



Topic/Objective CHAPTER:

NAME:

Venus

DATE

WHO is the goddess of Love

Astronomy 101

Essential Question

Did you know that our Sister (planet) is a real hottie, and a mess?

Cue: Review:
Thoughts: Main
Idea

Venus

NOTE Taking AREA:

2nd planet from the Sun and named after the Roman goddess of love and beauty. The mother to Mercury

Often know as our Sister planet because its similar in SIZE, DENSITY, Composition, & Gravity.... But that is where is stops

After the Sun & Moon, it is the *brightest natural object in the night sky and often called a morning or evening star.*

Its brightest reaching an **apparent magnitude of **-4.6****

Bright enough to cast shadows. It is *often been mistaken as an U.F.O.*

apparent magnitude: the magnitude of a celestial object as it is actually measured from the earth.

absolute magnitude: the magnitude (brightness) of a celestial object as it would be seen at a standard distance of 10 parsecs.

Parsecs: a unit of distance used in astronomy, equal to about 3.26 light years (3.086×10^{13} kilometers).

light years: a unit of astronomical distance equivalent to the distance that light travels in one year, which is 9.4607×10^{12} km (nearly 6 trillion miles).


Speed of light (in a vacuum) is **186,282 miles per second (299,792 kilometers per second)**, and in theory nothing can travel faster than light. In miles per hour, light speed is, well, a lot: about 670,616,629 mph. If you could travel at the speed of light, you could go around the Earth 7.5 times in one second.

Because Venus is an inferior planet from Earth, it never appears to venture far from the Sun $\sim 45^\circ$:

Its elongation reaches a *maximum of 47.8^\circ*

Venus is only 7,926 miles diameter ((0.95% of size of Earth)

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NOTE Taking AREA

0.723 A.U. from the Sun. That's 67.2 million miles away from the sun ⊕

Venus lacks a magnetic field, due to slow rotation and so it has NO protection from the solar wind.
 solar wind: the continuous flow of charged particles (ions) from the sun that permeates the solar system

Currently it has no natural satellites (moons)

Venus appears as a white disk & goes through phases.

Conditions on the Venusians' surface differ from those on Venus' atmosphere is a dense carbon dioxide atmosphere is 96.5% carbon dioxide Remaining 3.5% being nitrogen.

Much of the Venusians' surface appears to have *been shaped by volcanic activity* but there is no evidence of Tectonic activity
 Venus has several times as many volcanoes (100,000) as Earth
It has 167 large volcanoes that are over 100 km across.
 This is not because Venus is more volcanically active than Earth, but because its crust is older.
 Earth's oceanic crust is continually recycled by subduction at the boundaries of tectonic plates, and has an average age of about 100 million years, whereas the Venusian surface is estimated to be 300–600 million years old.

Project Magellan in 1990–91 made a detail map of the planet. The ground shows evidence of extensive volcanism, and the sulfur in the atmosphere may indicate there have been some recent eruptions.

**About 80% of the Venusian surface is covered by smooth, volcanic plains
 70% plains with wrinkle ridges
 10% smooth or lobate plains.**

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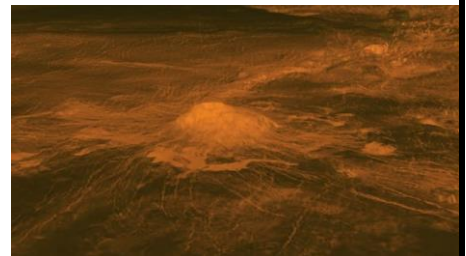
What is Venus surface really like?

Cue: Review:
Thoughts: Main
Idea


NOTE Taking AREA:

Two highland "continents" make up the rest of its surface area

- 1) **lying in the planet's northern hemisphere**
 - a) **The northern continent is called Ishtar Terra**
 - i) **after Ishtar, the Babylonian goddess of love**
 - ii) **about the size of Australia**
 - b) **Maxwell Montes, the highest mountain on Venus, lies on Ishtar Terra**
 - i) **Its peak is 11 km above the Venusian average surface elevation.**
 - ii) **Volcanic activity on Venus took place in the recent past, geologically speaking, and may still be happening on the planet today. New research takes a deeper look at one recent eruption on Venus' surface.**
 - c) **The Idunn Mons volcano in the southwestern hemisphere of Venus**
 - (i) **Rises 1.6 miles (2.5 kilometers**
 - (ii) **In 2010, revealed that Idunn Mons is a "hotspot,"**
 - 1. **Meaning it radiates high levels of infrared light compared to the surrounding area.**
 - 2. **That suggests that lava flowed at the spot recently, and that the area is still warm.**
 - d) **Huge volcanoes bubbles called Pancake Domes are located on the surface. Magma reaches the surface since the volcano doesn't "move" (lack of tectonic activity) for over 1000 years, it forms them**
 - e) **All surface features on Venus are named after women**



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Cue: Review:	<p>NOTE Taking AREA:</p> <p>2) and the other just south of the equator.</p> <ul style="list-style-type: none"> a) The southern continent is called Aphrodite Terra <ul style="list-style-type: none"> i) after the Greek goddess of love ii) The larger of the two highland regions at roughly the size of South America. <p>A network of fractures and faults covers much of this area Several lines of evidence point to ongoing volcanic activity on Venus.</p> <p>Due to the volcanic activity, the surface of Venus is often said to resemble traditional accounts of Hell. (Our Twin Sister Planet who's a hottie!)</p> <p>Surface temperatures of at least 735 K (460 °C). (860°F). This makes the <i>Venusian surface hotter than Mercury's</i></p> <ul style="list-style-type: none"> • minimum surface temperature of 55 K (-220 °C) • maximum surface temperature of 695 K (420 °C) <p>even though Venus is nearly twice Mercury's distance from the Sun and thus receives only</p> <ul style="list-style-type: none"> ○ 25% of Mercury's solar irradiance. <p>This temperature is higher than that used for sterilization and hot enough to melt Lead.</p> <p>The CO₂-rich atmosphere & thick clouds of sulfur dioxide, generates the strongest <u>runaway greenhouse effect</u> in the Solar System Greenhouse effect main ingredient CO₂ & H₂O vapor Venus has more acid per cm³ that a car battery. Meteors are often disintegrated before reaching the surface. Clouds reflect most of the sunlight into space, but a runaway greenhouse effect is when there is enough of a greenhouse gas in a planet's atmosphere such that the gas blocks thermal radiation from the planet, preventing the planet from cooling and from having liquid water on its surface.</p> <p>Tilt of 3° which does not have seasons</p>
Thoughts: Main Idea	

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Why Venus Spins backwards

Cue: Review:
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Revolution takes 224.68 days Rotation is 243 days (very slowly)
Thus, a year on Venus is shorter than a day on Venus.

This also means the planet spins slowly (rotates) backwards (retrograde) or clockwise. At the equator you can jog faster than it rotates.

Not only the Sun rises in the WEST, makes the planet more spherical

BUT WHY?

One of the earliest hypotheses was:

Venus may have been hit so hard by an asteroid that it reversed direction. The hypothesis seems to have been thrown out there in 1965 by two scientists who worked with the original radar data. They followed up the suggestion by saying: "The possibilities are limited mainly by one's imagination; supporting evidence is rather harder to come by." Which is super convincing. But when the mathematic is applied to the problem, the idea kind of falls apart. It turns out that anything big enough to reverse Venus's rotation would also destroy the planet. The impactor's kinetic energy would be some 10,000 times too high. So, the impact idea was pretty much shelved.


Another, first suggested in 1964,

Venus may have gradually slowed down and then reversed direction. This could've been triggered by a few things, including interactions with the Sun's magnetic field, or those atmospheric tides, or a combination of both. Venus's atmosphere would have been the first part of the planet to start rotating retrograde after that spin-down. Then, that may have provided the rest of the force necessary to get the whole planet going backward. As a bonus, this idea would also explain why Venus's days are so long.

It was replaced by a few actual evidence-based hypotheses.

One of the leading ones, proposed around 1970, is that Venus spins the same way it always has. Just at some point its life got flipped, turned upside down! This could've happened because of processes within Venus's interior and atmosphere. Venus is differentiated, meaning that it has layers like the Earth does: a core, a mantle, and a crust.

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As the planet rotates, the core and mantle can experience friction where they meet. Venus also has a thick atmosphere, which, thanks to the Sun's gravity and heat, experiences tides along with the rest of the planet.

This hypothesis says that the core-mantle friction and those atmospheric tides could both put some torque on the planet, and that instability could've flipped Venus over. Some models suggest this might work only if Venus formed with an initial tilt of about 90 degrees, but others show that it might work with less initial tilt.

But there's no clear winner between these two hypotheses yet.

A 2001 paper published in Nature, the axis-flip mechanism is most likely if Venus had a rapid initial rotation rate, small tilt, like less than 70 degrees, then slowing down and reversing is the most probable mechanism. Unfortunately, it's kind of hard to get evidence about Venus from four billion years ago.

The 1960s impact hypothesis is making a comeback. Or at least, a version of it. In 2008, one researcher suggested that Venus may have gotten its weird spin back when it was a wee little planetesimal.

They argue that, billions of years ago, another object about the same size slammed into it and sent it spinning like a backward top. But instead of destroying baby Venus, those two pieces came together to form a full-sized planet. Unlike in the '60s, there's actually some potential evidence for this now. Based on Venus's topography, we don't think there's a lot of water in the planet's interior compared with Earth's. And a huge impact could have provided the energy to get rid of it. This hypothesis would explain why Venus is so dry, but there are other competing models, too. Like, it's possible Venus lost its water through evaporation instead.

During the Soviet Venera program

Venera 11

Detected a constant stream of lightning

Venera 12

Descent probe recorded a powerful clap of thunder soon after it landed

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 Why is our sister so messed up?

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The European Space Agency's Venus Express recorded abundant lightning in the high atmosphere

Although rainfall drives thunderstorms on Earth, there is no rainfall on the surface of Venus... sort of...

Though sulfuric acid rain falls in the upper atmosphere, and then evaporates around 25 km (15.5 miles above the surface).

- 1) One possibility is that ash from a volcanic eruption was generating the lightning.
 - a. Cloud to cloud lightning
 - b. Ave bolt is 100,000°F (Earth 50,000°F)
- 2) Another piece of evidence comes from measurements of sulfur dioxide concentrations in the atmosphere, which dropped by a factor of 10 between 1978 and 1986, jumped in 2006, and again declined 10-fold.
 - a. This may mean that levels had been boosted several times by large volcanic eruptions
- 3) *There might be "SNOW" on the hottest planet*
 - a. If this shiny soil on the tops of mountains would be "snow" then it snows metal.
 - i. Bismuthinite (Bi₂S₃)
 - ii. Galena (PbS)

Venus has an extremely dense atmosphere, which consists mainly of carbon dioxide and a small amount of nitrogen.

The atmospheric mass is 93 times that of Earth's


This creates an eerie shadow on the ground and an evening sky appearance (twilight) atmosphere.

If present, microbes could explain evolving patterns in the planet's atmosphere when observed in ultraviolet light. Then these familiar locations frequently pop up in discussions about life in the solar system like on Mars, Europa, & Titan.

But what about the search for life on planetary neighbors closer to the Sun?

A recent study suggested that clouds in Venus's lower atmospheric layer might have the right conditions to support microorganisms.

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Furthermore, the existence of microbial life at those altitudes could help explain anomalous atmospheric patterns that scientists over the past century have seen in ultraviolet images of Venus.

But Venus's lower atmosphere, 47.5–50.5 kilometers above the surface, checks all the habitable boxes: *Pressures and temperatures at those altitudes are mild, 0.4–2 atmospheres and 0°C–60°C, respectively.*

The planet may have sustained liquid surface water for as long as 2 billion years, which is now present as water vapor in the atmosphere. Carbon dioxide, sulfuric acid compounds, and ultraviolet (UV) light would give microbes food and energy.

Moreover, the researchers noted, bacteria, mold spores, pollen, and algae have been discovered in Earth's atmosphere as high as 15 kilometers. These microorganisms likely reached such heights through evaporation, storms, eruptions, or meteor impacts: all processes that may have occurred on Venus, they said.

Planet's surface is about 92 times that at Earth's surface—a pressure equivalent to that at a depth of nearly 1 kilometer under Earth's oceans. The density at the surface is 65 kg/m³, 6.5% that of water or 50 times as dense as Earth's atmosphere at 20°C at sea level.

The surface of Venus is often said to resemble traditional accounts of Hell. But is Venus trying to cool down?

Diagram to the right is Polar Vortices On Venus – YouTube youtube.com

Venus has 2 vortices (whirlwinds) large long-lived pairs of inverted anticyclones, one near each pole (polar vortices), *discovered in 2006* by Venus Express probe.

Venus's southern pole vortex is the size of Europe and starts at the lower clouds of its atmosphere (42 kilometers from the surface) to the upper clouds of the atmosphere (63 kilometers from the surface).

The vortex's elements are constantly being broken apart and coming back together as the vortex circles every 2.2 days. "The vortex is never destroyed, but it evolves continuously between shapes. Two centers of rotation of the 12-mile-high (20 kilometers) storm, which exist at different altitudes, rarely ever line up.

Once in a while we can observe Venus what appears to be moving across the surface of the sun. This is called a *Transit*

They occur in pairs for 8 years but then do not happen again for a Century

Last one was in 2004, 2012 with the next one in 2117



SUMMARY: