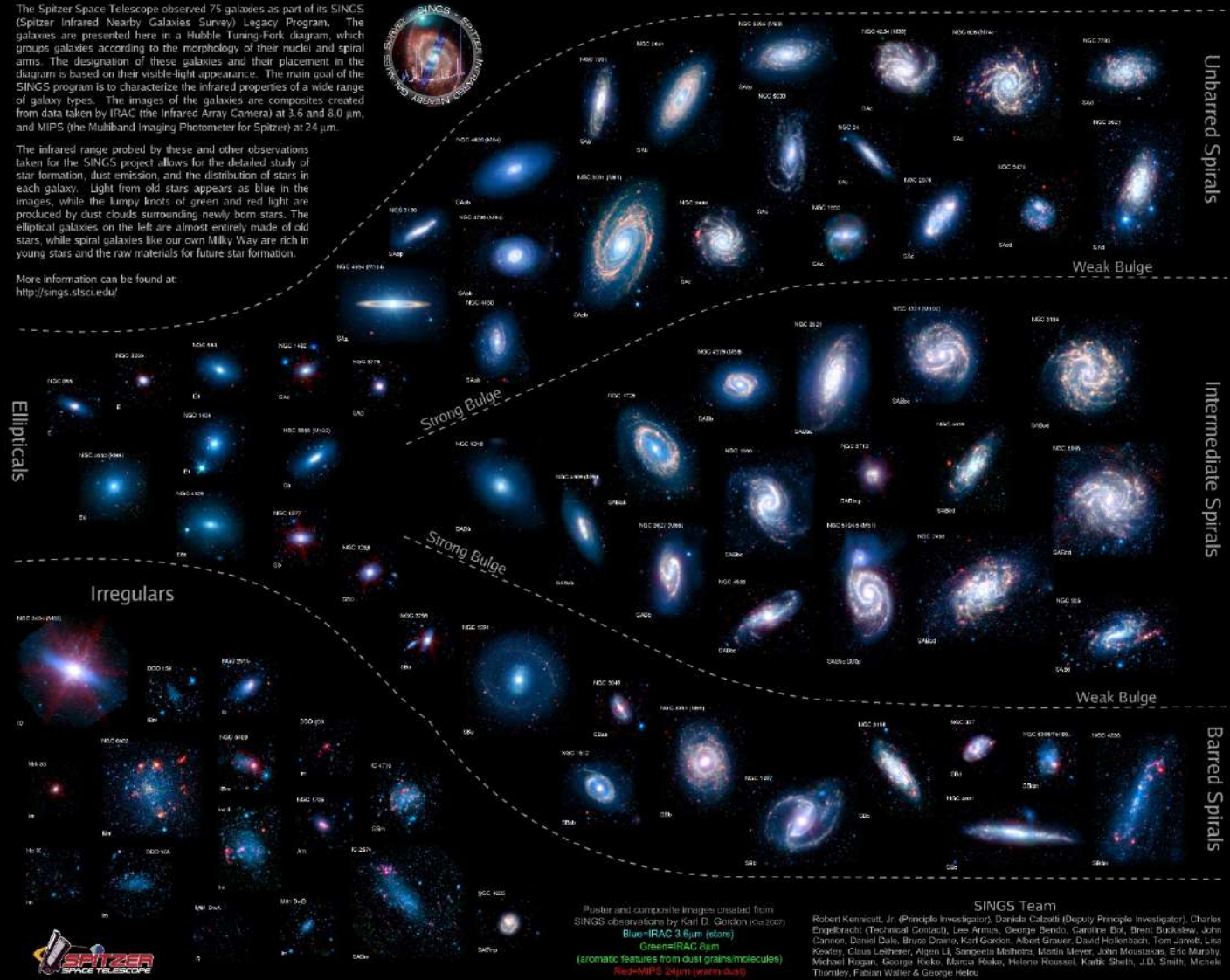
Other galaxies have different shapes:

The Spitzer Infrared Nearby Galaxies Survey (SINGS) Hubble Tuning-Fork

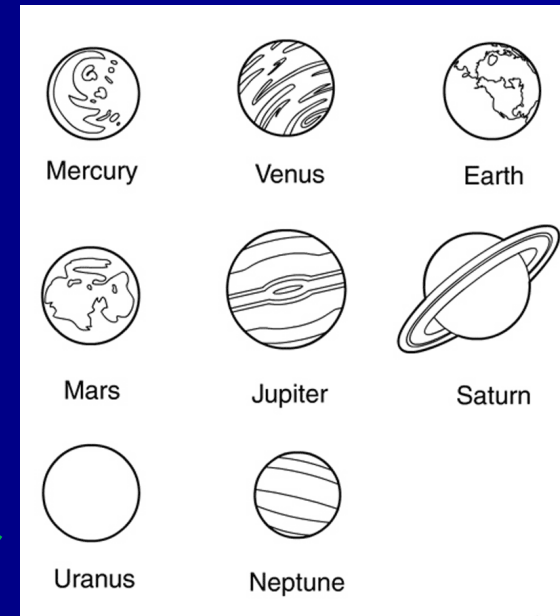
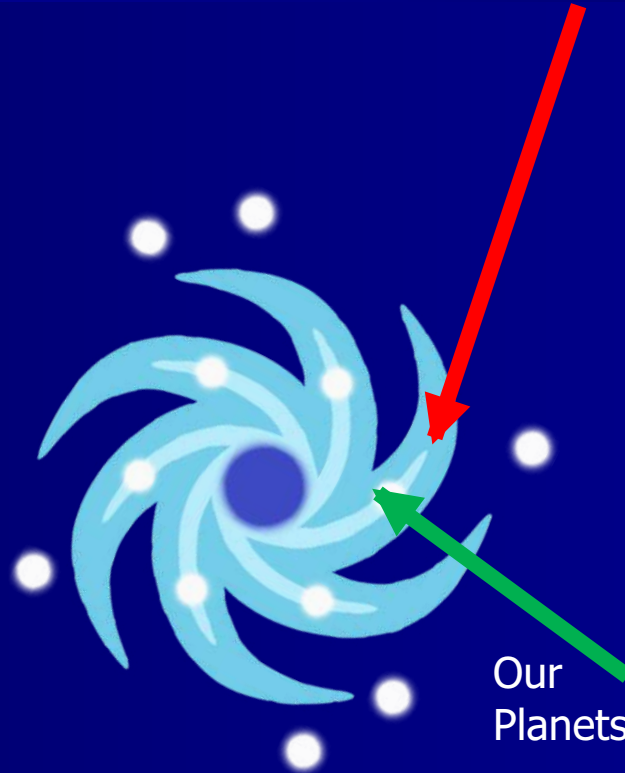
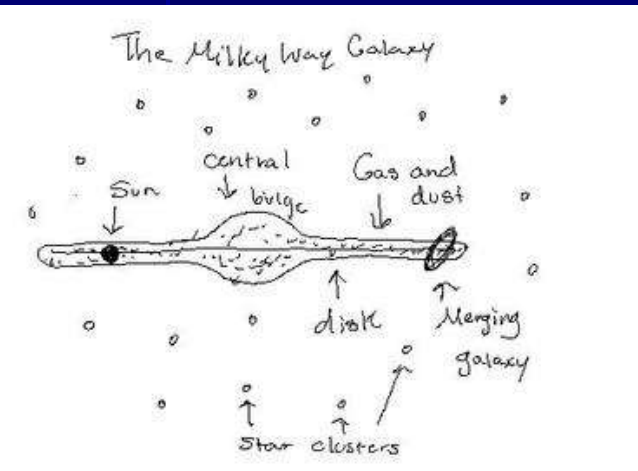
The Spitzer Space Telescope observed 75 galaxies as part of its SINGS (Spitzer Infrared Nearby Galaxies Survey) Legacy Program. The galaxies are presented here in a Hubble Tuning-Fork diagram, which groups galaxies according to the morphology of their nuclei and spiral arms. The designation of these galaxies and their placement in the diagram is based on their visible light appearance. The main goal of the SINGS program is to characterize the infrared properties of a wide range of galaxy types. The images of the galaxies are composites created from data taken by IRAC (the Infrared Array Camera) at 3.6 and 8.0 μm , and MIPS (the Multiband Imaging Photometer for Spitzer) at 24 μm .

The infrared range probed by these and other observations taken for the SINGS project allows for the detailed study of star formation, dust emission, and the distribution of stars in each galaxy. Light from old stars appears as blue in the images, while the lumpy knots of green and red light are produced by dust clouds surrounding newly born stars. The elliptical galaxies on the left are almost entirely made of old stars, while spiral galaxies like our own Milky Way are rich in young stars and the raw materials for future star formation.

More information can be found at:
<http://sings.stsci.edu/>

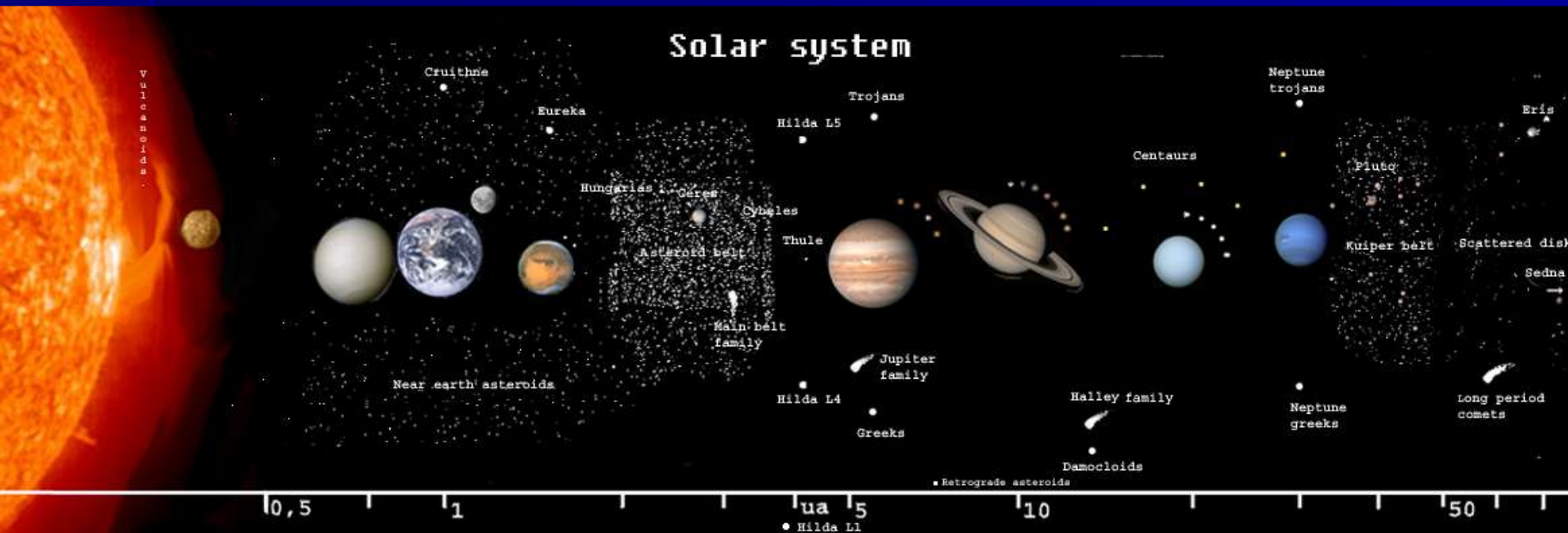


Our Solar System is on a side arm called ORION'S ARM

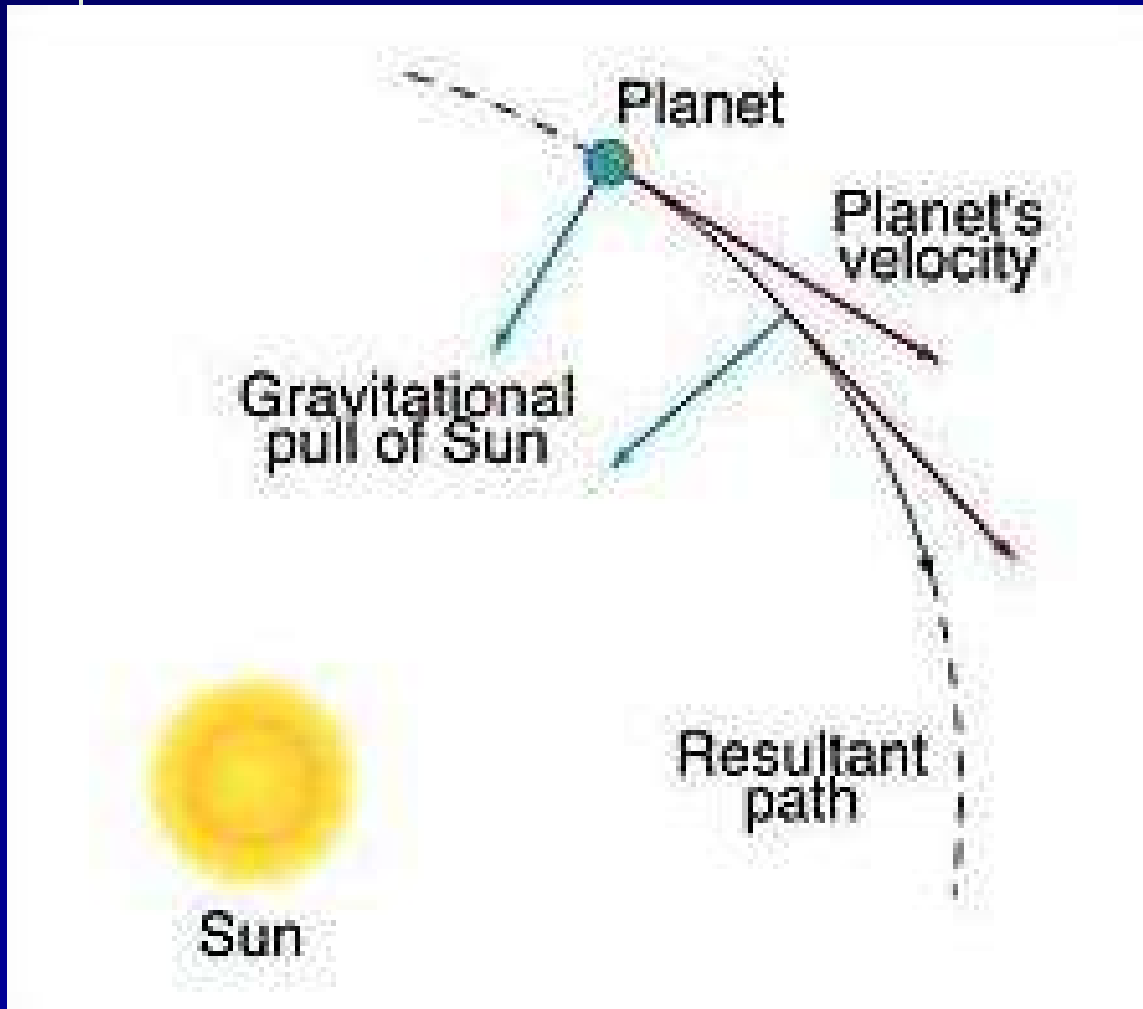


What is a Solar System?

The sun & the planets, asteroids, comets & meteors that revolve around it, held together by gravity.



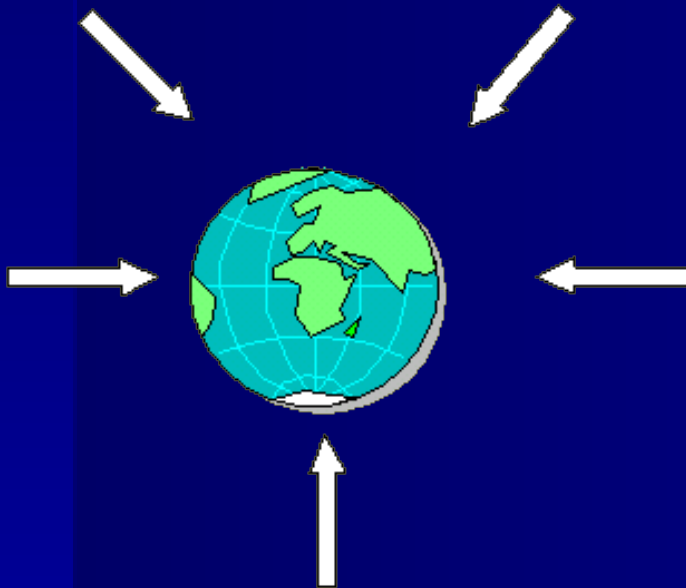
How do the planets stay in motion around the Sun?



Gravity
&
Inertia
exert
forces on
the
planets.

■ Gravity

Gravity attracts all objects toward each other, pulling planets toward the sun



■ Inertia

Inertia is a force that wants to push the planet away from the sun, stay moving straight out in space

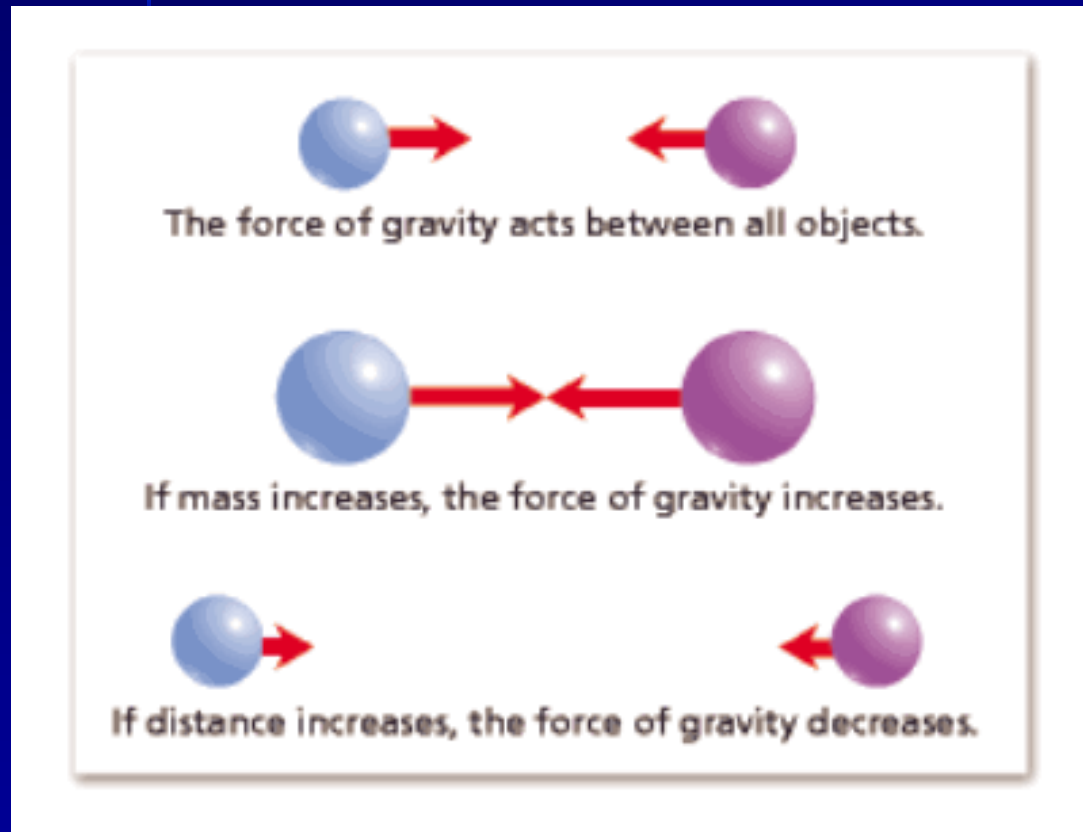


INERTIA

Your truck has brakes...the massive hunk of stone doesn't

CREATED BY HOMES

What determines the amount of gravity?



The size of an object and distance between objects determines the force of gravity

These are OUT OF ORDER...

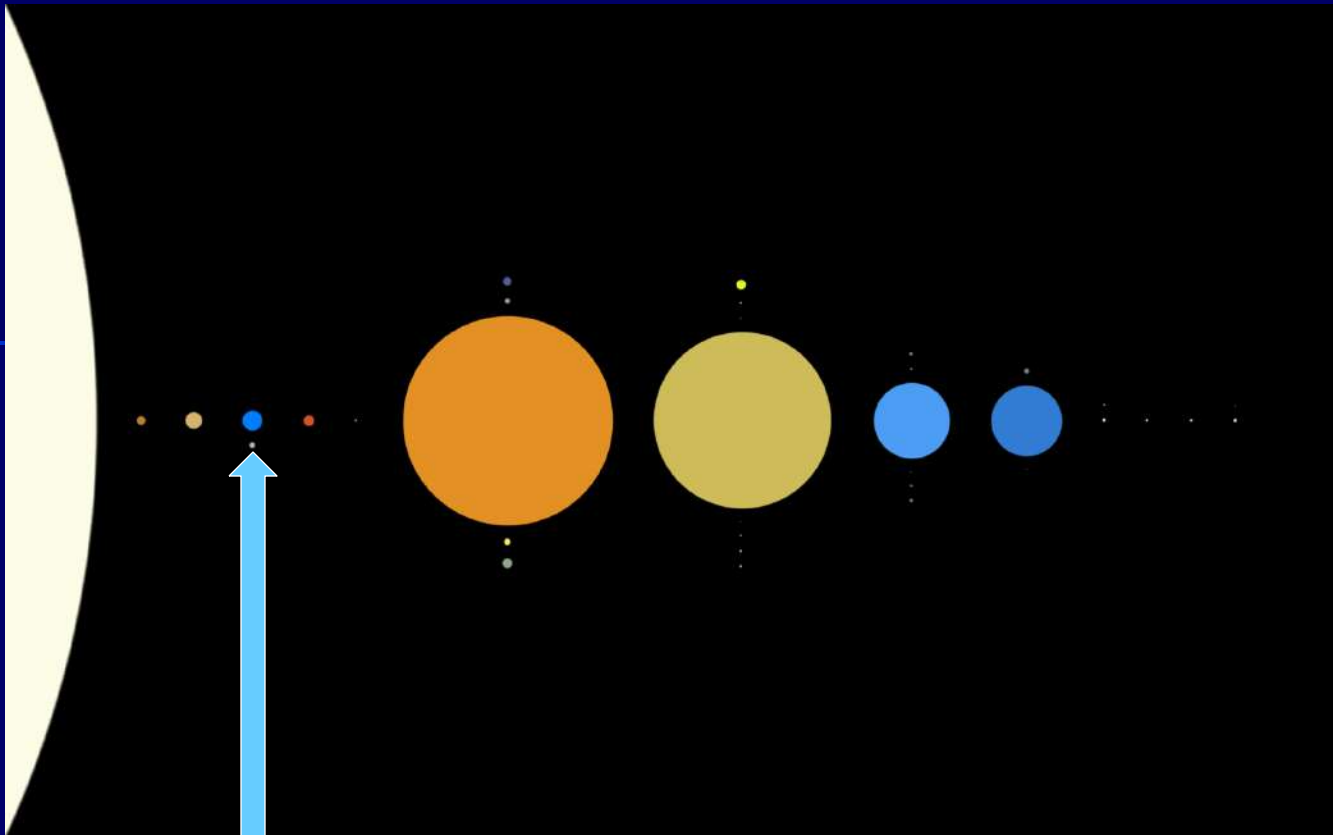
**Put them in the correct order
from 1-4 with (1) Largest to (4)
Smallest:**

- The Sun
- Our Solar System
- The Milky Way Galaxy
- The Universe

Correct Answers

(from largest to smallest):

1. The Universe
2. The Milky Way Galaxy
3. The Solar System
4. The Sun



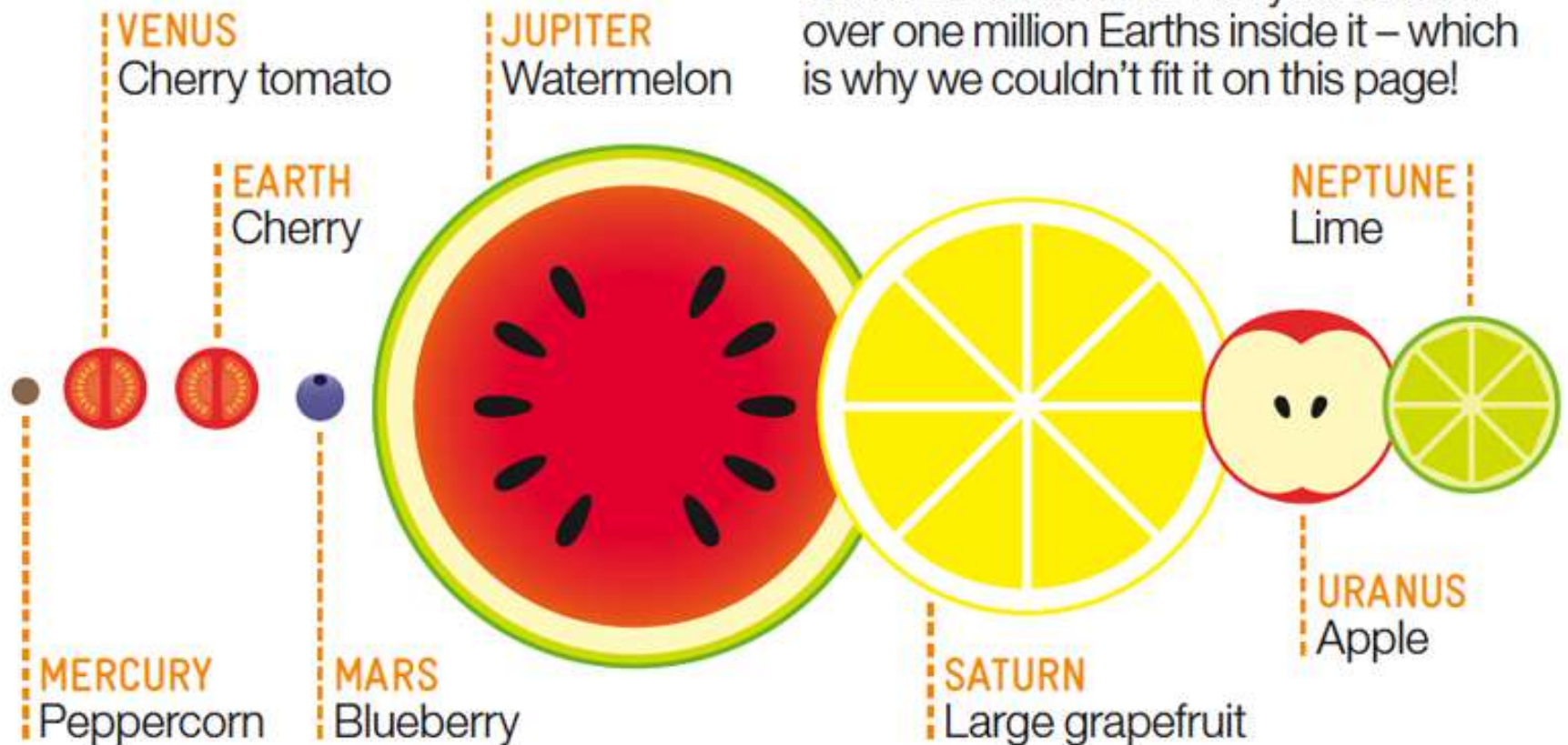
We are the 3rd planet
from the Sun!

Home Sweet Home!

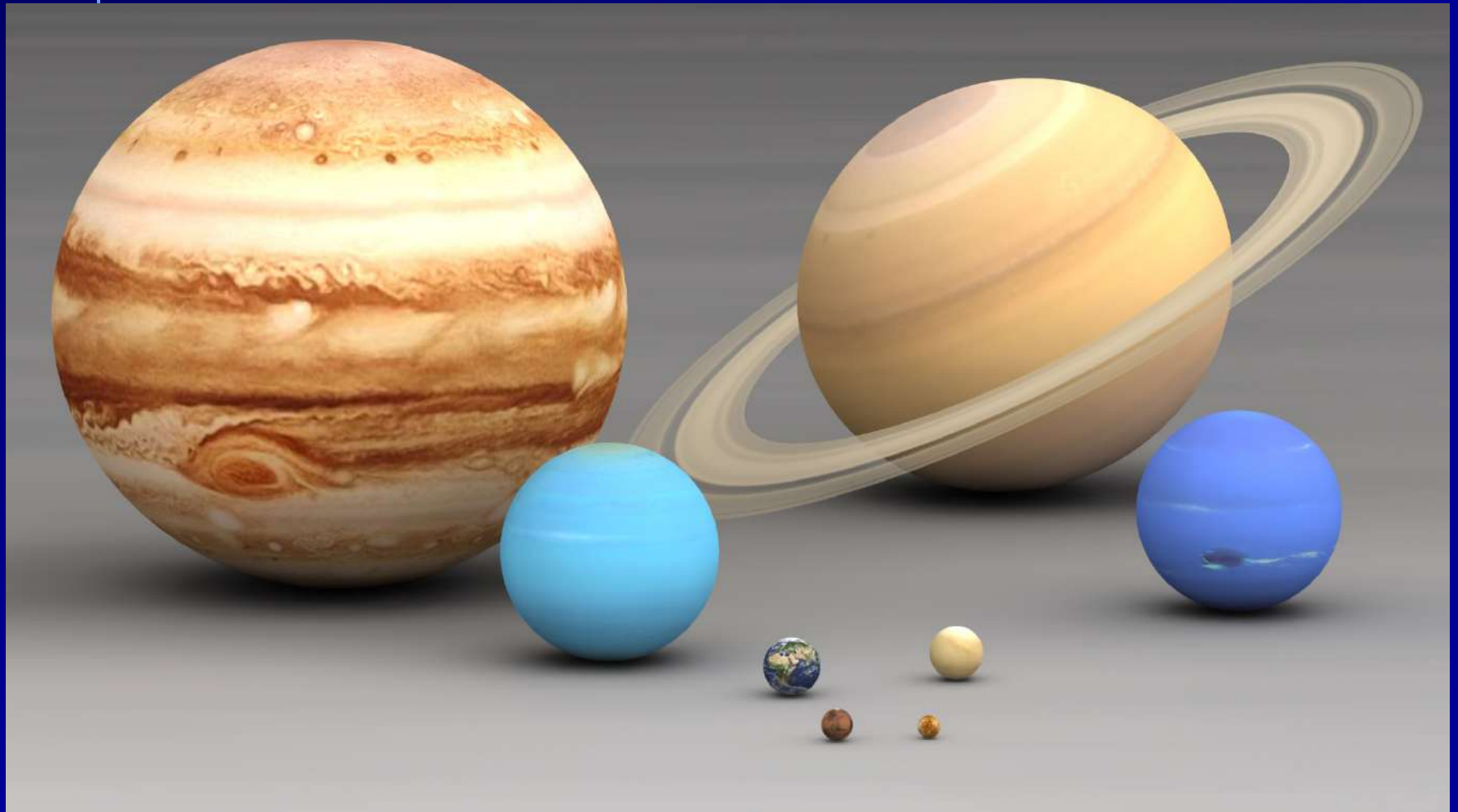
SPACE STATS!

HOW BIG ARE THE PLANETS?

Here are the relative sizes of the other planets in our Solar System if the Earth was the size of a cherry tomato! The Sun is so enormous that you could fit over one million Earths inside it – which is why we couldn't fit it on this page!



Comparing the sizes of the planets in our Solar System



We group the planets by location & characteristics:

■ Inner Planets

- Small
- Rocky
- Metal cores

Mercury, Venus,
Earth, Mars

■ Outer Planets

- Large
- Gas giants
- No solid surface

Jupiter, Saturn,
Uranus,
Neptune

- Avg. distance from Sun: $\sim 58,000,000$ km or 0.39 AU
- Mass: .055 x Earth's mass
- Diameter: $\sim 4,900$ km
- Rotation: 58.7 Earth days/1409 Earth hours
- Revolution: 88 Earth days
- Atmosphere: thin, H & He
- Temp.: -300°F to 800°F
- Surface: rocky, looks like our moon, craters, ancient lava flows, cliffs, fault lines
- Moons: 0 Rings: 0

Mercury

**Roman
Messenger
god**

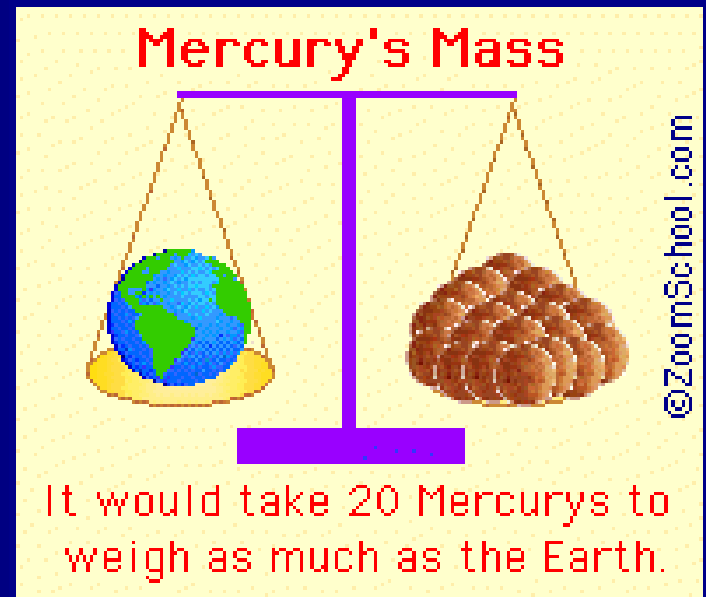
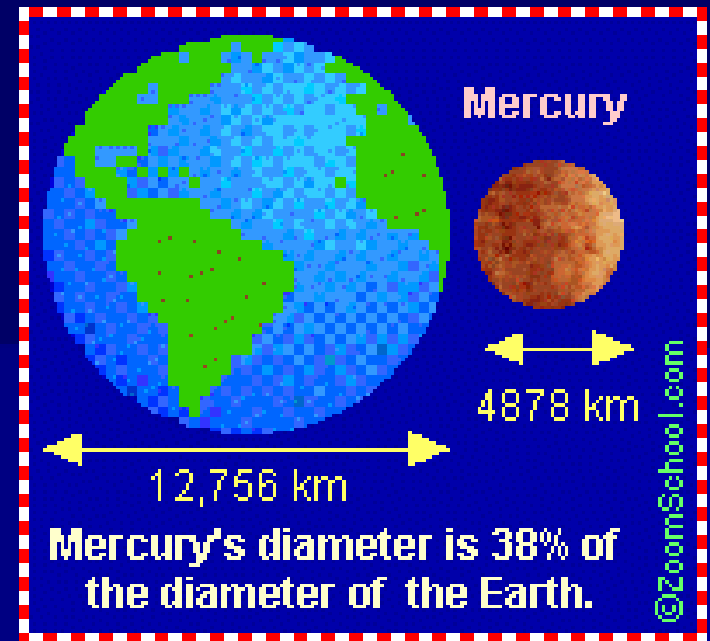
**naked eye
planet**



Taken by the probe Mariner 10

Mercury

- Closest to the Sun
- Smallest planet
- Almost no atmosphere
- Extreme low & high temps!
- Has no seasons...why?



- Avg. distance from Sun:
~108,000,000 km or 0.72 AU
- Mass: 0.815 x Earth's mass
- Diameter: ~12,000 km = "Earth's Twin"
- Rotation: 243 Earth days/5,832 Earth hours
 - Rotates backwards (retrograde)
- Revolution: ~225 Earth days
- Atmosphere Features: thick & toxic cloud coverage, CO₂, Sulfuric Acid, Nitrogen=intense **Greenhouse Effect!**
- Temp.: ~860° F = Hottest planet!
- Surface: rocks, volcanoes, mountains & valleys
- Moons: 0 Rings: 0

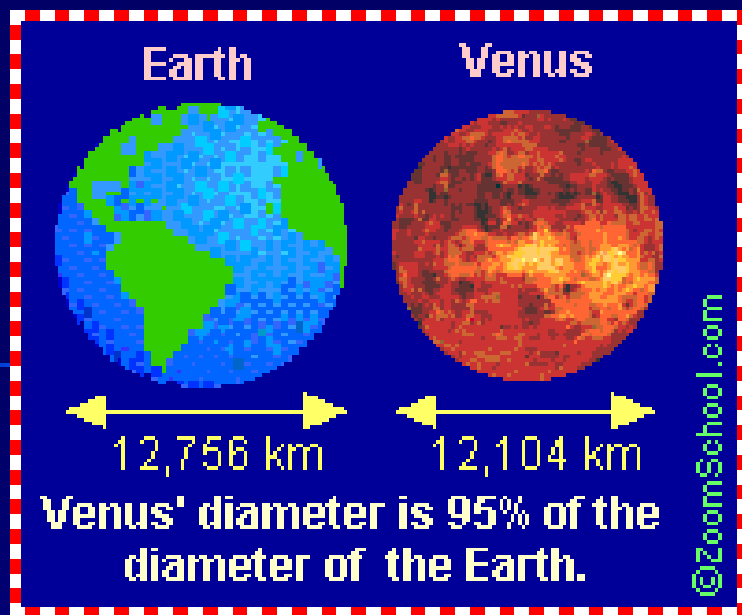
Venus

**Roman
goddess of
love**

**Naked eye
planet**

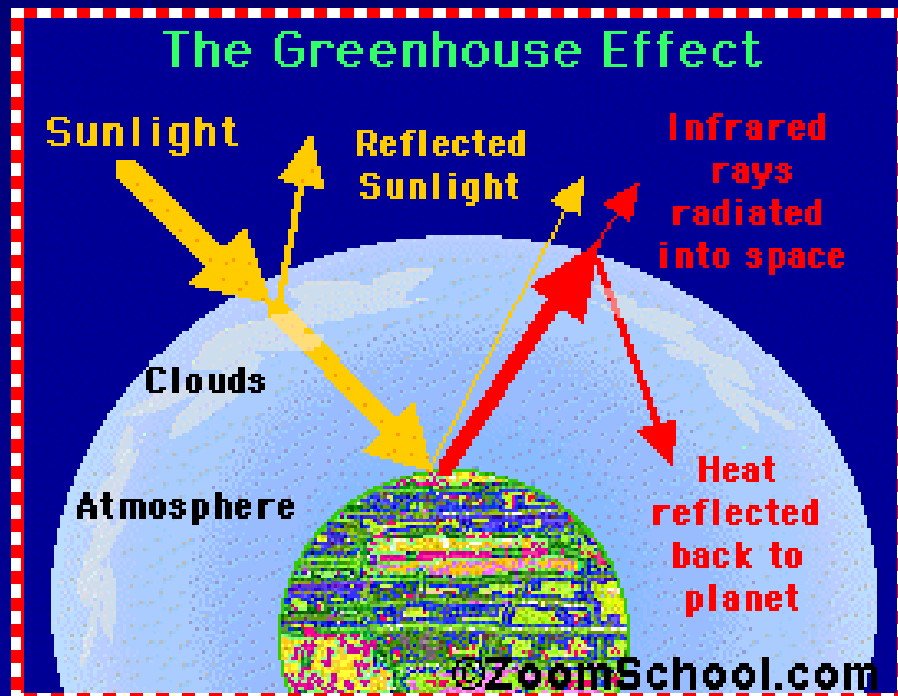


Taken by the probe Mariner 10



Venus

- 2nd planet
- Rotates clockwise
VERY SLOWLY
- **HOTTEST** planet
due to thick
atmosphere &
extreme
**GREENHOUSE
EFFECT!**



Avg. distance from Sun:
~150,000,000 km or 1 AU

Mass: 1 Earth mass =
5,973,700 x 10²¹ kg
Diameter: ~12,800 km

Rotation: 24 hrs = 1 day
Revolution: ~365 days = 1 year

Atmosphere Features:
78%N, 21%O, 1% trace gases
(CO₂, argon), only planet w/water
in all 3 forms, perfect conditions
for living things!
Temp: avg ~ 61°F

Surface: oceans, rivers & lakes,
mountains, glaciers

Moons: 1 Luna Rings: 0

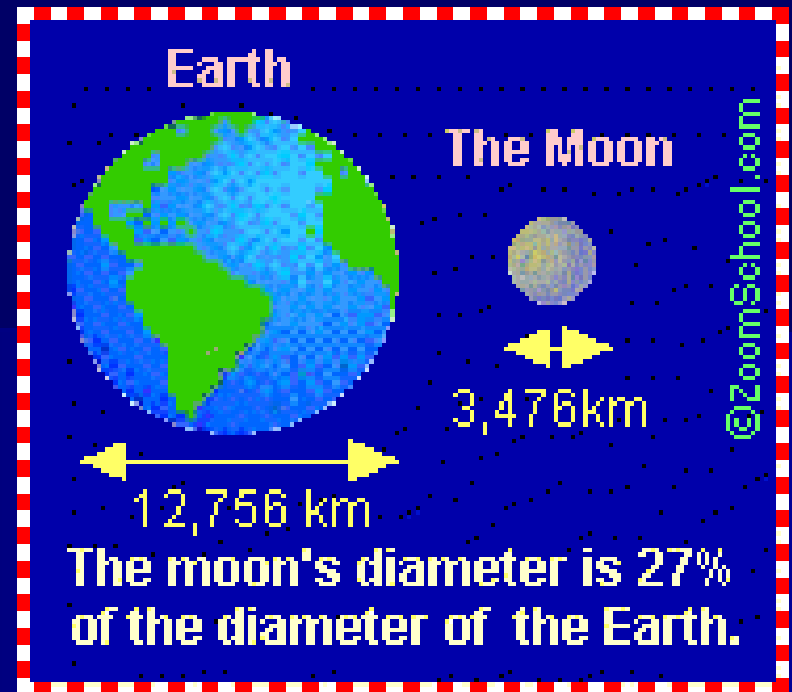
Earth

**named
from Old
English**



Earth

- 3rd planet
- Our Moon is about $\frac{1}{4}$ the size of Earth and may have broken off of Earth at some point
- Earth has 4 seasons due to the tilt on its axis



Mars

**Roman
god of
war**

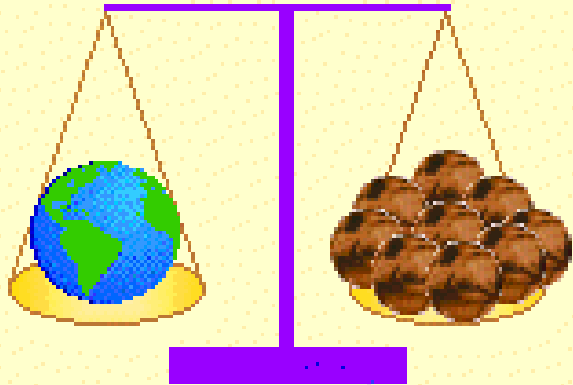
**naked
eye
planet**

- Avg. distance from Sun:
~228,000,000 km or 1.5 AU
- Mass: 0.107 x Earth's mass
- Diameter: ~6,800 km
- Rotation: 24.6 Earth hrs (almost the same as Earth)
- Revolution: ~687 Earth days
- Atmosphere Features: CO₂ & trace gases (N & Argon),
- Temp.: -195° F to 70° F
- Surface: polar ice caps, iron = "The Red Planet", dry river beds, largest volcano in the SS = Olympus Mons
- Moons: 2 Phobos and Deimos Rings: 0



Mars

Mars' Mass

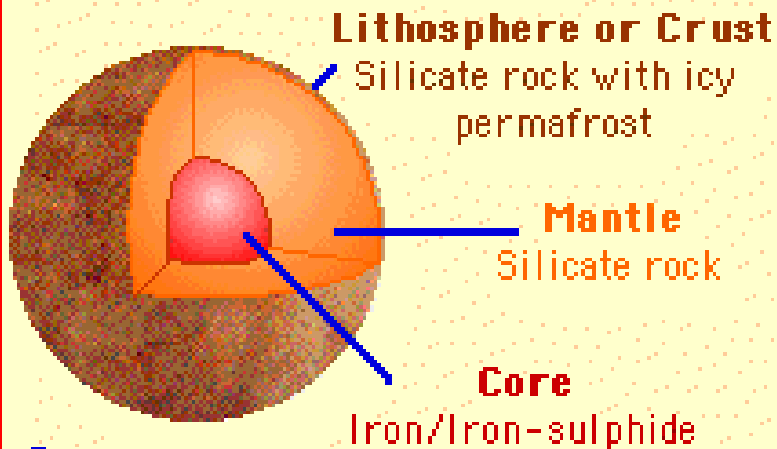


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Mars' mass is about 11% of the Earth's mass. It would take 9 Mars to equal the mass of the Earth.

- 4th planet
- 1/2 the size of Earth
- Mars is much colder than Earth

Inside Mars



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Jupiter

**King of the
Roman gods**

**naked eye
planet**

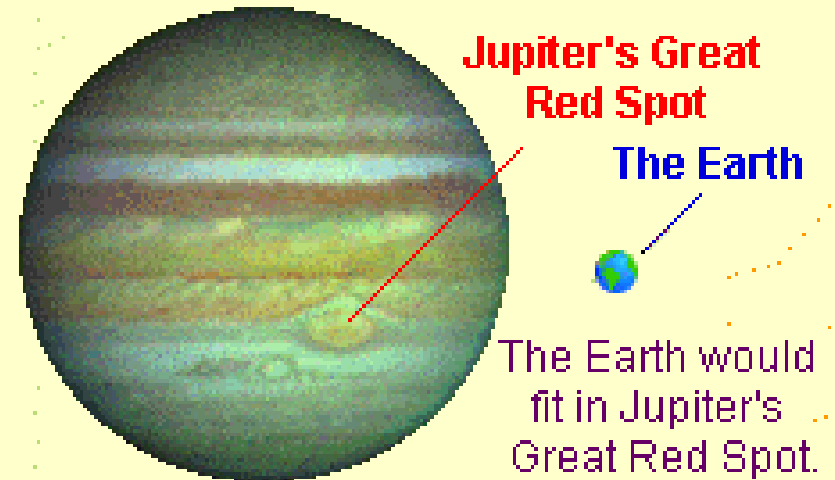
- Avg. distance from Sun:
~778,000,000 km or 5.2 AU
- Mass: 318 x Earth's mass
- Diameter: ~143,000 km
- Rotation (length of day): 9.8 Earth hrs
- Revolution (length of year): ~12 Earth years
- Atmosphere Features: H, He, clouds of frozen ammonia & water vapor
- Temp.: avg -166° F
- Moons: 67 (4 Galilean Moons are Io, Europa, Ganymede and Callisto)
- Rings: Yes



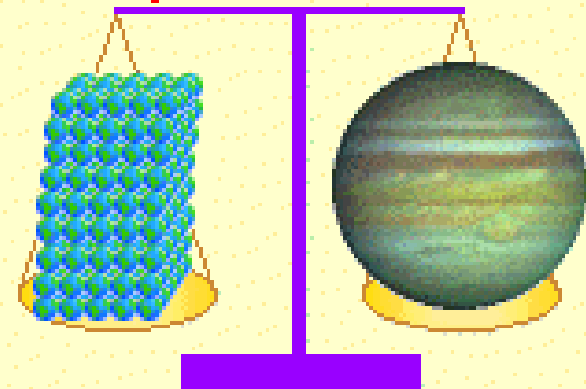
Jupiter

- 5th planet
- Largest GAS GIANT
- No seasons
- Faint, dark rings were discovered in 1980

Relative Sizes of Jupiter and the Earth



Jupiter's Mass



Jupiter's mass is 318 times of the Earth's mass. It would take over 318 Earths to equal the mass of Jupiter.

Avg. distance from Sun:
~1.4 billion km or 9.5 AU

Mass: 95 x Earth's mass
Diameter: ~121,000 km

Rotation (length of day): 10.2 Earth hrs
Revolution (length of year): ~29 Earth years

Atmosphere Features: NH₃, CH₄, H, He &
other toxic compounds
Temp.: -140° C (mean)

Moons: 62
Titan, Enceladus, Iapetus, and Mimas

Rings: Yes

Saturn

**Roman god
of
agriculture**

**naked eye
planet**



Taken by the probe Cassini

Saturn

- 6th planet
- 2nd largest GAS GIANT
- Wide & thin rings made of ice & rock
- Less dense than H₂O, would float in an extra large bathtub!



Saturn



Hubble
Heritage

- Avg. distance from Sun:
~2.9 billion km or 19.2 AU

- Mass: 14.4 x Earth's mass

- Diameter: 51,118 km

- Rotation (Length of day): 17.9 Earth hrs
 - Rotates on its side

- Revolution (Length of year): 84 Earth years

- Atmosphere Features: No real energy source – sun is too far away, H, He, Mixture of H₂O & CH₄

- Temp: - 195 °C

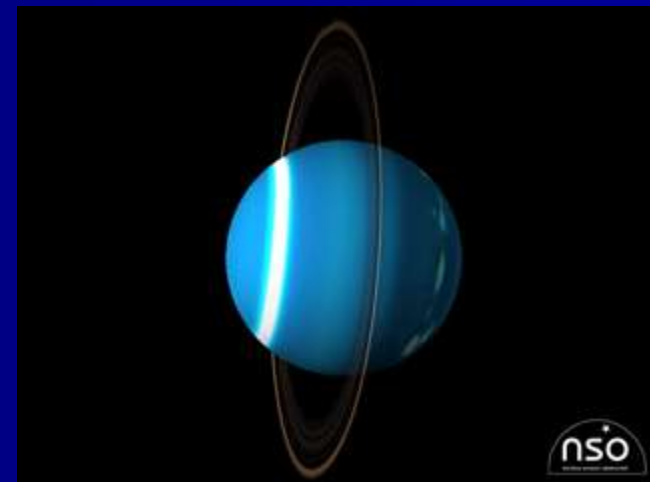
- Moons: 27 Titania is largest

- Rings: Yes

Uranus

**Greek sky
god**

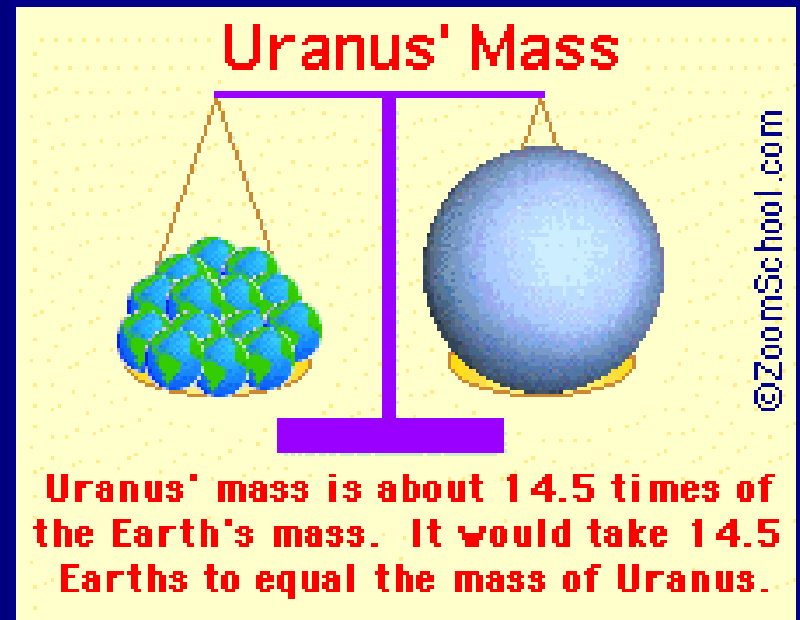
**Discovered
1781 by
Herschel**



Taken by the probe Voyager

Uranus

- 7th planet
- Icy gas giant
- Thinnest faint rings
- Because it rotates on its side, each season takes just over 21 years & there would 42 years of day & 42 years of night



- Avg. distance from Sun:

~4.5 billion km or 30.1 AU

- Mass: 17.1 x Earth's mass

- Diameter: ~49,000 km

- Length of day: 19.1 Earth hrs

- Length of year: ~165 Earth years

- Atmosphere Features: H, He, CH₄ (many clouds)

- Temp.: - 200° C

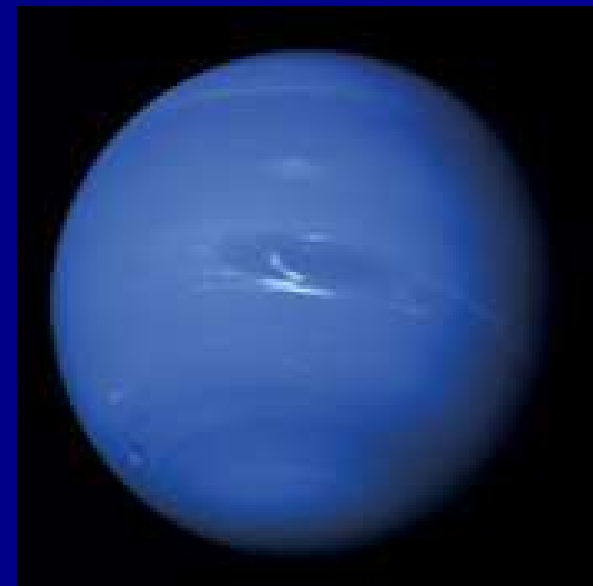
- Moons: 13 Triton is largest

- Rings: Yes

Neptune

**Roman god of
the sea**

**Discovered by
Galle in 1846**



Taken by the probe Voyager

Neptune



- 8th planet
- Frigid, gas giant
- Has rings that clump together
- Each season lasts 40 years!



Use your planet comparison table to answer these questions:

1. Which planet is hottest?
2. Which planet's surface is red from oxidation?
3. Which planet is known as "Earth's twin"?
4. Which planet's revolution period (year) is approx. 12 x Earth's revolution period (year)?
5. Which planet is approx. $\frac{1}{2}$ the size of Earth?
6. Which planet rotates backwards?
7. Which planet resembles our moon?
8. Which planets have rings?
9. Which planets are rocky?

- 10. Which planet has the fastest day?**
- 11. Which planet has the slowest day?**
- 12. Which planet has the largest volcano in the solar system?**
- 13. Which planet has water in all 3 forms?**
- 14. Which planets are about the same size? (2 pairs!)**
- 15. Which planet has a giant red storm?**
- 16. Which planet would float in water?**
- 17. Put the planets in the correct order from longest to shortest rotation period.**