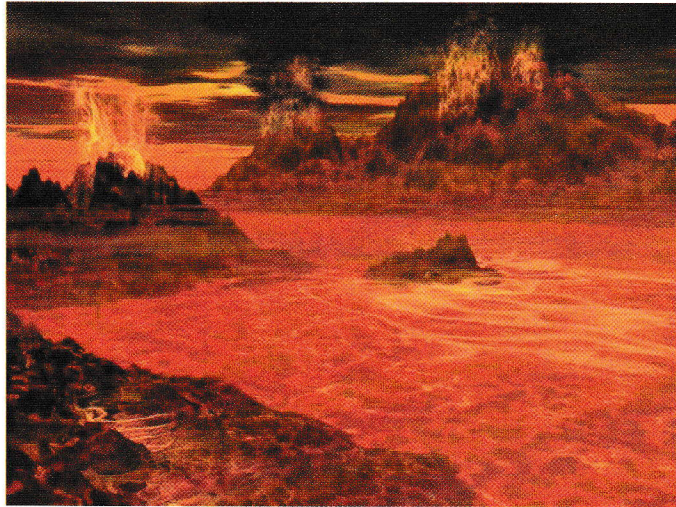


# Venus

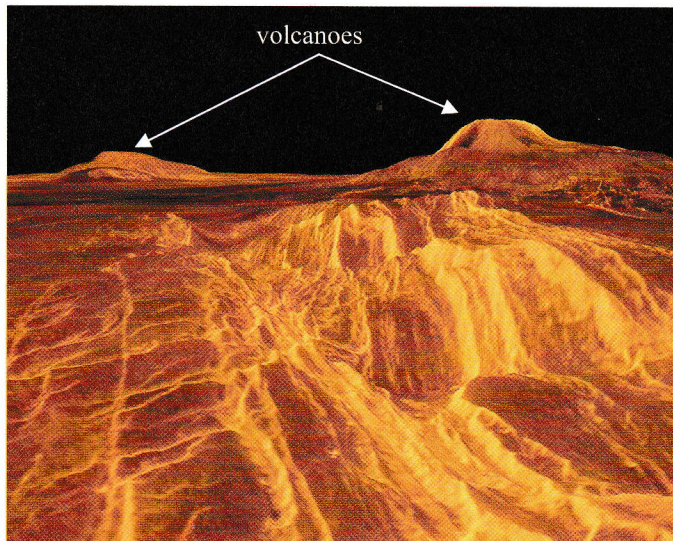
Hot! Hot! Hot! The hottest planet in the whole solar system is not the planet closest to the sun. It's the one that is second closest. Venus is burning hot and stays hot all day and all night. It is about 870 degrees on Venus. There isn't another planet as hot. It also has lots of volcanoes that spew lava onto its surface. Do you know what lava is? It is rock that is so hot it has melted, like butter melts in a pot on a stove. Lava, however, is much, much hotter than that. It is so hot it would melt the pot holding the butter, turning the pot into liquid! Lava comes out of a volcano when it erupts. When it is inside a volcano, this lava is called "molten rock" (which means "melted rock"). When it comes up to the surface and pours out of the volcano, it is then called lava.



This is an artist's idea of what active volcanoes on Venus might look like. The red liquid in the picture is lava.

*Digital artwork by Dr. David Heatley*

Venus has thousands of volcanoes all over it. They blow up every now and then, spouting and spraying hot, fiery lava all over the place. Many of the parts of Venus that are not covered with hot



This is an image of part of the surface of Venus. There are two volcanoes in the background, and the lighter-colored rocks are rocks that were once lava but have since cooled to form hard rocks.

lava are covered with places where lava once flowed and then cooled down enough to turn into hard rocks. Even though these hard rocks are no longer lava, they are still very hot, because everything on Venus is hot. Venus's whole surface is affected by these volcanic eruptions. When a volcano erupts here on earth, it wipes out every living thing it touches. Every tree, house, plant or animal that it touches becomes nothing but ash when the lava dries. When a volcano erupts, for years afterward, people are still trying to clean up all the ash that blows around the area.

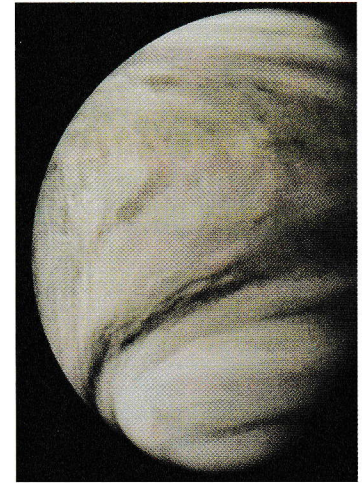
Do you have a fireplace? If you have real logs in your fireplace, you have seen the

ashes that are left when they have burned up. Venus probably doesn't have ashes all over it, because there is nothing living on Venus, so there is nothing to burn up and turn into ash.



## Too Much Atmosphere

You might be wondering why Venus is hotter than Mercury, which is right next to the sun. There is a very good reason. Do you remember what the word “atmosphere” means? The atmosphere is made up of all the gases that surround a planet. Venus has a very heavy atmosphere, with thick, heavy clouds swirling around it. These clouds and the atmosphere trap the heat that comes from the sun, and the heat cannot escape Venus and go out into space. As a result, the sun’s heat comes in, but it doesn’t go out very easily. This keeps Venus very hot. The clouds on Venus are made of different stuff from the clouds on earth. They are heat-trapping clouds made of sulfuric (suhl fyur’ ik) acid. Sulfuric acid is not good to breathe.



This is a picture of the clouds that constantly surround Venus.

When your mother is trying to make water boil in a pan on the stove, it will boil faster if she puts a lid on the pot. The lid keeps the heat from escaping, trapping it inside the pot. This makes it hotter and hotter inside the pot so that the water will boil more quickly. The clouds on Venus are similar to the lid on the pot; they surround the planet, keeping the heat from escaping into space.

The clouds and atmosphere that trap heat on Venus are always moving across the planet. They move quickly and are always circling the planet, heating up everything they pass over. So, the side of Venus that faces away from the sun isn’t cooler than the side that faces the sun. Remember, this is not what it’s like on Mercury. On Mercury, the side of the planet that faces away from the sun gets very cold, because there is no atmosphere and no clouds to keep it warm. On Venus, the side that faces away from the sun is kept warm by the atmosphere and clouds, so it never has a chance to cool off. Because of this, it’s just as hot at night on Venus as it is during the day.

## Rotation and Revolution

Venus rotates slowly. Do you remember what rotate means? It is the circular movement that makes a planet face the sun and then turn away from it, changing day into night. Venus rotates even more slowly than Mercury. It takes 243 earth days for Venus to make a full turn. Because of this, daytime on Venus lasts just over 121 earth days, and nighttime lasts just over 121 earth days.

Another funny thing about Venus is that it rotates in the opposite direction as compared to the earth. On the earth, when we see the sun come up early in the morning, we know we are looking east, because the sun always rises in the east. When we see the sun going down, we are looking west,



because the sun sets in the west. But on Venus, the sun rises in the west and sets in the east! Remember, the reason the sun seems to rise and set is that the planet is rotating. The sun is not actually moving in the sky, the part of the planet you are on is just turning towards and then away from the sun. Since Venus rotates opposite of earth, the sunrise and sunset are opposite as well.



On earth, the sun sets in the west. Because Venus rotates opposite the direction earth rotates, the sun sets in the east on Venus.

*Photo by Mark Whitney*

This is more important than most people realize. You see, some scientists think the universe began by a big accident in space. The way they describe this accident is that all the planets just formed out of a huge explosion (they call it the “big bang”) that sent particles into space. Those particles then eventually formed stars and the planets that orbit around the stars. Well, if this were so, all the planets would have been formed spinning in the same direction. Venus’s rotation is strong evidence that this did not happen. Venus spins in the opposite direction of most planets, so it is hard to understand how it could form from the same bits of dust that some people think all things came from. Try to remember that when someone tells you they believe that everything began as a big accident in space.

Believe it or not, a year on Venus is shorter than a day on Venus! This means that Venus orbits around the sun faster than it rotates! You see, it takes Venus only 225 earth days to orbit around the sun, but it takes 243 earth days for Venus to make a complete rotation. If you were on Venus, then, by the time day turned into night and back into day again, *more than a year* would have passed! This is not true for any other planet.

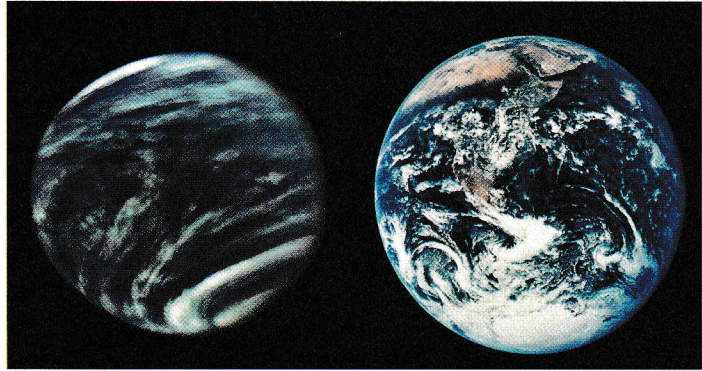
Now I want you to think back to how long a year is on Mercury. Look in your notebook and see if you can find out how many earth days it takes Mercury to make one orbit around the sun. Now compare that to the length of a year on Venus. Which is longer? A year on Venus is longer than a year on Mercury. It turns out that the farther a planet is from the sun, the slower it travels around the sun. Because of this, the farther a planet is from the sun, the longer its year will be. Since Mercury is closest to the sun, its year is very short. Can you guess which planet has the longest year? Think back to what you learned in Lesson 1. Which planet is farthest from the sun? The answer is Pluto. That means Pluto has the longest year. You will learn how long a year is on Pluto later on in the course.

*Can you explain in your own words all that you have learned about Venus so far?*



## Not a Twin

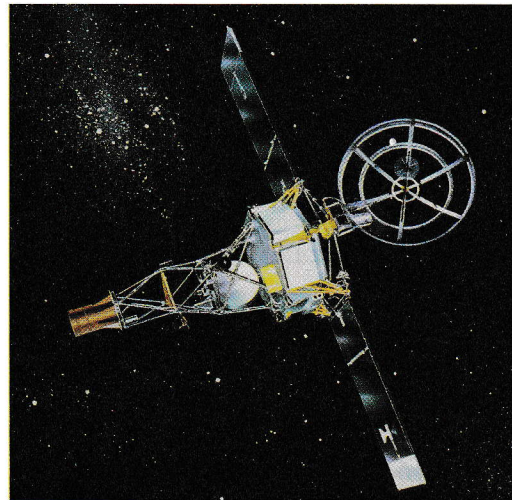
Venus is right next to the earth. It's also about the same size as the earth. Long ago, before anyone knew much about Venus, scientists said Venus was a twin of earth. Many scientists back then thought there might even be dinosaurs or other creatures roaming around on Venus. Today we know that Venus is very different from the earth. No plants or animals could ever live on Venus, because it is too close to the sun and has that terrible atmosphere. This just shows you that looks can be deceiving. Looking at Venus through a telescope made people think that Venus and earth were "twins." Now that scientists have studied Venus "up close" using unmanned spacecraft, we know just how deceiving looks can be!



This is a size comparison of Venus (left) and the earth (right). Venus is colored blue just to emphasize how much it looks like the earth.

## Spacecraft to Venus

Do you remember how many spacecraft have visited the planet Mercury? There has been only one. However, 22 spacecraft have visited Venus! All of these spacecraft have been unmanned, but they were equipped with lots of scientific instruments, so we know a lot more about Venus than we do about Mercury! The first spacecraft to visit Venus was Mariner 2, way back in 1962. Do you remember the year your mother was born? You were supposed to learn that in Lesson 2. If you don't remember, ask her again. If she was born before 1962, do the same kind of subtraction that you did in Lesson 2 to find out how old she was back then. If she was born after 1962, she had not even been born when Mariner 2 visited Venus!



This is an artist's idea of what Mariner 2 looked like as it flew through space to visit Venus.

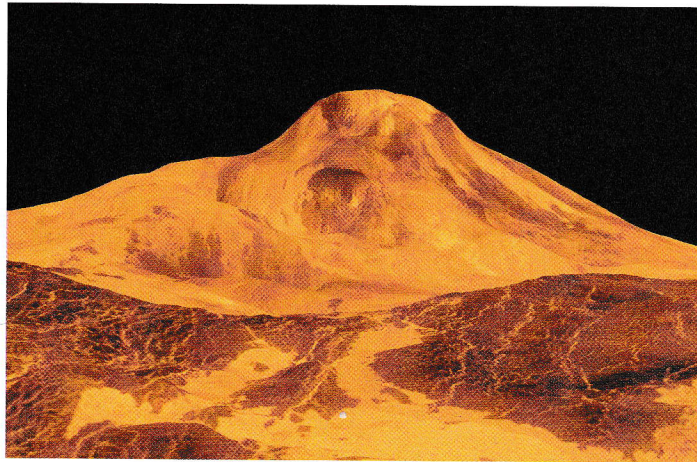
Now remember, Venus is very hot and is covered with sulfuric acid clouds. Because of this, most of the spacecraft that visited Venus never tried to land on its surface, because the conditions on the planet would just destroy them. Instead, most of the spacecraft simply orbited around the planet, using their scientific instruments to gather as much information as possible. That was actually a very hard thing to do. Why? Well, it is hard to see through the clouds



that surround Venus, which means it is very hard to see the surface. Of course, scientists wanted to learn as much as possible about the surface of Venus, so they used **radar** (ray' dar) to find out what Venus looked like below the clouds, because radar can get through the clouds.

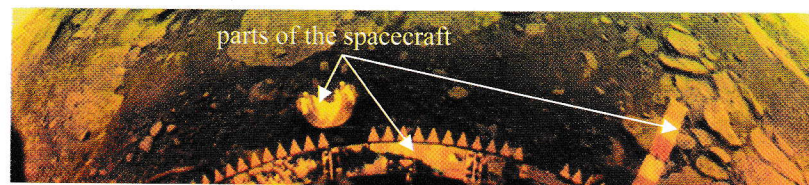
What is radar? Well, a radar unit shoots out signals and then waits for those signals to bounce off of something and come back. It measures the time it takes for this to happen, and from that, it figures out how far away that something was. In the case of spacecraft orbiting Venus, the radar unit sent signals down to the planet, and it waited for them to bounce off the surface of the planet and then come back. From that, it determined how far away the surface of the planet was.

What good does that do? Think about sending a radar signal to one spot on the planet, and then think about sending another radar signal to a second spot just to the right of the first spot. Suppose the radar said that the first signal traveled 500 miles and that the second signal traveled 505 miles. What would that tell you? It would tell you that the second spot on the planet is five miles lower than the first spot, because the signal traveled five miles farther before bouncing back. In other words, there is a cliff there that is five miles high! If you use radar carefully like that, you can figure out what the surface of the planet looks like, even though you cannot see it because of the thick clouds. The project at the end of this lesson gives you a little experience working with something that is very much like radar.



This is an image of a volcano and the valley below it on the surface of Venus. It was made using radar.

Although many of the spacecraft that visited Venus did not land on the surface of the planet, some did. The temperature and conditions of the planet were hard on the spacecraft, and some were destroyed either as they were in the process of landing or once they had landed. Even though these spacecraft were destroyed, scientists did learn things from them. For example, a Soviet spacecraft called "Venera 13" was able to land on the surface, but it stopped working shortly after it landed. Before it stopped working, however, it was able to send two photographs back to earth. One of those photographs is shown above. The picture you see on top is what was taken by



This is two different views of a photo sent back from the surface of Venus.

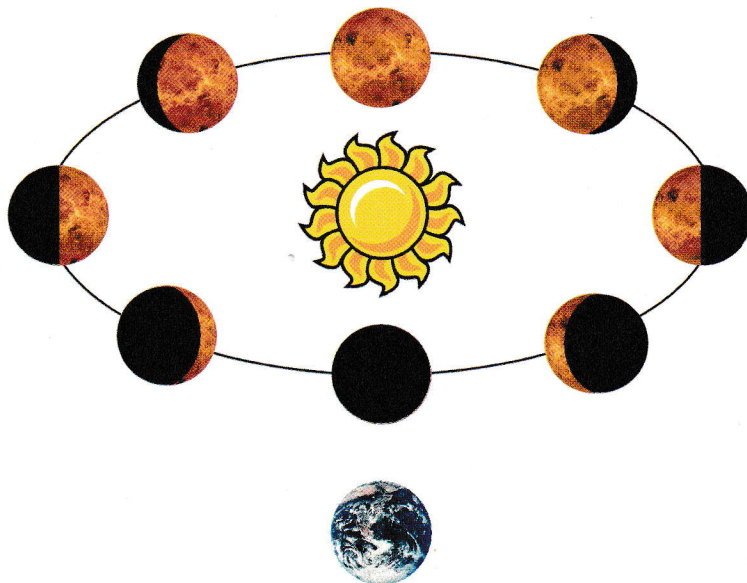


the spacecraft. The picture on the bottom is the same, but the effects of Venus's atmosphere are removed. In other words, this is what the picture would have looked like if Venus had no atmosphere. The difference between the pictures shows you how Venus's atmosphere "colors" everything on its surface.

## The Phases of Venus

If you look at Venus through a telescope, you will see that it appears to change shape from day to day. Galileo discovered this. Do you remember who Galileo was? He was the man who first began studying space with a telescope. He noticed that when he looked at Venus with his telescope, sometimes it looked like a curved sliver, called a **crescent** (kres' unt); sometimes it looked like half of a disk; and sometimes it looked like a full disk. At other times, it could not be seen at all. He called these shapes the **phases** of Venus, and he correctly concluded that this was strong evidence that Venus orbited around the sun.

In this drawing, you can see what Venus looks like to someone on the earth at different spots in its path around the sun. Sometimes it is completely black because it is between the earth and the sun. Remember, the planets do not shine with their own light. They must reflect the light of the sun in order to be seen. If Venus is between the earth and the sun, it reflects light back to the sun, not to the earth. This means Venus looks dark to us, because we do not see any light coming from it. During those times, then, we cannot see Venus in the night sky.



This drawing shows you why Venus has phases when you view it from the earth with a telescope.

When Venus is behind the sun, it looks like a bright disk, because the side facing the sun reflects light back to earth. Because of this, we see an entire side of the planet, and it looks like a disk. When Venus is to one side of the sun or the other, only about half of the planet can reflect light back to the earth, so we see the planet as half of a disk. At other points in its orbit around the sun, only a sliver of Venus can reflect light back to the earth, so we see Venus as a thin crescent. At other points in its orbit, all but a sliver of the planet can reflect light back to the earth, so we see most of Venus, with just a sliver removed. Of course, Venus is so far away that it just looks like a

point of light to you and me. However, if you look at Venus through a telescope, you will see these phases quite clearly.

Look at the drawing of the phases of Venus again. Does that look familiar to you? It should. If you have spent much time looking at the moon, you will see that its shape seems to change, much like what is shown in the drawing. That's because the moon goes through phases, just like Venus. We will talk about the phases of the moon in detail later on in this course.

## Finding Venus in the Sky

Because Venus is close to the sun, we can only see it for a while before the sun rises and for a while after the sun sets. Of course, since Venus goes through phases, we won't always be able to see it in the night sky. When it is visible, however, Venus is the brightest thing in the night sky, except for the moon. It is often called the "morning star" or the "evening star," because it shines brilliantly after sunset or before sunrise. In fact, this is the reason the Romans named it "Venus." It shined so brilliantly in the sky that they thought it was the most beautiful thing in the sky. As a result, they named it after their goddess of beauty, who was called "Venus."

On a very clear morning or evening, look toward the early rising or setting sun. You might see a bright point of light that looks like a star. That's Venus. Of course, you will know that it's not a star at all. It's a burning hot planet with lava and heat-trapping clouds made of sulfuric acid swirling madly around it. If you need help finding Venus, go to the website I told you about in the introduction to the course. It will tell you where to look for Venus and whether or not Venus is visible when you are looking for it.

## What Do You Remember?

What do you remember about Venus? Why did astronomers think Venus was a twin of the earth? What would it feel like on Venus? What is the atmosphere like on Venus? What is special about the rotation of Venus? Have very many spacecraft visited Venus? Since we can't see through the thick clouds over Venus, how do we know what the planet's surface looks like? Why does Venus go through phases? Tell someone all that you learned about this planet. That way, you will be less likely to forget the interesting things you have learned.