



# Planets

**Equipment  
needed:  
Horizon Globe,  
planets**

You have probably learned that there are eight or nine planets orbiting our Sun:

1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. (Pluto)

This is a great list for advanced astronomy, but for beginning observational astronomy the list is much shorter. Here's why:

**EARTH DOES NOT LOOK LIKE A PLANET TO US.** To us, the Earth appears to be a large flat disc, like the Horizon Plate. When we are outside looking for planets, we won't be searching the sky for Earth.

**MERCURY IS ELUSIVE.** It can only be seen occasionally when viewing conditions are just right.

**URANUS IS VERY DIM.** You either need perfect conditions and perfect eyesight, or a telescope to see it.

**NEPTUNE IS EVEN DIMMER THAN URANUS.** You definitely need a telescope to see it.

**PLUTO HAS BEEN RECLASSIFIED AS A DWARF PLANET.** Professional astronomers have decided that Pluto is not really a planet like the others on our list. Even if it were, you would not be able to see it without a giant telescope.

So, to start, we will be learning to find four planets: **VENUS, MARS, JUPITER, AND SATURN.**

## Exercise

1. Place all the planet discs in random places on the Ecliptic Ring.
2. Turn the globe to see how planets rise and set.

*There are four planets to look for*



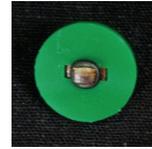
Venus



Mars

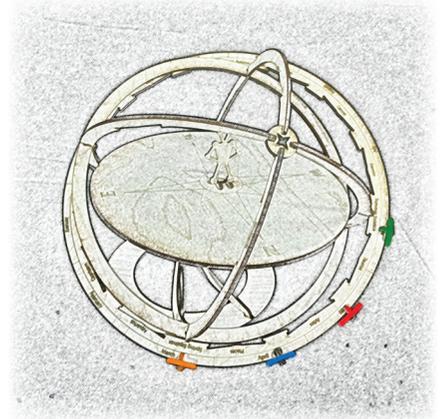
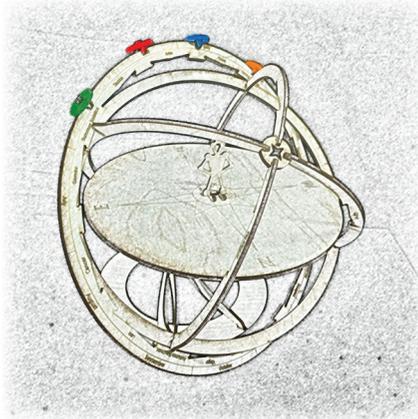
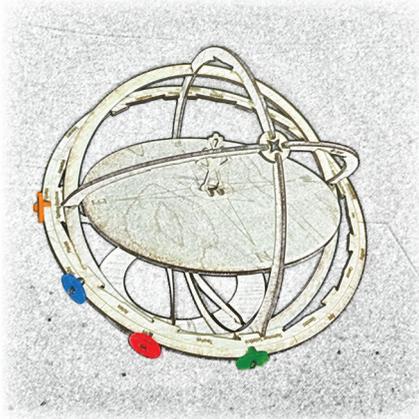


Jupiter



Saturn

## Planets



1

Place all the planet discs  
anywhere on the ecliptic

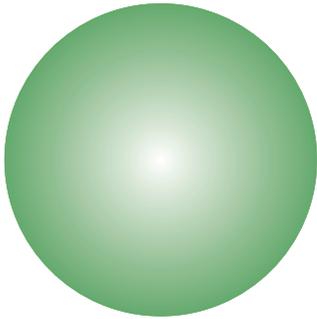
2

Spin the globe and  
notice how the planets  
rise and set

Venus Mars Jupiter Saturn

## Planets are Wandering Stars

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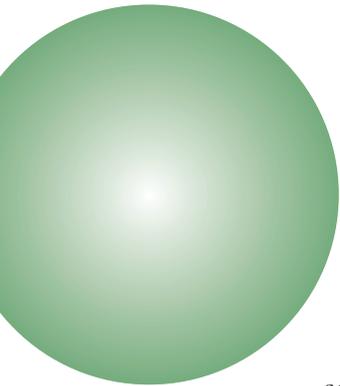


Today we know that planets are completely different kinds of things than stars are.

Planets are more like Earth, giant spheres that orbit the Sun. And Stars are like the Sun, just really far away. Some stars even have planets of their own.

But Ancient stargazers only knew what they saw, that planets look like stars. The reason they gave planets a different name is because they wander. The stars all move as you turn the globe, but they all move together, so the constellations stay intact as they rise and set.

Planets are different. Planets move along the ecliptic like the Moon. If you know where Orion is, you know where any other star is because they always stay the same distance from each other. But you need a calendar to know where the planets will be.

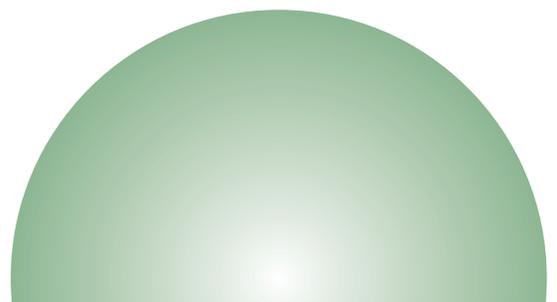
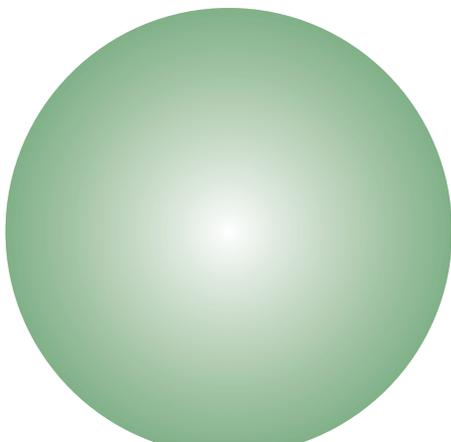


The word planet means “wandering star,” but on any given night you can’t see them wander, you just see them move across the sky with everything else. The wandering can only be noticed over longer periods of time, weeks and months.

To find planets, you really should know the stars. Every fixed star is part of a constellation. So if you know the constellations, you can pick out the wandering star that doesn’t belong. That one is the planet.

This is easier than it sounds. Venus and Jupiter are much brighter than any star, so you are unlikely to mistake them for ordinary stars. Mars and Saturn stay on the ecliptic and are always at least as bright as the top 20 stars.

If we learn all the very bright fixed stars near the ecliptic, we will be able to distinguish them from planets. Luckily, there are only 6 bright stars that could be mistaken for planets. We will learn about these in a later chapter.



*The word planet means “wandering star”*

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## Wandering Stars

Planets are called wandering stars, but only Saturn is very much like the other stars. Here’s how the planets stand out, aside from their wandering:



**VENUS** - So bright that once you know about it, you can’t mistake it for a star.



**JUPITER** - Also too bright to be mistaken for an ordinary star.



**MARS** - Bright red and also sometimes too bright to be a star. There is really only one star that looks very much like Mars.



**SATURN** - Really the only true “wandering star” that looks like the other stars.

# Wandering Stars

## Venus is the Evening Star

**Equipment  
needed:  
Horizon Globe,  
Venus, sun**

Next time you view a sunset, watch for Venus.

This planet will appear as a super-bright star following the Sun. You won't mistake Venus for an ordinary star, it is much, much brighter, almost as bright as a thin crescent moon.

When the sky turns a dark blue right after sunset, but just before the stars appear, Venus is a beautiful sight to behold. No wonder this planet is named after the Roman god of beauty and love.

Venus is the evening star about 1/3 of the time, it can be seen following the sunset for about six months out of every 19 months. The rest of the time Venus is either working as the morning star, or is too close to the Sun to see. In the next chapters, we will learn how to use charts to know when Venus is visible.

In the days just before Venus appears as the evening star, she is traveling with the Sun, just like the new moon. Like the moon, Venus falls behind the Sun a little more each day, until it gets far enough away for us to see after sunset.

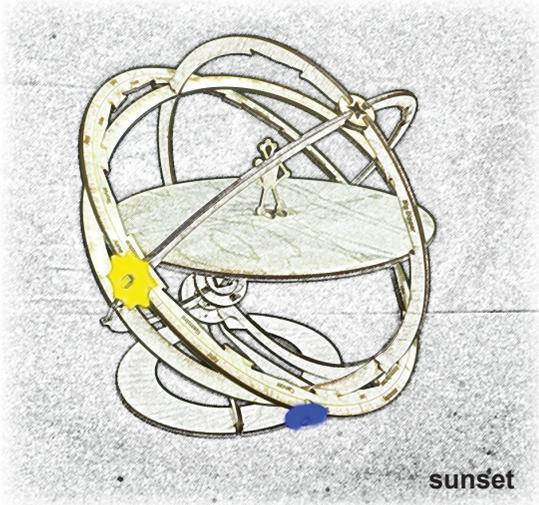
For the next five months, Venus appears a little higher and farther from the Sun each day, until she gets about three hours behind the Sun. When her shift as evening star is done, she rapidly sinks, appearing lower and lower in the west each evening until she is once again too close to the Sun to see. During this time Venus is moving fast and catching the Sun.

Now we have to wait about a year for our evening star to reappear.

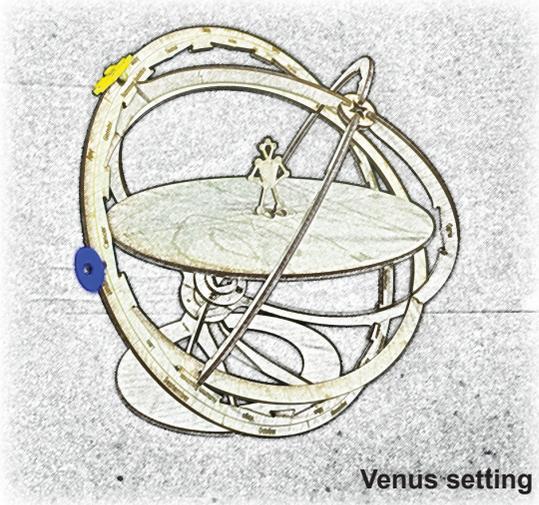
Use your Horizon Globe to model the Evening Star. Place Venus on the ecliptic one to three hours behind the Sun. Turn the globe to see when Venus is visible.

### Exercise

1. Place Venus on the Ecliptic 1 to 3 hours behind the Sun.
2. Turn the globe and notice when Venus rises and sets each day.  
When can you see Venus?



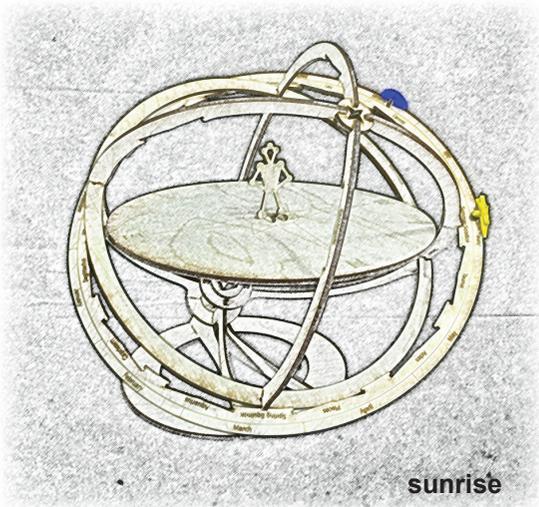
sunset



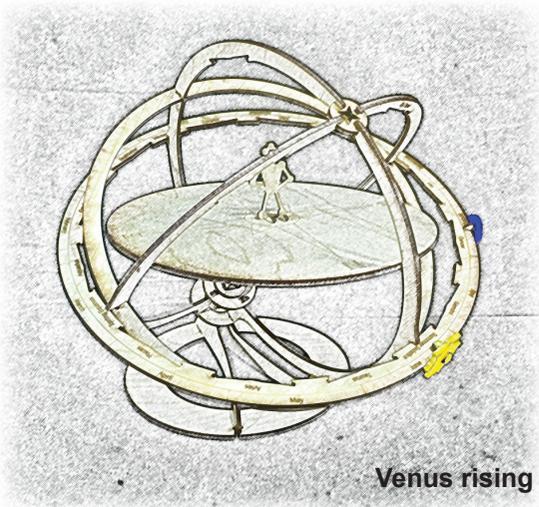
Venus setting

1 Place Sun on ecliptic. Place Venus three hours behind the Sun

2 Spin the globe and notice when Venus rises and sets

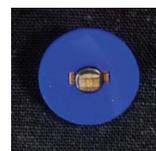


sunrise



Venus rising

# Evening Star



Venus

## Venus is the **Morning Star**

**Equipment  
needed:  
Horizon Globe,  
Venus, sun**

Right after Venus leaves her post as the **Evening Star**, she rushes over to become the **Morning Star**.

Now you will see her rising ahead of the Sunrise, holding out as the last visible night-sky object as dawn brightens the sky.

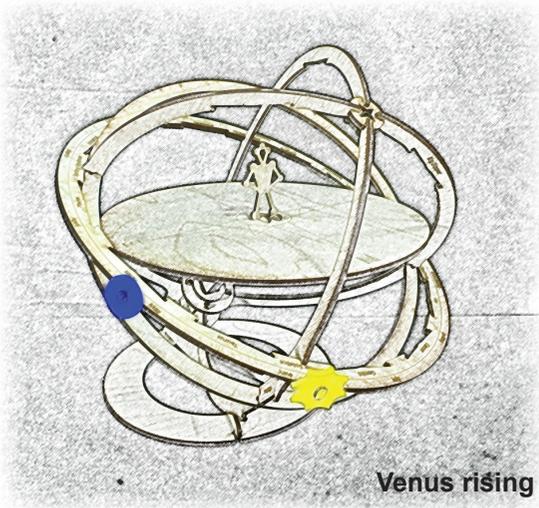
About 1/3 of Venus' time is spent as the **Morning Star**, making sunrise watching more interesting for about six months out of 19 months.

Venus the **Morning Star** is like a mirror image of Venus the **Evening star**. The **Evening Star** slowly drifts back from the Sun over five months, then quickly reverses course and catches up. The **Morning Star** quickly races ahead of the Sun, then slowly loses ground until it is too close to the Sun to see.

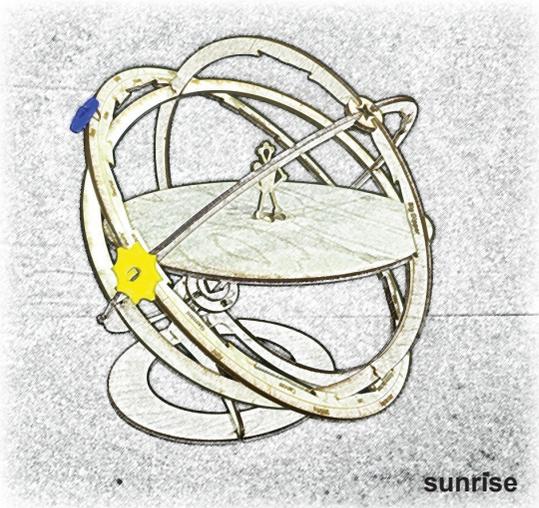
Just as with the **Evening Star**, we have to wait about a year between **Morning Star** appearances while Venus either hides by the Sun, or does her work in the West as the **Evening Star**.

### Exercise

1. Place Venus on the Ecliptic 1 to 3 hours ahead of the Sun.
2. Turn the globe and notice when Venus rises and sets each day.  
When can you see Venus?



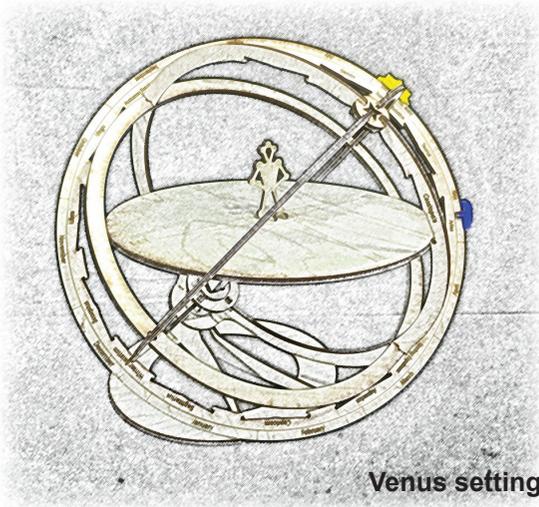
Venus rising



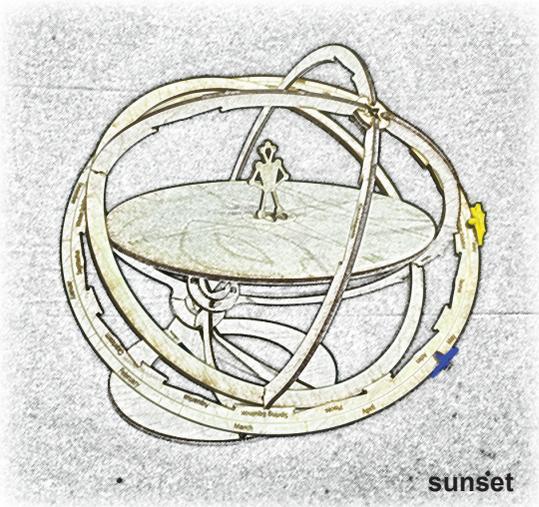
sunrise

1 Place Sun on ecliptic. Place Venus three hours ahead of the Sun

2 Spin the globe and notice when Venus rises and sets



Venus setting



sunset



Venus

# Morning Star

## Venus is a Dog on a Leash

Venus is the easiest planet to find.

**Equipment  
needed:  
Horizon Globe,  
Venus, sun**

It is 10 times brighter than any star. In fact it is so bright that you can almost see it during the daytime. As soon as the sky darkens a little to twilight, Venus will appear, sometimes in the evening, and sometimes in the morning.

Venus is easy to see when it is out, but her pattern of motion relative to the Sun is strange and unique among celestial objects.\* We saw that the Moon is consistently slower than the Sun, losing one lap on the ecliptic per month. Orion and the stars are consistently faster, gaining one lap on the Sun in a year.

Venus is different. Sometimes it is slower than the Sun, and sometimes faster. Ancient astronomers compared Venus to a dog on a leash. The leash is being held by the Sun and Venus runs back and forth.

Like a frisky dog, Venus runs ahead of the Sun to the end of her leash. The leash is only long enough for her to get ahead of the Sun by about three hours. It takes about one month for Venus to go from the Sun to three hours ahead.

After straining on the leash for a while, Venus starts sniffing around in the bushes and losing ground on the Sun. The Sun eventually catches and passes Venus, then keeps getting ahead until Venus trails by about three hours. It takes Venus about 17 months to go from ahead of the Sun to fully behind.

Then Venus races ahead again for two months and the cycle repeats. When Venus is ahead of the Sun she is the **Morning Star** and when she is behind she is the **Evening Star**. When she is close to the Sun, she is like the New Moon and we can't see her.

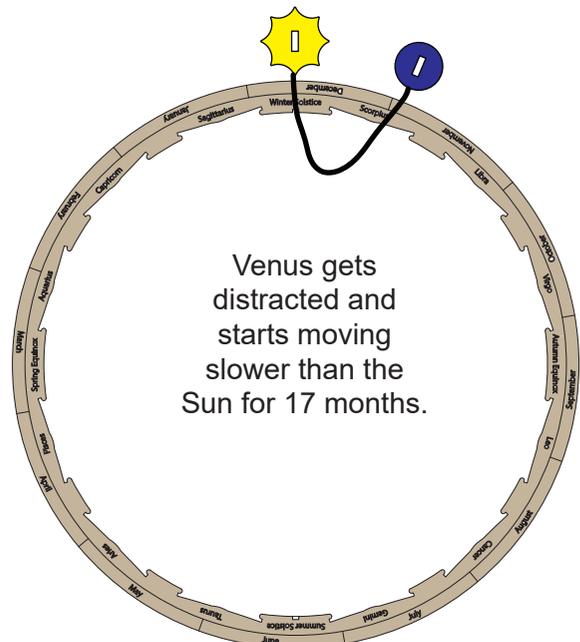
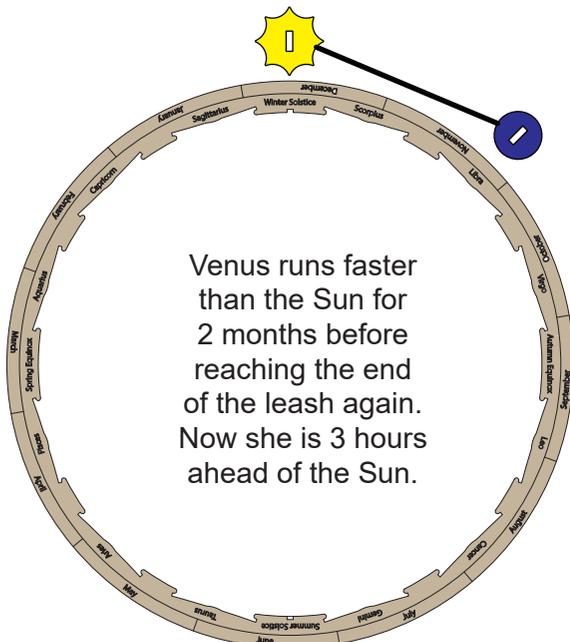
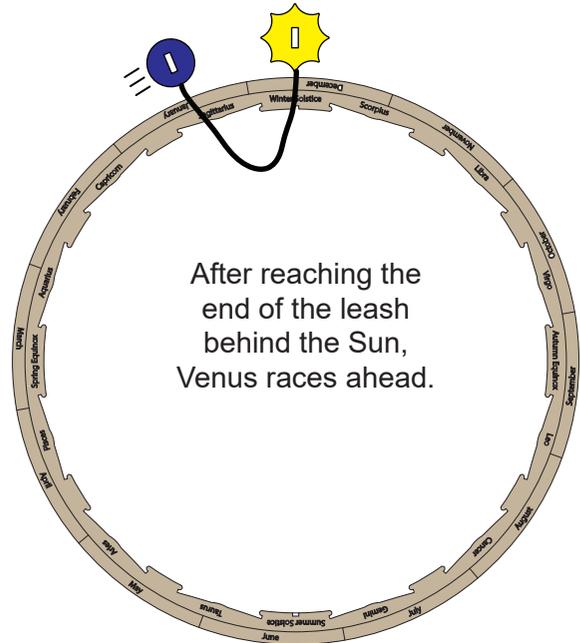
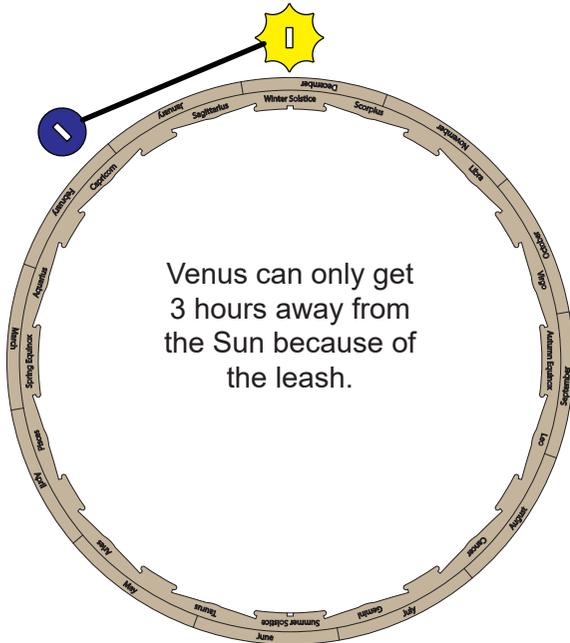
Remember, like all celestial objects, Venus moves relative to the Sun over weeks and months. On a daily basis she goes around East to West just like the Sun, at about the same speed.

### Exercise

1. Place Venus near and far from the Sun, but always within 3 hours of the Sun.
2. Turn the globe to see if or when you can see Venus in each position.

\* Only Mercury has a similar motion, which will be easy to understand after you get to know Venus.

*Venus is like a playful dog on a leash*



### Venus Acts Like a Dog on a Leash

## How to Find Venus

**Equipment  
needed:  
Horizon Globe,  
Venus, sun**

Just like the Moon, Venus is easy to find if you know where to look.

If Venus is trailing the Sun, look for it in the west at sunset and for a few hours after sunset. If Venus is leading the Sun, you can see it rising in the East before the Sun in the early morning.

The facing page shows a Moon and Planet Calendar from Appendix A. Venus is represented by a dark blue circle with the letter “v.”

In July, 1969 Venus was leading the Sun by about three hours. Place the Sun on your Horizon Globe. Then place Venus three hours ahead of the Sun.

Turn the globe to see that Venus rises in the morning before the Sun. On the day of the Moon landing, Venus was the Morning Star.

By January, 1970, Venus has fallen back to where the Sun is and in July 1970, Venus is three hours behind the Sun. Place the Sun and Venus on your Horizon Globe to model July, 1970. Turn the globe to see how Venus is now the Evening Star.

Use Appendix A to place Venus in its current location. Is it the Morning or Evening Star, or is it too close to the Sun to see? If it is visible, try to find it outside.

Scan through the Moon and Planet Calendars in Appendix A. Notice how Venus behaves like a dog on a leash, running quickly ahead of the Sun, then slowly lollygagging until she is behind.

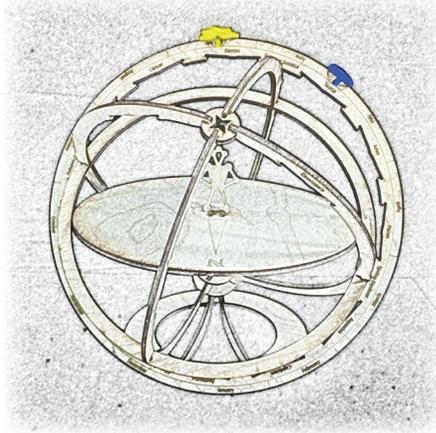
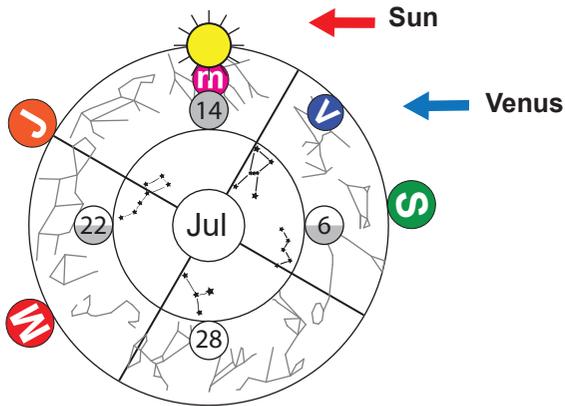
Remember, Venus is 10 times brighter than any star. If you are outside at dusk or dawn when Venus is out, you will surely spot it. Also remember that Venus never strays more than three hours from the Sun. You will never see Venus high in the sky at night.

### Exercise

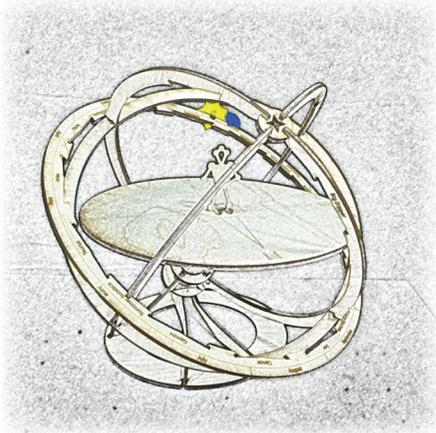
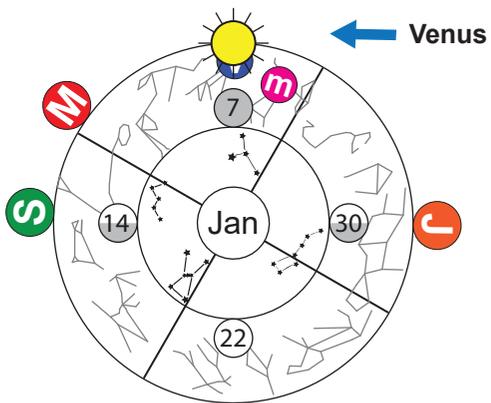
1. Use the 1969 and 1970 Moon and Planet Calendars in Appendix A to model Venus around the time of the moon landing.
2. Use the current year charts to find where Venus is now.



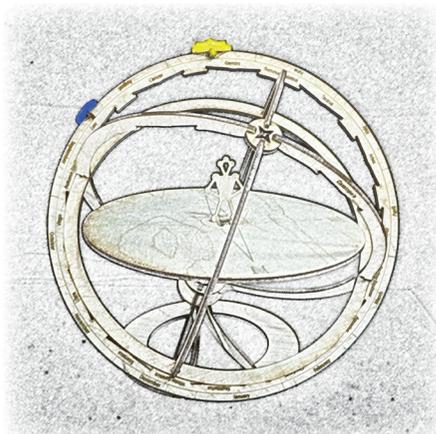
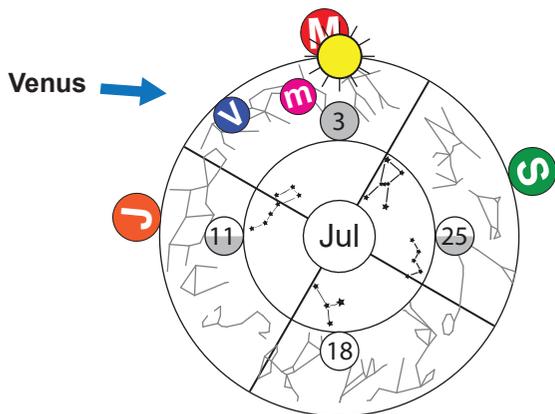
*Venus is very, very bright*



Venus is the Morning Star - July 1969



Venus is near the sun - January 1970



Venus is the Evening Star - July 1970

# Jupiter

**Equipment  
needed:  
Horizon Globe,  
Jupiter, sun**

Jupiter is the next brightest object after Venus, much brighter than any star.

Venus always stays near the Sun, in that sense she is like a crescent moon. You can only see Venus in the evening or morning, in the West or the East. The wee hours of the night and the middle of the sky are off limits to her.

Jupiter doesn't have such restrictions. Jupiter can appear at any time of night and across the whole span of the ecliptic. When you see a super-bright celestial object that is not Venus, it's sure to be Jupiter.

If Venus is like the crescent moon, Jupiter is like the whole moon cycle. It can be too near to the Sun to see, like a New Moon, or opposite the Sun like a Full Moon. But we don't say planets are New, or Full. We say they are in "conjunction," or in "opposition."

**Conjunction** means in the same direction as the Sun, like a New Moon.

**Opposition** means opposite the Sun, like a Full Moon.

Jupiter travels along the ecliptic on his own schedule, he is not as lazy as the moon, or as ambitious as Orion. He travels the ecliptic just a little slower than Orion, but still faster than the Sun. It takes Jupiter 13 months to lap the Sun (remember, it takes Orion only 12 months).

Jupiter is represented by the orange disc on your Horizon Globe. Place the Sun and Jupiter different places on the ecliptic and turn the globe to see when you might see Jupiter in that position.

Like Venus, if you know generally where Jupiter is, you can't miss it. It is much brighter than any star. Once you catch a glimpse of Jupiter in the sky, you will wonder how you missed him before.

## Exercise

1. Place the Sun and Jupiter various places on the ecliptic.
2. Turn the globe to see when you would be able to see Jupiter.

*Jupiter is brighter than a star*



June



August



October

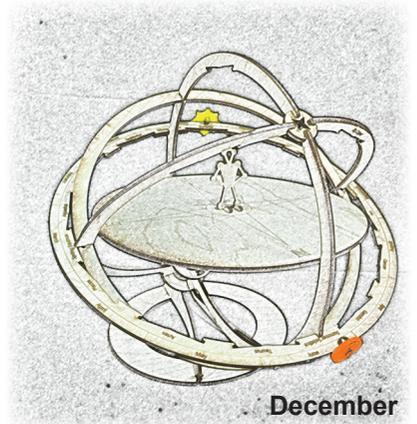
1

Jupiter in conjunction

2

Jupiter laps the Sun in 13 months

In this example Jupiter is in conjunction in June. You need to consult the Moon and Planet Calendar to see when conjunction occurs for the year you are interested in.



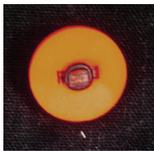
December



February



April



Jupiter

# Jupiter

## How to Find Jupiter

**Equipment  
needed:  
Horizon Globe,  
Jupiter, sun**

We always know where to look for Orion, because he is in sync with the seasons and with our calendar. Orion is always near the Sun at the end of June.

Jupiter is just as regular, but he keeps a different schedule. We can't keep track of Jupiter by what month it is, but we can find him using the Moon and Planet Calendars in Appendix A.

Let's practice by finding where Jupiter was during the Moon Landing. The Moon and Planet Calendar on the facing page shows us that it was about four hours behind the Sun. Look for the orange circle with a white "J". In that month, Jupiter would be in the western sky at sunset. When Jupiter is here, be careful not to mistake it for Venus.

Three months later, in October 1969 Jupiter has caught up to the Sun and is in opposition. The next opposition of Jupiter was in April 1970.

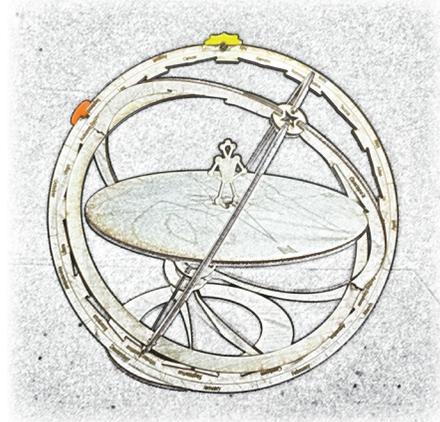
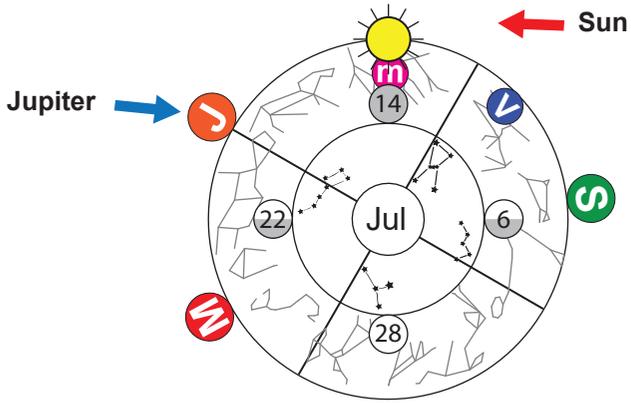
Use Appendix A to place Jupiter in its current location on the Horizon Globe. Is it far enough from the Sun to see? When would be a good time to look for it? When is the next time Jupiter will be in conjunction, or in opposition?

Look at the Moon and Planet Calendars in Appendix A. Notice how Jupiter catches and passes the Sun in a little more than a year. You may want to copy the Moon and Planet Calendar for this year from Appendix A to post on the refrigerator or hang on your wall so you remember to look for Jupiter when viewing is good.

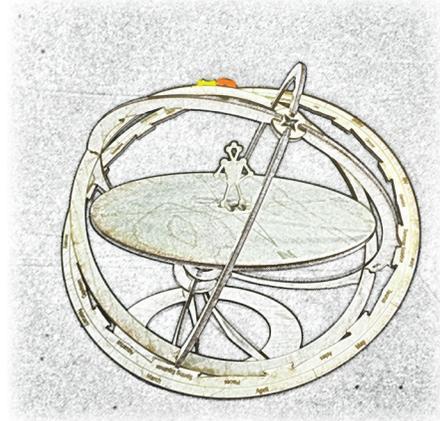
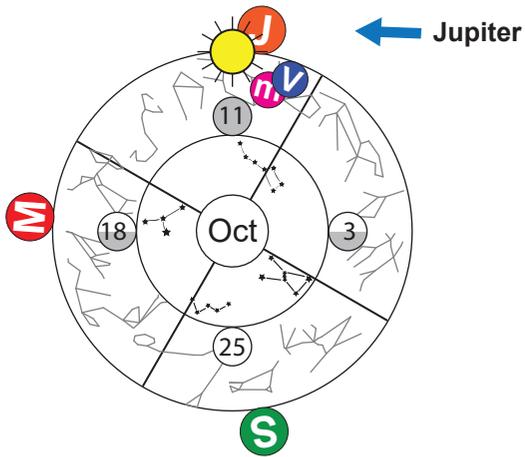
### Exercise

1. Use the calendar charts to place Jupiter in its current location.
2. Use the globe to go out and find Jupiter.

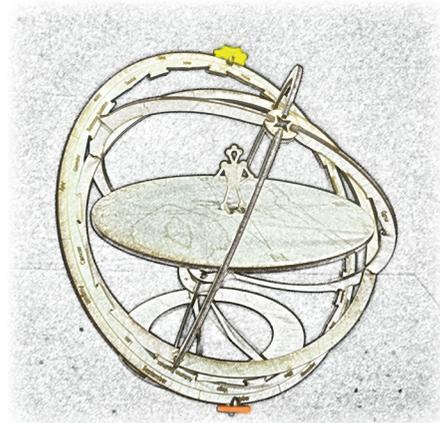
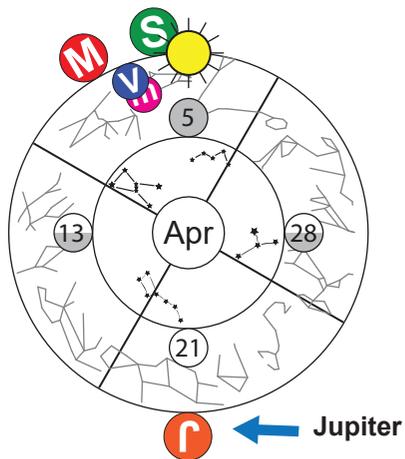




Jupiter on the Moon Landing - July 1969



Jupiter near Conjunction - October 1969



Jupiter in Opposition - April 1970

# Saturn

**Equipment  
needed:  
Horizon Globe,  
Saturn, sun**

Saturn is the archetype wandering star. Unlike super bright Venus and Jupiter, Saturn is about as bright as the top 20 brightest stars so it really does look like a star.

Saturn moves almost the same as Jupiter, lapping the Sun in 12 ½ months to Jupiter's 13 months. Like Jupiter, it traverses the entire ecliptic cycling from conjunction to opposition and back in just over a year. Saturn is faster than the Sun and Moon, but slower than Orion and the stars.

The challenge with finding Saturn is that it looks exactly like the top 20 stars. Since it stays on the ecliptic, Saturn appears as an extra star in the zodiac constellations. You can confidently view Venus and Jupiter without knowledge of the constellations because they are both much brighter than any star.

But to find Saturn, you must know which bright star does not belong to the constellation it is in. That one will be the wanderer, Saturn. (Mars also poses as a bright star, but as we will see, Mars has other characteristics that make it easier to pick out).

Saturn is represented by the green disc on your Horizon Globe. Place the Sun and Saturn different places on the ecliptic and turn the globe to see when you might see Saturn in that position.

Which constellation is Saturn in? In a later chapter, we will discuss which Zodiac constellations have bright stars that Saturn could be mistaken for. But most of the time, Saturn will be the brightest “star” in its place on the ecliptic.

## Exercise

1. Place the Sun and Saturn various places on the ecliptic.
2. Turn the globe to see when you would be able to see Saturn.

*...I still remember when the first time I pointed the telescope at the sky  
and I saw Saturn with the rings. It was a beautiful image*

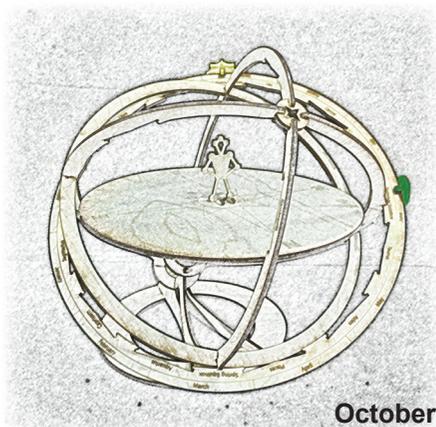
-Umberto Guidoni



June



August



October

1

Saturn in  
conjunction

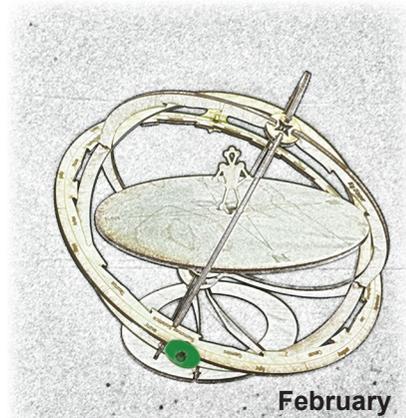
2

Saturn laps  
the Sun in  
12 ½ months



December

In this example Saturn is in conjunction in June. You need to consult the Moon and Planet Calendar to see when conjunction occurs for the year you are interested in.



February



Saturn

# Saturn



April

## How to Find Saturn

**Equipment  
needed:  
Horizon Globe,  
Saturn, sun**

We can find Saturn using the Moon and Planet Calendars the same way we found Jupiter.

Where was Saturn during the Moon Landing? The calendar chart on the facing page shows us that it was about five hours ahead of the Sun. Look for the green circle with an S. In that month, Saturn was rising in the East just after midnight.

Three months earlier, in April 1969, Saturn was in conjunction with the Sun. Six months later, in October 1969, Saturn reached opposition. In opposition, a planet rises at sunset and sets at sunrise, like the Full Moon.

In 1969, Saturn stays near the zodiac constellation Aries. Since there are no bright stars in Aries, a viewer at that time would have been sure that he was looking at Saturn and not a bright star.

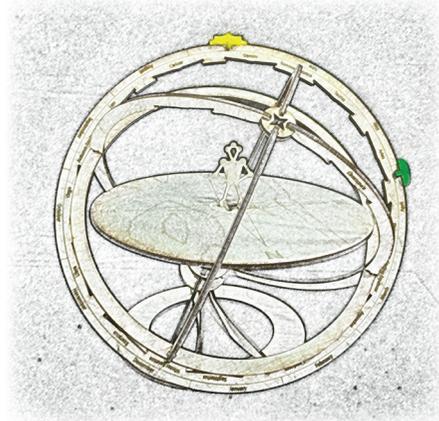
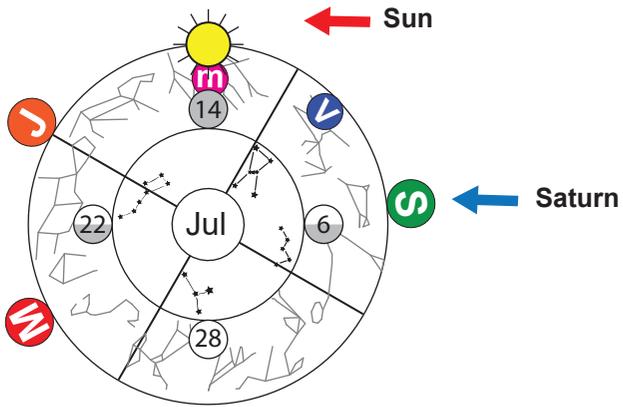
Use Appendix A to place Saturn in its current location on the Horizon Globe. Is it far enough from the Sun to see? When would be a good time to look for it? When is the next time Saturn will be in conjunction, or in opposition?

Look at the Moon and Planet Calendars in Appendix A. Notice how Saturn catches and passes the Sun in a little more than a year. Remember to post a copy of this year's Moon and Planet Calendar in a convenient place so it prompts you to look for Saturn and the other planets when you go outside at night.

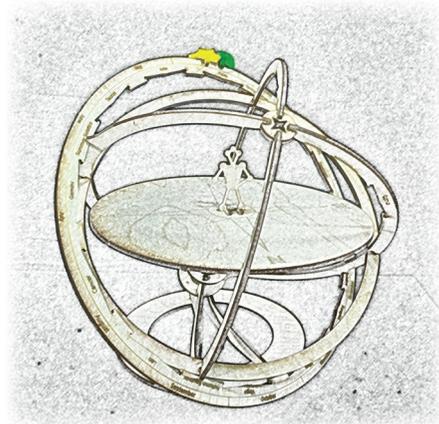
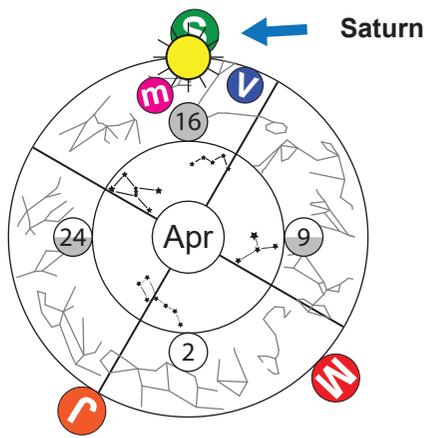
### Exercise

1. Use the Moon and Planet Calendar to place Saturn in its current location.
2. Use the globe to go out and find Saturn.

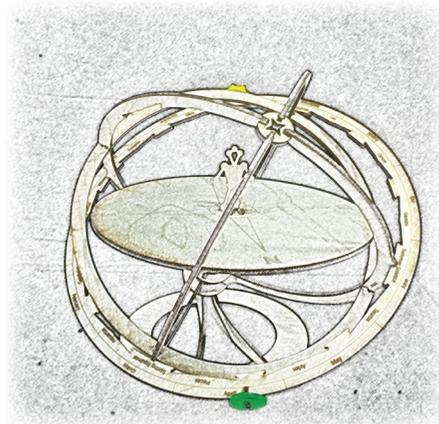
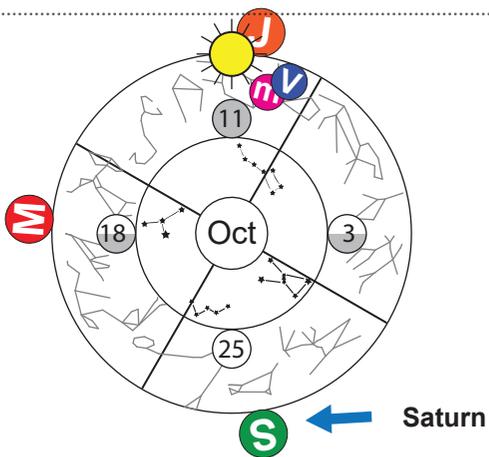




Saturn on the Moon Landing - July 1969



Saturn in Conjunction - April 1969



Saturn near Opposition - October 1969

# Mars

**Equipment  
needed:  
Horizon Globe,  
Mars, sun**

Mars just may be the most interesting planet to track.

There are three characteristics of Mars that make it one of the most fun objects in the sky to find:

**COLOR** - Mars is bright red. Only the bright star Antares in Scorpio and Betelgeuse in Orion approach this color of red.

**BRIGHTNESS** - Sometimes Mars is super bright, as bright as Jupiter. Other times Mars wouldn't even make the top 20 stars.

**SPEED** - Mars changes speed radically, sometimes moving so fast that it would catch the Sun every seven months, other times slowing to a crawl that would take seven years to lap the Sun.

Mars is easier to track if you know a few things about his behavior.

In terms of brightness, think of Mars like the Moon: dim when near the Sun and bright when far away. In terms of speed, the brighter Mars is, the faster he goes. In opposition, Mars is bright and fast. In conjunction, Mars is dim and slow.

On average, Mars is the slowest planet, taking just over two years to lap the Sun, compared to Jupiter's 13 months, and Saturn's 12 ½ months.

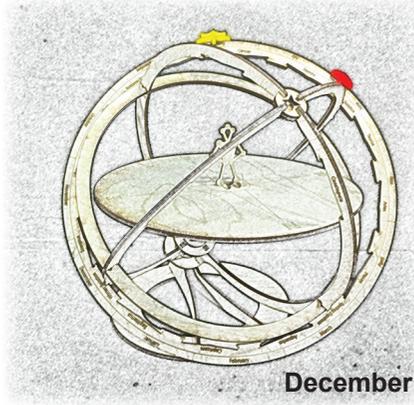
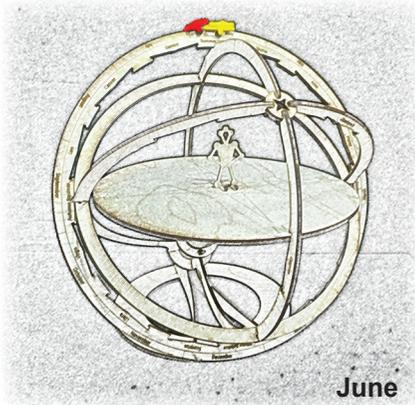
You should be able to find Mars if you know where to look because it is one of the only red objects in the sky. If you remember that its brightness changes with its angle with the Sun, you will know how bright of a wandering star you're looking for.

Mars is represented by the red disc on your Horizon Globe. Place the Sun and Mars different places on the ecliptic and turn the globe to see when you might see Mars in that position.

## Exercise

1. Place the Sun and Mars various places on the ecliptic.
2. Turn the globe to see when you would be able to see Mars.

*Mars is faster than the sun*

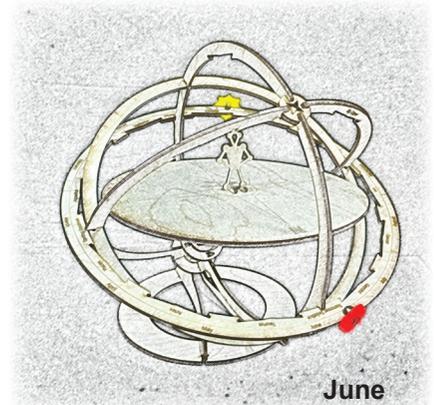


1

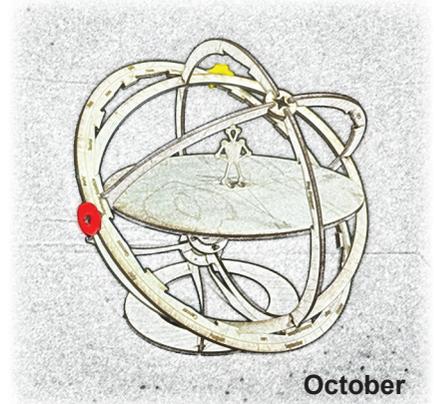
Mars in conjunction

2

Mars laps the Sun in ~2 years



In this example Mars is in conjunction in June. You need to consult the Moon and Planet Calendar to see when conjunction occurs for the year you are interested in.



Mars

# Mars

**Mars is dim and slow when in conjunction (near the sun)  
Mars is bright and fast when in opposition (opposite the sun)**



## How to Find Mars

**Equipment  
needed:  
Horizon Globe,  
Mars, sun**

The Moon and Planet Calendars depict Mars the same way they show the other planets.

Where was Mars during the Moon Landing? The Moon and Planet Calendar on the facing page shows us that it was about eight hours behind the Sun. Look for the red circle with an “M”. On the day of the Moon Landing, Mars rose at about 2:00 p.m. and was visible high in the sky right after sunset. It was catching up to the Sun after opposition, so it was slowing down and getting dimmer.

Mars was nearing opposition two months earlier, in May 1969. It wouldn't reach conjunction for another year, July 1970.

Interestingly, Mars was near Scorpio during the Moon Landing. The red star Antares in Scorpio is the star most likely to be confused with Mars. In fact, the name “Antares” means “rival of Mars.”

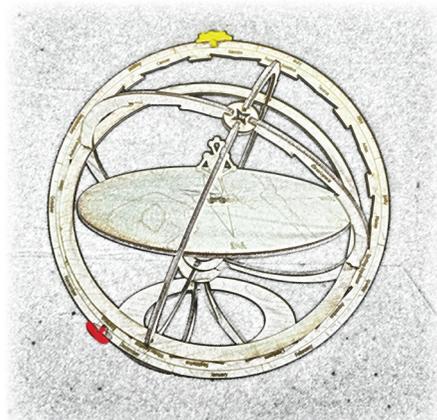
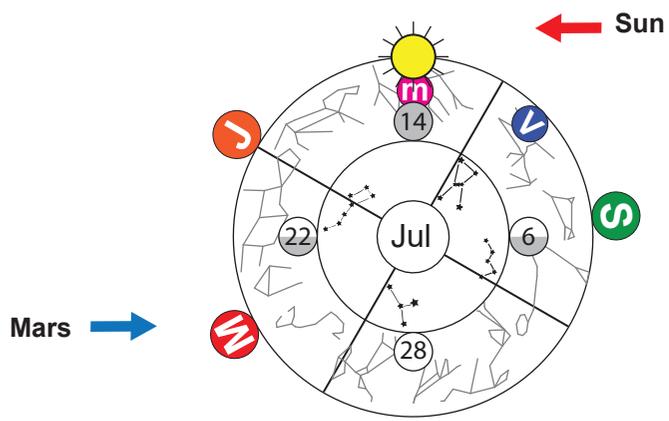
Use Appendix A to place Mars in its current location on the Horizon Globe. Is it far enough from the Sun to see? When would be a good time to look for it? When is the next time Mars will be in conjunction, or in opposition?

Look at the Moon and Planet Calendars in Appendix A. Notice how Mars takes over two years to catch and pass the Sun. Notice how much it jumps in a month when it is near opposition and how many months it takes to pass the Sun when it is near conjunction.

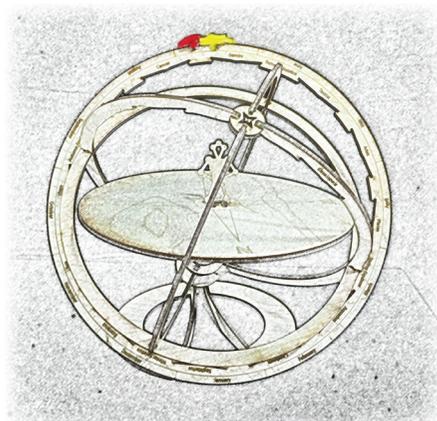
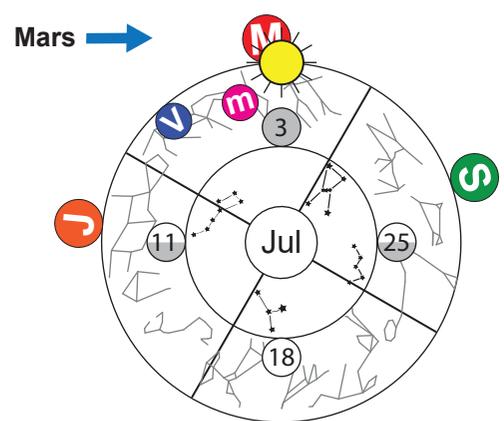
### Exercise

1. Use the Moon and Planet Calendars to place Mars in its current location on the Horizon Globe.
2. Use your globe to help you go outside find Mars in the sky.

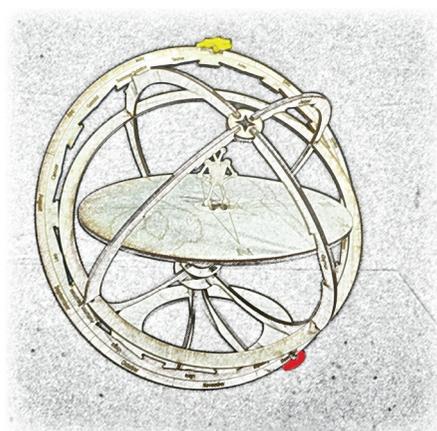
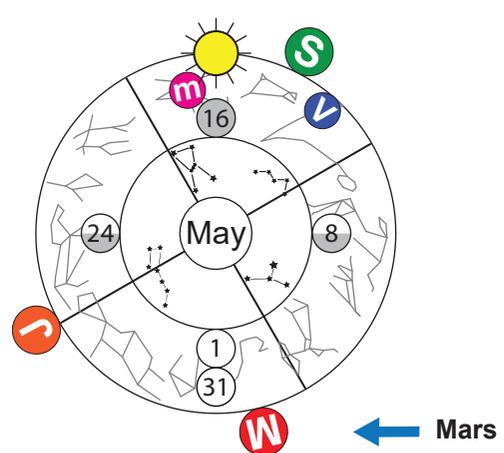




Mars on the Moon Landing - July 1969



Mars near Conjunction - July 1970



Mars nearing Opposition - May 1969

# Telling Planets from Stars

**Equipment  
needed:  
zodiac  
constellations**

Let's take a look at the six stars that could be mistaken for a planet.

Start with the stars around Orion. There are quite a few bright stars in Orion's part of the sky, but only 3 are near the ecliptic. The distance from Orion's shoulders to the ecliptic is about the same distance as Orion's height, from his feet to his shoulders. If we can see Orion, we can estimate pretty accurately where the ecliptic is.

Taurus the Bull has a bright, orangeish star in its neck called Aldebaran. Since it is orange, you probably won't think it's Saturn, which is more white in color. You may mistake Aldebaran for Mars if you are unfamiliar with the shape of the Bull. Follow Orion's belt up and to the right to find Aldebaran. Find it when Mars is not nearby so you know what it looks like.

Castor and Pollux are the two bright stars in Gemini the Twins. If you follow a line through the two bright shoulder stars of Orion, it leads to Pollux and Castor. They are whitish/yellowish so be careful not to confuse them with Saturn. As with Aldebaran in the Bull, your best bet is to learn to recognize them ahead of time, so when Saturn arrives, you will see the contrast.

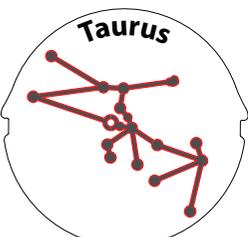
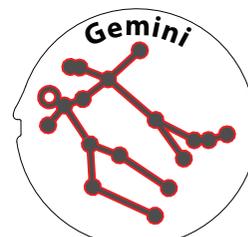
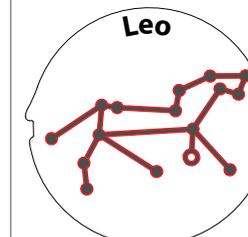
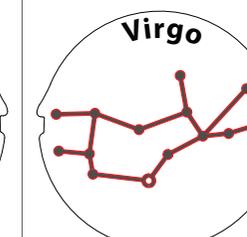
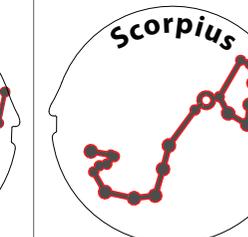
Next look in the Big Dipper's part of the sky. Straight south of the Big Dipper there are two bright stars on the ecliptic. Regulus in Leo the Lion and Spica in Virgo the Virgin. If there is a third bright star in this area, you know it's a planet. Both of these stars are blueish, so Mars won't be a problem, only Saturn.

The only other bright star near the ecliptic is Antares in Scorpio the Scorpion. Antares is a bright red star just below the ecliptic in Cygnus the Swan's part of the sky. It looks so much like Mars that Antares means "rival of Mars." If your planet calendar places Mars near Scorpio, look for two bright red objects.

## Exercise

1. Look carefully at the Zodiac discs on your Horizon Globe and find the double circles that represent bright stars.

*Sometimes stars and planets look alike*

Orion		Big Dipper		Cygnus
				
Aldebaran	Castor and Pollux	Regulus	Spica	Antares

### These Bright Stars are Sometimes Mistaken for Planets

That's it. You can't mistake Venus or Jupiter for stars because they are so much brighter. That's also true for Mars when it is in opposition.

If you can distinguish star colors, only the stars in Scorpio and Taurus could be Mars, though Taurus' star is more orange than red. Only the stars in Gemini, Leo, and Virgo could be mistaken for Saturn.

Of course separating planets from stars requires that you know where the ecliptic is. Luckily, you will become an expert at finding the ecliptic through using your Horizon Globe and watching the Sun and Moon in the sky.

Later, when you learn more about identifying and locating stars and constellations, you will never confuse a planet with a star.

# Star or planet?