The Sun

The sun dominates activity on Earth: living and non-living.

It'd be hard to imagine a day without it.

The daily pattern of the sun rising in the East and setting in the West is how we measure time...marking off the days of our lives.

The Sun

Virtually all life on Earth is aware of, and responds to, the sun's movements.

Well before there was written history, humankind had studied those patterns.

Daily Patterns of the Sun

- The sun rises in the east and sets in the west.

- The time between sunrises is always the same: that amount of time is called a "day," which we divide into 24 hours.

Note: The term "day" can be confusing since it is used in two ways:
- The time between sunrises (always 24 hours).
- To contrast "day" to "night," in which case day means the time during which there is daylight (varies in length).

For instance, when we refer to the summer solstice as being the longest day of the year, we mean that it has the most daylight hours of any day.

Explaining the Sun

What would be the simplest explanation of these two patterns?

- The sun rises in the east and sets in the west.
- The time between sunrises is always the same: that amount of time is called a "day." We now divide the day into 24 hours.

Discuss some ideas to explain these patterns.

But only use what you see around you everyday and the above two patterns to create your explanation.

1 The sun rises in the:

A North

B East

C West

D I need help

Answer

https://njctl.org/video/?v=-4nDpLLwzQY

2 The sun sets in the:

A North

B East

C West

D I need help

Answer

https://njctl.org/video/?v=g8gnXlrHZVM

3 The time between two sunrises is:

A 6 hours

B 12 hours

C 24 hours

D I need help

Answer

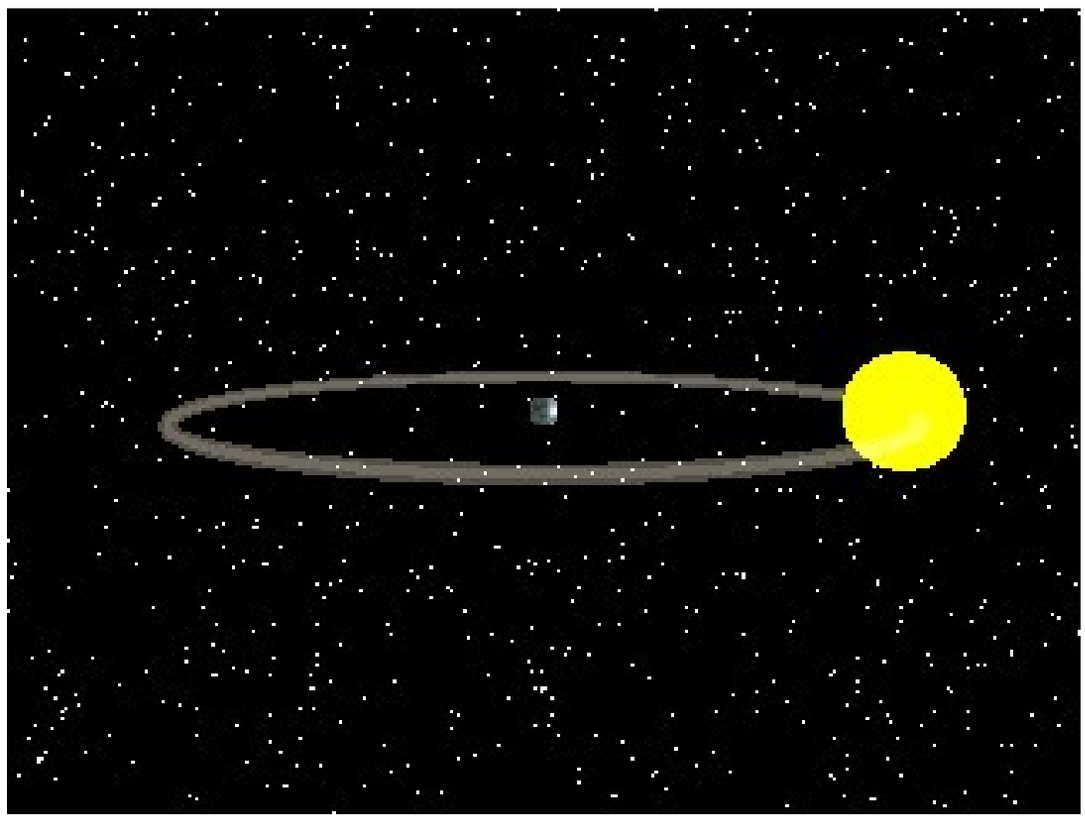
https://njctl.org/video/?v=u5lNXoQRvdM

Days of Equal Length

For many thousands of years, until a few hundred years ago, people thought that the sun and all the stars moved around Earth.

The idea of the sun "rising" in the east and "setting" in the west captures that idea.

They thought days were the same amount of time because the orbit of the sun was constant.



https://njctl.org/video/?v=Ya9ik8TDCtE

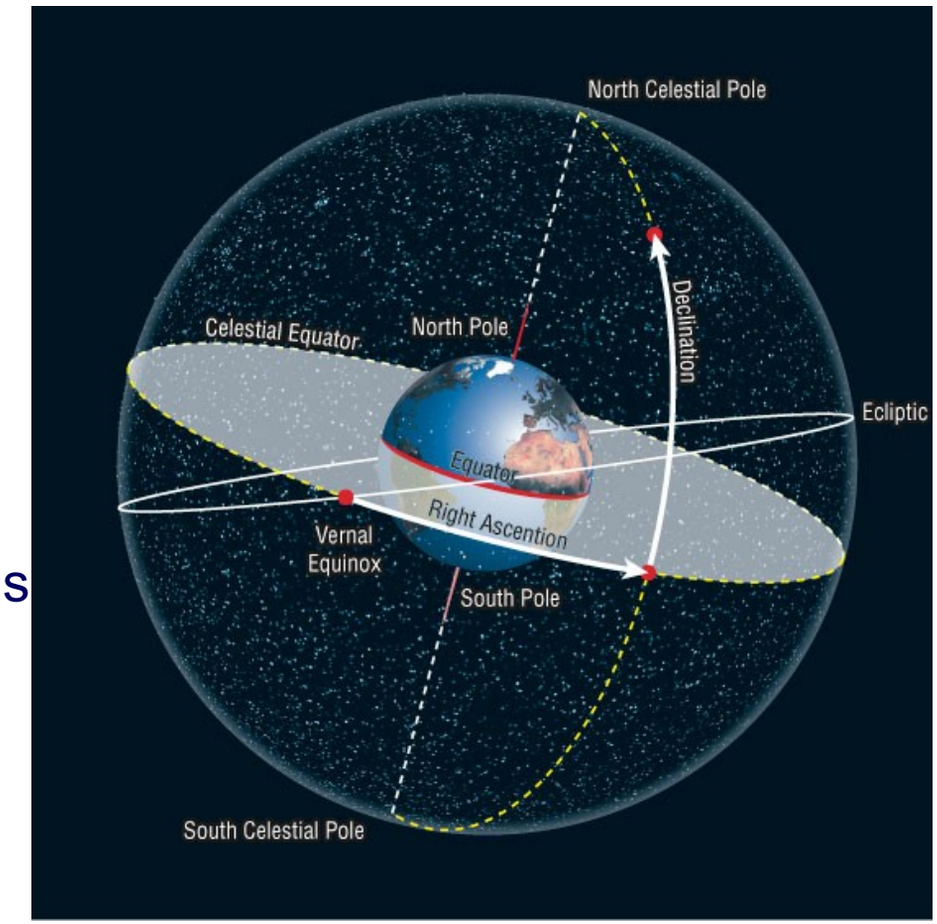
Explaining the Sun

For most purposes, that idea works fine...it explains what we see around us everyday.

In fact, celestial navigation is still done by assuming that Earth is standing still while the sun and stars rotate around it.

And, more than 25% of Americans still believe that is true.

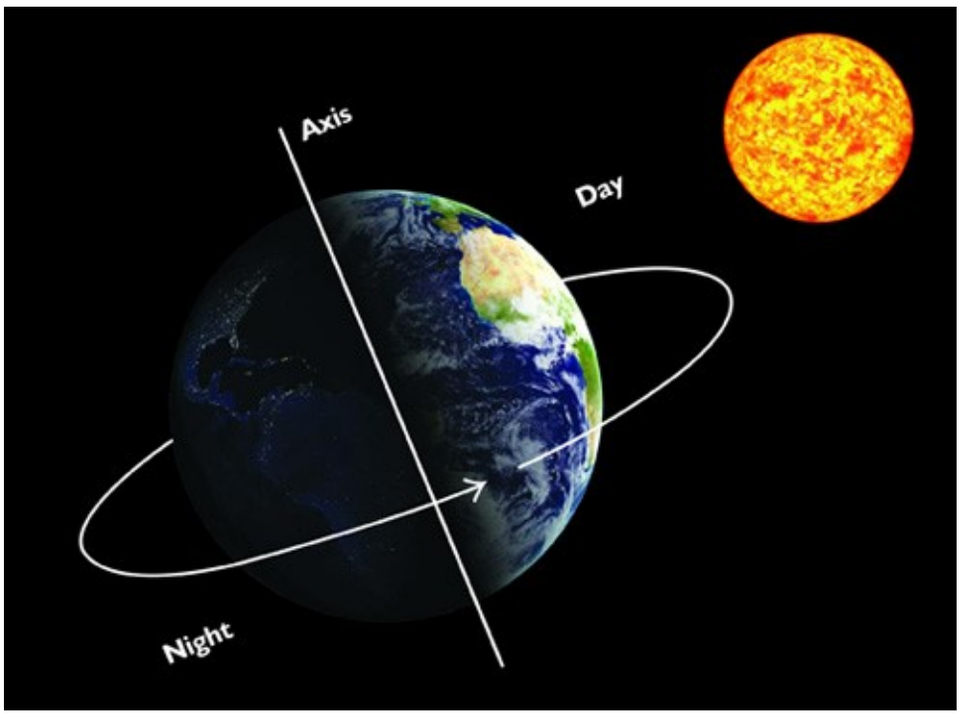
But, it doesn't work as a theory once you go beyond the everyday.



A Better Explanation of the Daily Patterns of the Sun?

The daily patterns of the sun can also be understood by assuming:

- The sun is stationary.
- Earth rotates on its axis once every 24 hours, as shown.
- Half of Earth has day while the other half has night.
- The sun doesn't rise or set, the earth rotates, bringing day to different parts of its surface, from east to west.



A Better Explanation of the Daily Patterns of the Sun?

That explanation doesn't better explain the two phenomena we were discussing, but it does explain them.

It also provides the foundation we need to explain some other phenomena: the annual patterns of the sun.

Annual Solar Patterns

People described and predicted the annual patterns of the sun for many thousands of years.

Those patterns were connected to the seasons.

Can you think of why it'd be important to have a way of keeping track of the seasons?

Discuss.

Annual Solar Patterns

Being able to predict the seasons allowed people to plan their lives.

For instance, when to plant crops and when to harvest them.

North and South Hemispheres

On the next few slides we are going to talk about the seasons.

It's important to know that when it is summer in the northern hemisphere, it is winter in the southern hemisphere.

So during months of June, July, and August, it's summer in the northern hemisphere and winter in the southern hemisphere.

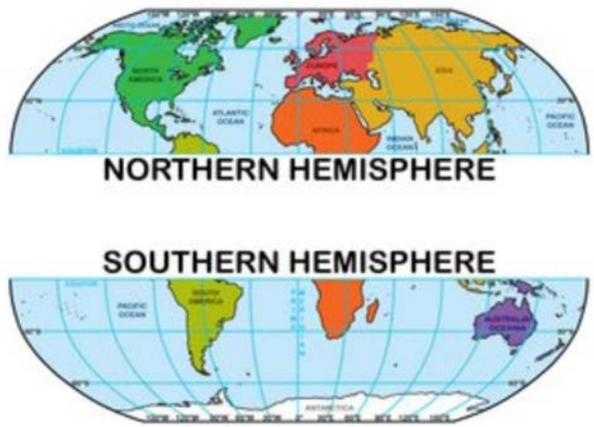
We'll explain why a little later in the chapter, but for now keep in mind when we say summer, we mean June, July, August for the northern hemisphere AND December, January, February for the southern hemisphere.

The Summer Sun

Each day after the winter solstice:

- The sun rises farther to the north in the northern hemisphere (and to the south in the southern hemisphere).
- Days (daylight hours) are longer.
- The sun is more overhead.

Until the summer solstice.



Summer Solstice

In the northern hemisphere:

- The sun rises farther to the north each day until it reaches its northernmost point.
- On that day, the sun would "stand still" in its daily progression northward.

The Latin word for sun is "sol" and for "stand still" is "sistere" so "solstice" is the day sunrises stand still in their movement north or south.

The pattern is opposite in the southern hemisphere, sunrises move to the south until they reach their southernmost point.

Summer Solstice

The day when the sun rises farthest to the north in the northern hemisphere, or farthest to the south in the southern hemisphere, is called the summer solstice.

The summer solstice is also the longest day of the year.

And, marks the beginning of summer.

It occurs on about June 21 in the northern hemisphere.

It occurs on about December 21 in the southern hemisphere.

Those dates are linked to important celebrations in most cultures.

The Winter Sun

Each day, after the summer solstice:

- The sun rises farther to the south in the northern hemisphere (and to the north in the southern hemisphere).
- Days (daylight hours) are shorter.
- The sun is less overhead.

Until the winter solstice.

Winter Solstice

In the northern hemisphere:

- The sun rises farther to the south, on the eastern horizon, each day until it reaches its southernmost point.
- On that day, the sun would "stand still" in its daily progression southward.

The pattern is opposite in the southern hemisphere, sunrises move to the north until they reach their northernmost point.

Winter Solstice

The day when the sun rises farthest to the south in the northern hemisphere, or farthest to the north in the southern hemisphere, is called the winter solstice.

The winter solstice is also the shortest day of the year.

It marks the beginning of winter.

It occurs on about December 21 in the northern hemisphere.

It occurs on about June 21 in the southern hemisphere.

Equinoxes

Exactly in between the winter and the summer solstices are the equinoxes.

On equinoxes, the length of daytime and nighttime are equal everywhere on Earth.

(Equinox comes from Latin for "equal nights.")

The vernal (spring) equinox takes place as the sun moves from the winter to the summer solstice.

The autumnal equinox occurs as the sun moves from the summer to the winter solstice.

Equinoxes

The vernal (spring) equinox takes place on about

- March 21 in the northern hemisphere.
- September 21 in the southern hemisphere.

When do you think the autumnal equinox would occur in each hemisphere?

Discuss.

Equinoxes

The autumnal equinox occurs on the reverse dates:

- September 21 in the northern hemisphere.
- March 21 in the southern hemisphere.

Annual Patterns of the Sun

- The summer solstice (the longest day) occurs in one hemisphere on the day the winter solstice (shortest day) occurs in the other.
- Equinoxes (day and night of equal length) occur twice a year, exactly between the solstices.
- Sunrises moves further north during summer in the northern hemisphere and further south in the southern hemisphere. The reverse occurs in winter.
- The sun is more overhead during the summer than in the winter.
- Each solstice or equinox occurs once each 365.25 days.

The Solstices

These stones at Stonehenge date back many thousands of years and still accurately predict the solstices and equinoxes.

Those dates are critical for farming and survival.

Why?

Discuss.

Winter Solstice

The northern hemisphere's winter solstice at Stonehenge.

That is the day the sun shines between these two stones at sunrise.

After December 21, each day is longer in the north, and shorter in the south, until June 21.

What would be the date of the winter solstice in the southern hemisphere?

Summer Solstice

Here's the summer solstice at Stonehenge.

The sun at sunrise aligns with these stones only on this day.

The hours of daylight grow shorter each day after the summer solstice, until the winter solstice.

Equinoxes

Two days each year the length of day is equal to the length of night everywhere on Earth.

The vernal (spring) equinox is on about March 21 in the northern hemisphere while the autumnal (fall) equinox is on about September 21.

Those equinoxes' dates are reversed in the southern hemisphere.

This is the vernal equinox at Stonehenge.

To be Precise...

On equinoxes, the number of daylight hours is supposed to equal the number of nighttime hours. However, this is not actually the case, for two major reasons.

1. The sun is a disc on the horizon, not a point. That adds to the length of the day, and shortens the night, for the time it takes for all of the sun to rise and to set.

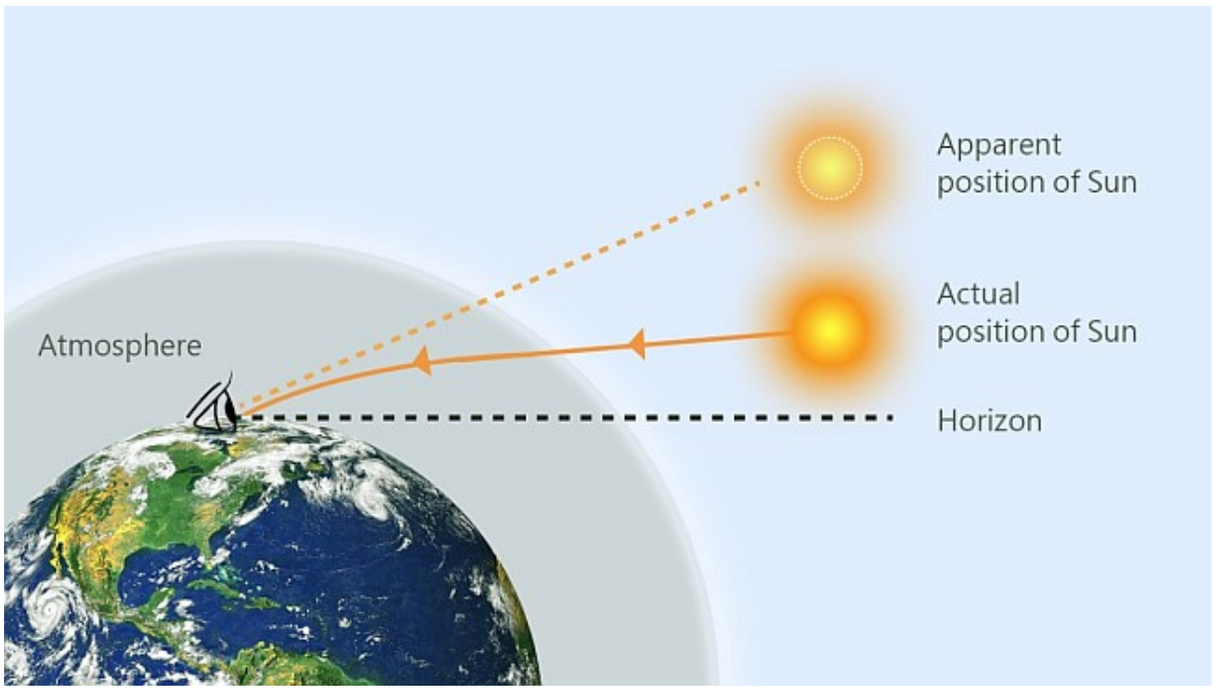
This effect depends on your latitude but adds at least 2 minutes to the daylight hours and takes them from the nighttime hours.

To be Precise...

2. The sun's light is bent by the atmosphere, adding more daylight hours. We see the sun rise before it actually does and we still see it above the horizon after it has set.

These two effects depend on your latitude.

Together, they lengthen the equinox daylight hours, and reduce its nighttime hours, by at least 8 minutes.



However, it is the case that there will be 12 hours from when the center of the sun actually crosses the horizon at sunrise and then sunset.

4 You observe the winter solstice on June 21. Where are you?

A northern hemisphere

B southern hemisphere

C eastern hemisphere

D western hemisphere

E I need help

Answer

https://njctl.org/video/?v=kHMQgIiP_qk

5 You observe the vernal equinox on March 21. Where are you?

A northern hemisphere

B southern hemisphere

C eastern hemisphere

D western hemisphere

E I need help

Answer

https://njctl.org/video/?v=RdAwxplOIqQ

6 You observe the autumnal equinox on March 21. Where are you?

A northern hemisphere

B southern hemisphere

C eastern hemisphere

D western hemisphere

E I need help

Answer

https://njctl.org/video/?v=AP89ks5Mo6g

7 You observe the summer solstice on June 21. Where are you?

A northern hemisphere

B southern hemisphere

C eastern hemisphere

D western hemisphere

E I need help

Answer

https://njctl.org/video/?v=XozHolDsJ6c

8 How long is the night on March 21?

A 6 hours

B 12 hours

C 18 hours

D it depends where you are

E I need help

Answer

https://njctl.org/video/?v=6uOa5j6ZQcE

9 In the northern hemisphere, the sun rises at its northernmost point on which date?

A Vernal Equinox

B Summer Solstice

C Autumnal Equinox

D Winter Solstice

E I need help

Answer

https://njctl.org/video/?v=A6mSZ2ueE0I

10 On which date is the night 12 hours long everywhere on Earth?

A Vernal Equinox

B Summer Solstice

C Winter Solstice

D I need help

Answer

https://njctl.org/video/?v=j-ZntY6EFSw

11 In the southern hemisphere, the sun rises at its northernmost point on which date?

A Vernal Equinox

B Summer Solstice

C Autumnal Equinox

D Winter Solstice

E I need help

Answer

https://njctl.org/video/?v=Y_sGJNUqCS4

12 In the southern hemisphere, the sun rises at its southernmost point on which date?

A Vernal Equinox

B Summer Solstice

C Autumnal Equinox

D Winter Solstice

E I need help

Answer

https://njctl.org/video/?v=FGlxPCZ-YcA

13 About how many days, to the nearest whole number, are there between summer solstices in the northern hemisphere?

A 30 days

B 91 days

C 183 days

D 365 days

E I need help

Answer

https://njctl.org/video/?v=lYiqM7Fp0Hc

14 About how many days, to the nearest whole number, are there between equinoxes?

A 30 days

B 91 days

C 183 days

D 365 days

E I need help

Answer

https://njctl.org/video/?v=HsOe008yF8c

The Seasons

Some people think that the summer is warmer than the winter because Earth is closer to the sun in the summer.

How would you disprove that based on the annual patterns we've described?

Discuss.

https://njctl.org/video/?v=cjyxrhSlji0

Explaining Solar Patterns

https://njctl.org/video/?v=ZNS3I_vscH0

Return to Table of Contents

Explaining the Solar Patterns

The annual solar pattern we've observed repeats about every 365.25 days.

While people could document and predict the apparent motion of the sun, they couldn't explain it until the the time of Isaac Newton.

There are two motions going on at the same time:

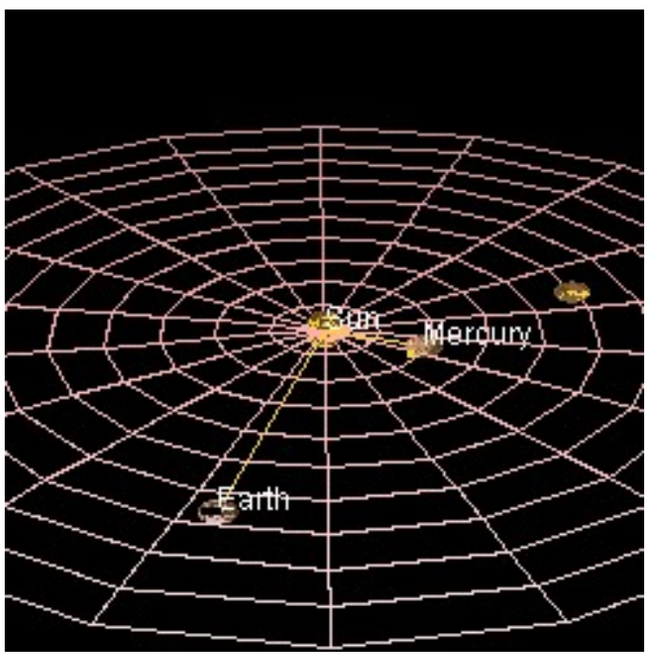
- Earth rotates once each day on its axis.
- Earth revolves around the sun once each year (365.25 days).

Explaining the Solar Patterns

Earth is moving in two different ways:

Earth **rotates** about its axis.

Rotation describes spinning, not traveling through space in an orbit.



Earth **revolves** around the sun.

Revolution describes moving through space in an orbit around another object.

The Tilt of Earth's Axis

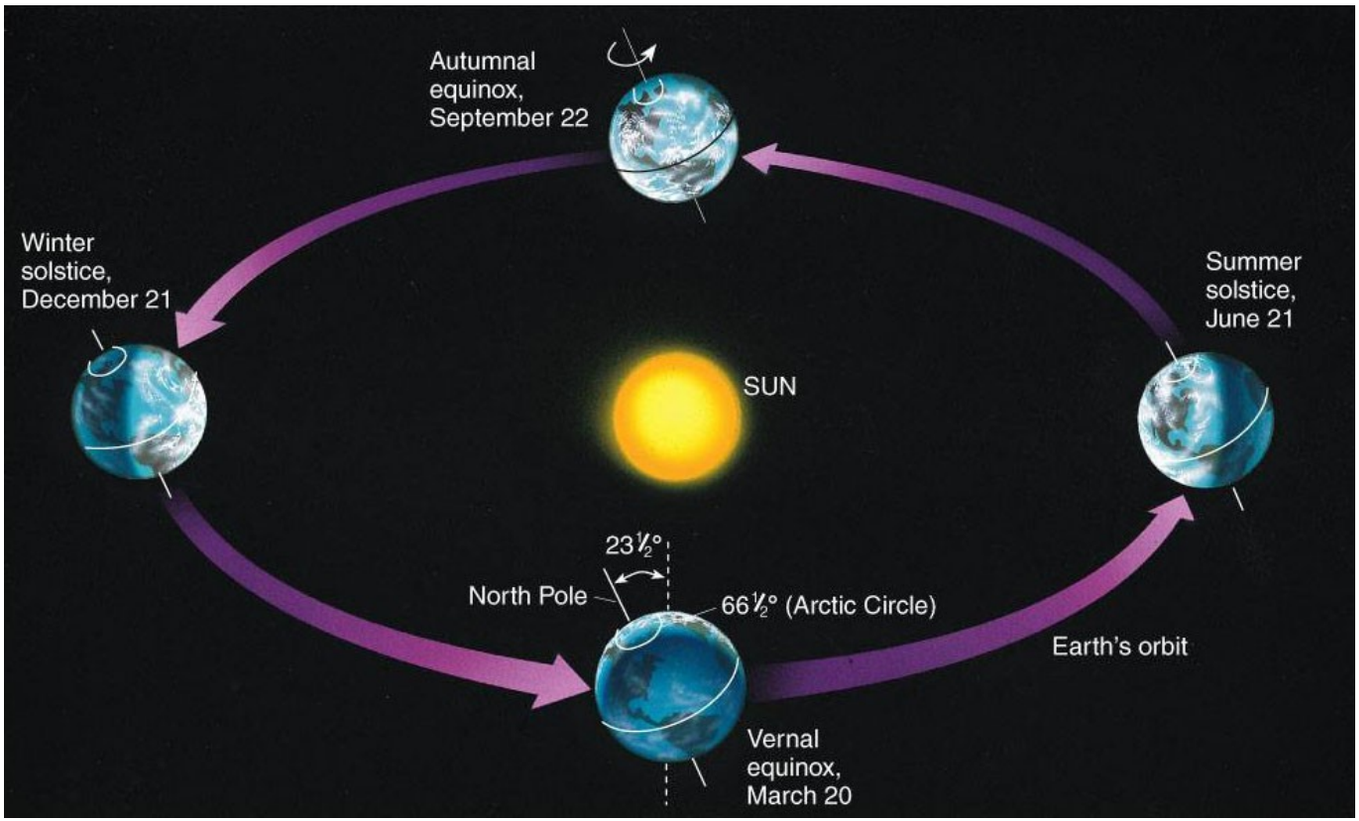
If Earth's axis of rotation was perpendicular to its orbit, this would not explain the annual solar patterns or the seasons.

Earth would be in different parts of its orbit for each of the 365 days, but every day would be like the last.

But the Earth's axis of rotation is tilted by 23.5^{o} relative to its orbit.

That explains what we see around us, including the seasons.

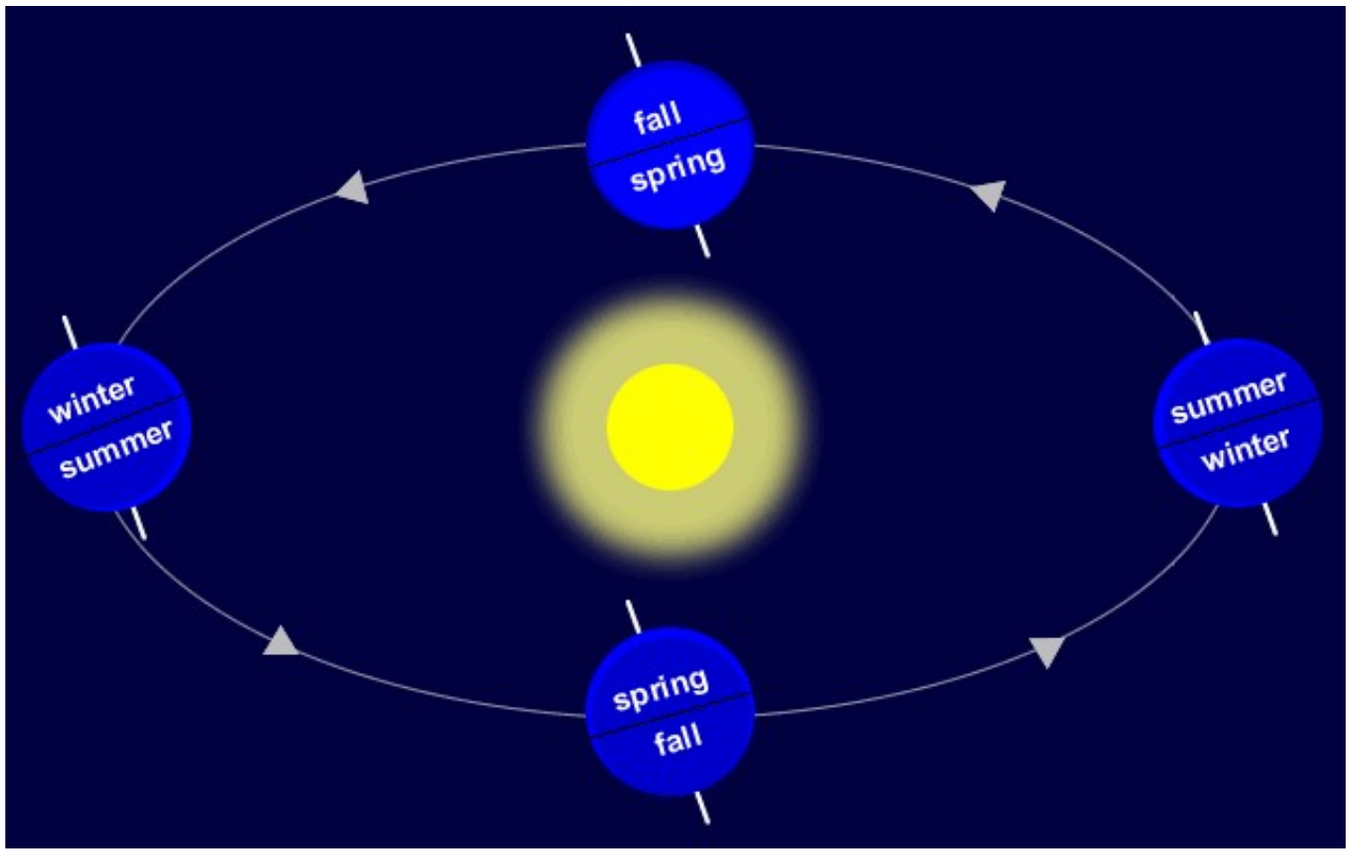
Explaining the Solar Patterns



Do you see how the sun is directly over different parts of Earth when in different parts of Earth's orbit? (The next slides may help.)

Discuss: The solstices and equinoxes are named here based on someone living in which hemisphere?

Explaining the Solar Patterns



Note how the seasons are reversed in the two hemispheres.

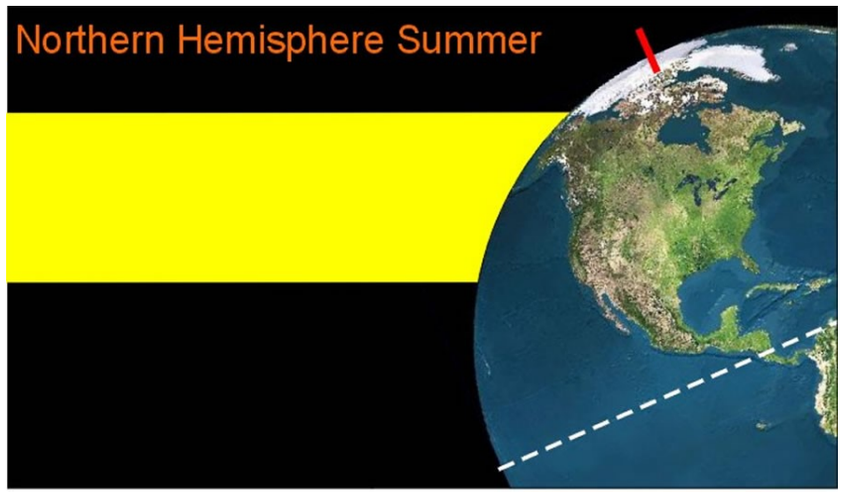
Explaining the Solar Patterns

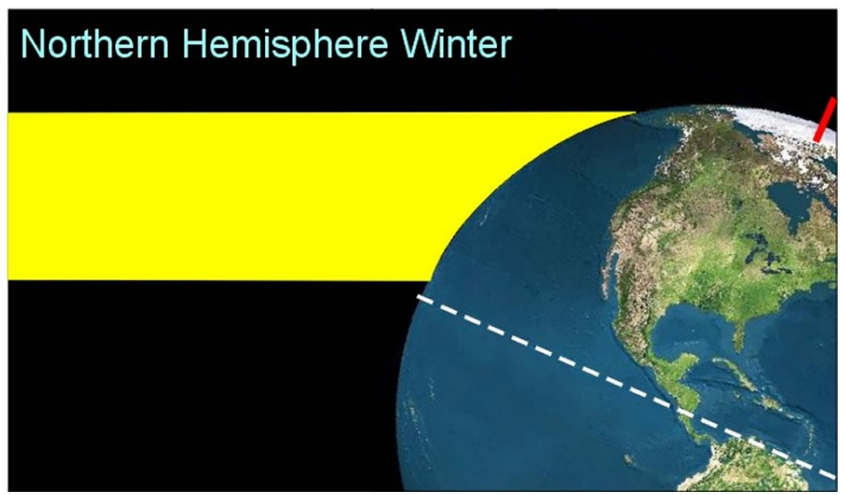
This is a snapshot of Earth at the same time of day, but in the winter versus the summer.

On one side of its orbit, the sun is more overhead.

Moving around its orbit, the sun would appear to be rising farther north or south each day.

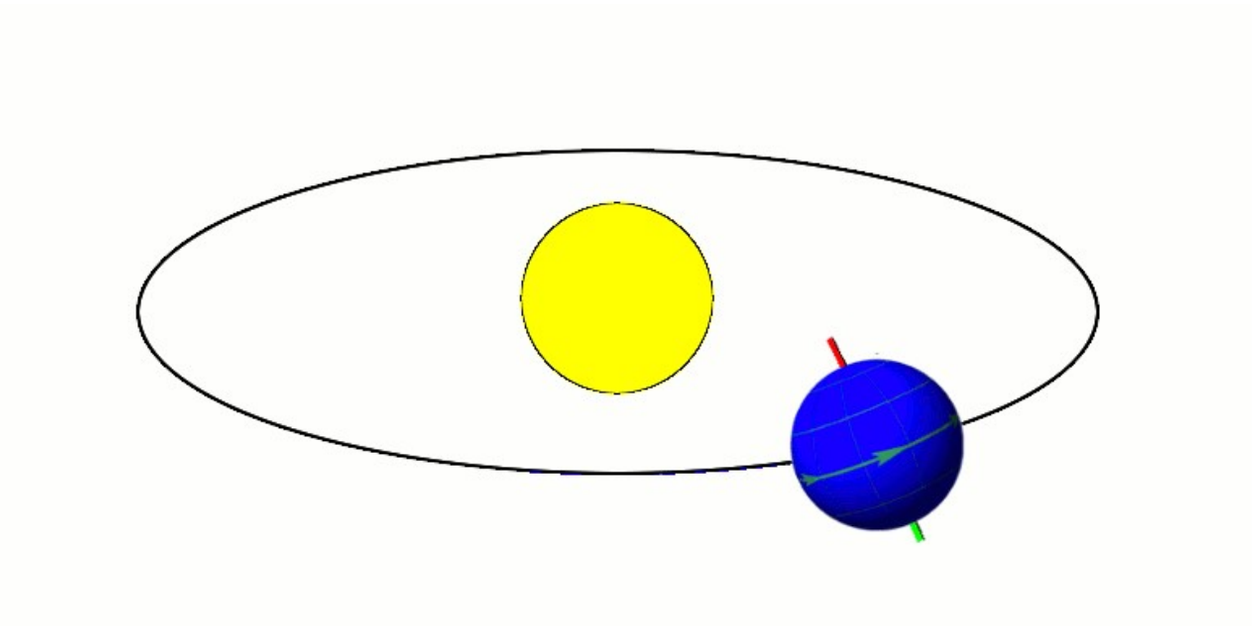
Keep in mind that this is a snapshot. Earth would rotate every 24 hours in this orbital location.





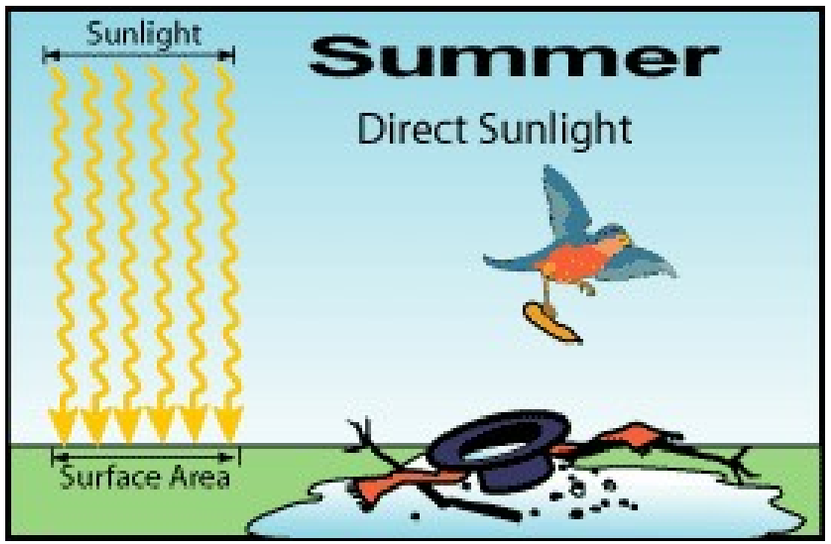
The Earth's Tilt

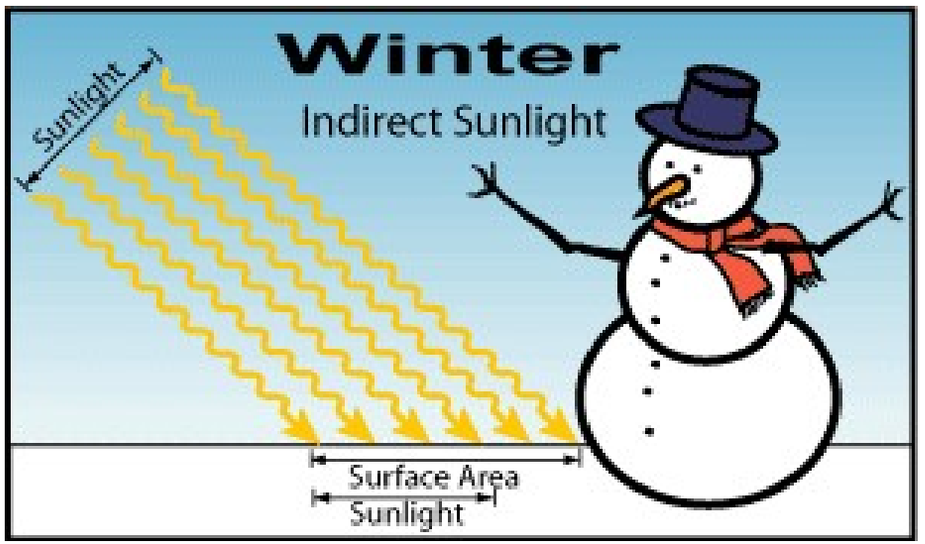
As the Earth circles the sun, the tilt of its axis creates the seasons.



Sunlight is more concentrated in the Summer

In the summertime, the sun is more directly overhead, so its light is spread over a smaller area, making it warmer than in the winter.





Days are longer in the summer than winter

In the summer, the longer days allow Earth's surface to be heated by the sun for a longer period of time.

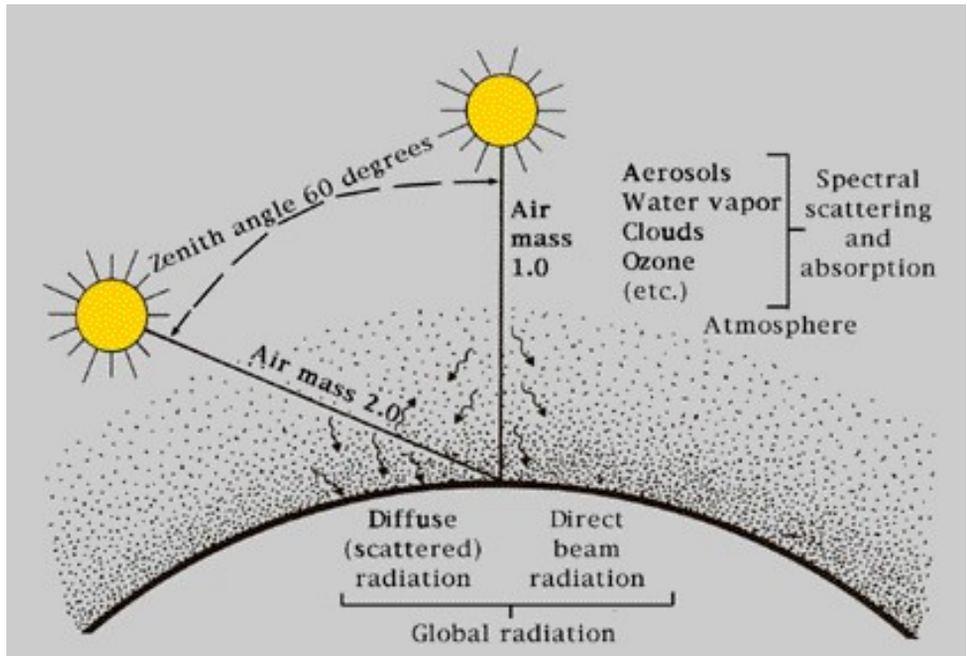
This makes the air, ground, and water heat up!

Sunlight Travels Through Less Atmosphere

In the summer, the sun is more overhead, so it passes through less of the atmosphere, so more of it reaches the ground without being reflected or absorbed.

When the sun is at the position on the left, its light passes through more atmosphere than when it is overhead.

So, in the summer, more sunlight reaches the surface, heating it more.



15 If the Northern Hemisphere is experiencing summer, what season would the Southern Hemisphere be experiencing?

A Spring

B Summer

C Autumn

D Winter

E I need help

Answer

https://njctl.org/video/?v=K9mWNqDOWis

Equator

People who live near, or on, the Equator generally experience the same temperatures year round.

This is because the sun is always pretty close to being overhead the equator.

The closer you get to the Equator, the less your seasons will change over the course of the year.

https://njctl.org/video/?v=d9wqm3t6Yzk

Spring and Fall

Spring and fall occur when neither pole is pointing toward or away from the sun.

The sun heats both hemispheres equally at these times.

This is why spring and fall have fairly similar temperatures (although spring tends to gradually heat up, while fall starts to cool down).

Equinox

The beginning of spring or fall is marked by an equinox.

16 Daylight hours are longer in the:

A Spring

B Summer

C Autumn

D Winter

E I need help

Answer

https://njctl.org/video/?v=kQQse7WBF3c

17 Sunlight passes through more atmosphere in:

A Spring

B Summer

C Autumn

D Winter

E I need help

Answer

https://njctl.org/video/?v=3hEZdlXJkJk

18 Sunlight is spread over more land area in:

A Spring

B Summer

C Autumn

D Winter

E I need help

Answer

https://njctl.org/video/?v=BujP8aPfkPk

19 Daylight hours are close to half the day during:

A Summer and Winter

B Summer and Spring

C Winter and Autumn

D Spring and Autumn

E I need help

Answer

https://njctl.org/video/?v=NkRjqaFIiZY

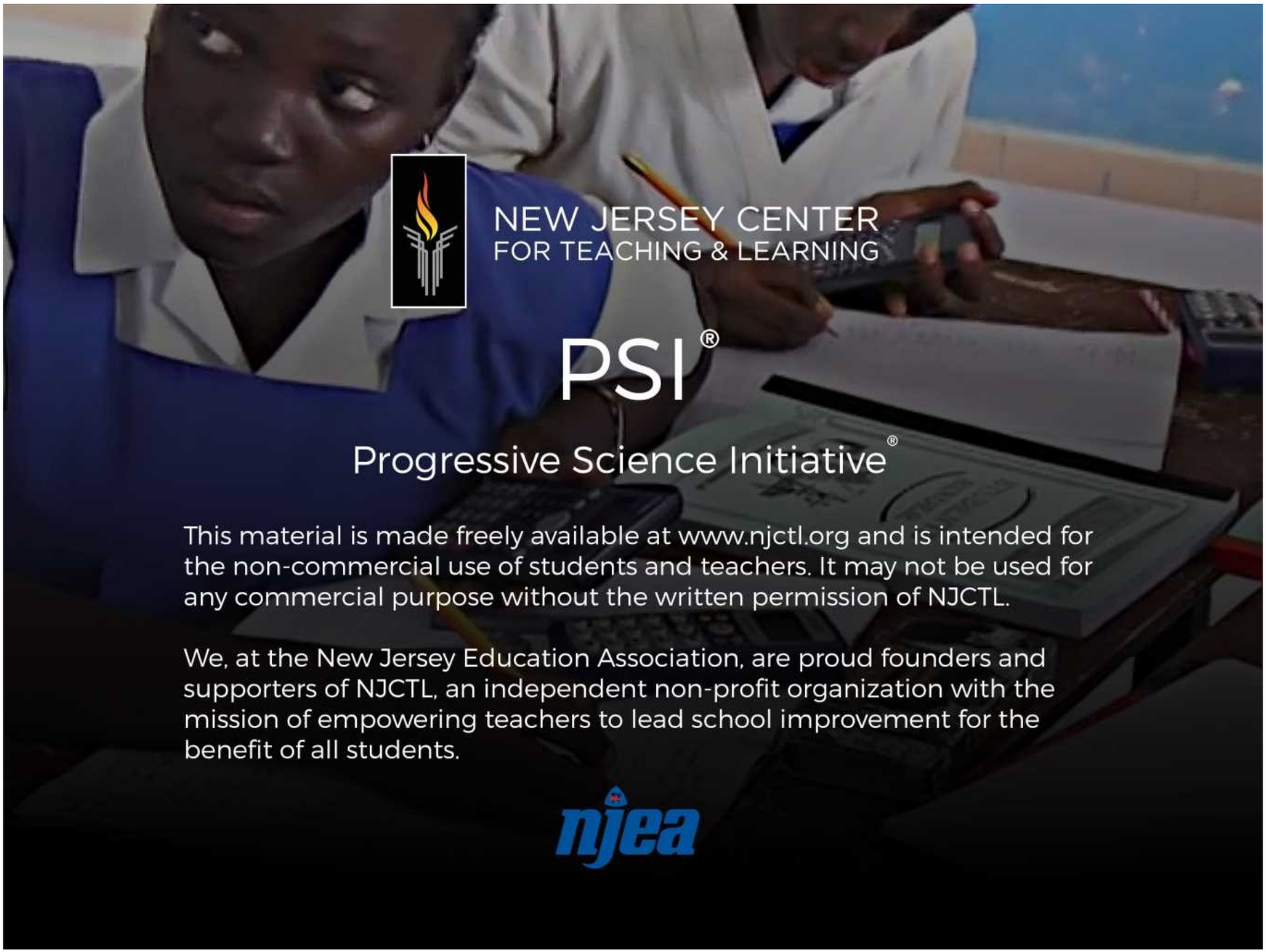
More Information

To download the entire presentation that contains these slides, please use the link below:

https://njctl.org/materials/resources/earth-moon-sun-system-presentation/attachments/

To access the full chapter of files that support the content in this presentation, please use the link below:

https://njctl.org/materials/chapters/earth-moon-sun-system/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