A Content Secondary Science Newsletter from the Southern Nevada Regional Professional Development Program

Science Dissected

Reasons for the Seasons
Model-Evidence Link Diagram (MEL)

There is a popular misconception that the seasons on the Earth are caused by varying distances of the Earth from the Sun on its elliptical orbit. The seasons are controlled by the distance between the earth and sun. During winter, the earth is farther from the sun than in summer. The primary cause of the seasons is the 23.5 degree of the Earth's rotation axis with respect to the plane of the ecliptic. This means that as the Earth goes around its orbit the Northern hemisphere is at various times oriented more toward and more away from the Sun, and likewise for the Southern hemisphere. Thus, we experience Summer in the Northern Hemisphere when it is oriented more toward the Sun and therefore the Sun rises higher in the sky and is above the horizon longer, and the rays of the Sun strike the ground more directly.

Model A: Seasons are caused by variations in the amounts of the Sun's energy reaching Earth's surface due to the planet's elliptical orbit, and it is the distance from the sun.

Model B: Seasons are caused by variations in the amounts of the Sun's energy reaching Earth's surface due to the planet's axial tilt of 23.5 degrees.

Evidence #1: The Earth is closer to the sun during perihelion and further from the sun during aphelion.

Evidence #2: The Earth's relationship with the sun also creates seasons. The Earth's axis tips a little -- about 23.5 degrees. One hemisphere points toward the sun as the other points away.

Evidence #3: As Earth orbits the Sun, but tilted a bit and always with the axis pointed in the same direction. Different parts of Earth get the Sun's direct rays as we travel through the year causing different seasons.

Evidence #4: Earth has seasons because its axis is tilted. Earth rotates on its axis as it orbits the Sun, but the axis always points in the same direction.

The following is a suggestion for using this MEL with students:

1. Hand out the Reasons for the Seasons Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the four evidence texts presented.
2. Handout the four evidence text pages (pages 3-6).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-4 (pages 4-6).
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of the seasons and create questions that they might explore in the future.

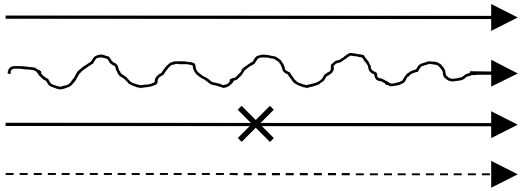
Archived Issues of Science Dissected, *http://www.rpdp.net/link.news.php?type=sciencedis*. ***Instructional Resource resulting from Plausibility, It's All About Connecting the Models Workshop co-sponsored by CPDD and SNRPDP Science March 6, 2012***

Written by: Juniper Gill

Name:_____ _____ **Period:**_____

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 8 arrows.

Key:



The evidence **supports** the model

The evidence **STRONGLY supports** the model

The evidence **contradicts** the model (shows its wrong)

The evidence has **nothing to do with** the model

Standard: E.8.A.1

Model A

Seasons are caused by variations in the amounts of the Sun's energy reaching Earth's surface due to the planet's elliptical orbit, and it is the distance from the sun.

Evidence #1

The Earth is closer to the sun during perihelion and further from the sun during aphelion.

Evidence #3

As Earth orbits the Sun, but tilted a bit and always with the axis pointed in the same direction. Different parts of Earth get the Sun's direct rays as we travel through the year causing different seasons.

Evidence #2

The Earth's relationship with the sun also creates seasons. The Earth's axis tips a little -- about 23.5 degrees. One hemisphere points toward the sun as the other points away.

Model B

Seasons are caused by variations in the amounts of the Sun's energy reaching Earth's surface due to the planet's axial tilt of 23.5^0.

Evidence #4

Earth has seasons because its axis is tilted. Earth rotates on its axis as it orbits the Sun, but the axis always points in the same direction.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate descriptor (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write the letter of the model you are writing about.
D. Then write your reason.

1. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

2. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

3. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

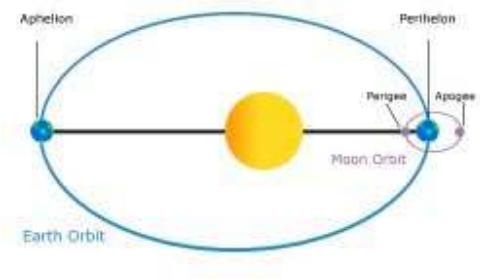
4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct

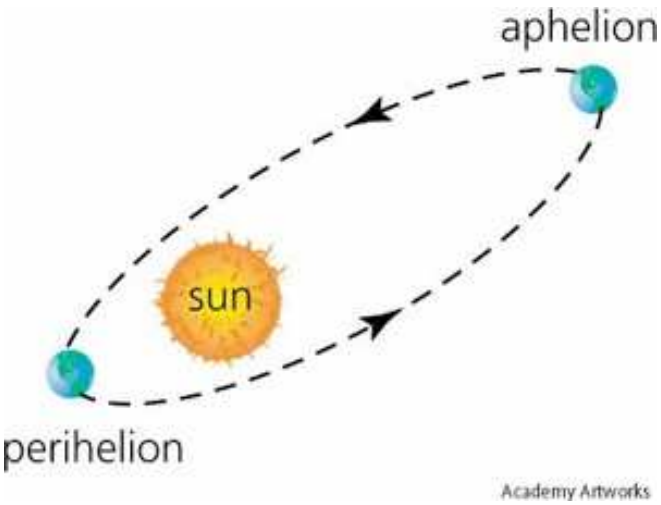
Evidence #1: The Earth is closer to the sun during perihelion and further from the sun during aphelion.



The Earth's orbit around the Sun has many interesting characteristics. First, the speed of our orbit is 108,000 km/h. The planet travels 940 million km during one orbit. The Earth completes one orbit every 365.242199 mean solar days(that might help explain the need for a leap year). The planet's distance from the Sun varies as it orbits. Actually, the Earth is never the same distance from the Sun from day to day. When the Earth is closest to the Sun it is said to be at perihelion. This occurs around January 3rd at a distance of 147,098,074 km. When it is at its furthest distance from the Sun, Earth is said to be at aphelion. That happens around July 4th at a distance of 152,097,701 km.

http://www.universetoday.com/61202/earths-orbit-around-the-sun/

Since the Sun is not at the center of an elliptical orbit, the planet moves closer towards and further away from the Sun as it orbits. The place where the planet is closest to the Sun is called perihelion. When the planet is furthest away from the Sun, it is at aphelion. The words "aphelion" and "perihelion" come from the Greek language. In Greek, "helios" mean Sun, "peri" means near, and "apo" means away from.



When Earth is at perihelion, it is about 147 million km (91 million miles) from the Sun. When it is at aphelion, it is 152 million km (almost 95 million miles) from the Sun. Earth is about 5 million km (more than 3 million miles) further from the Sun at aphelion than at perihelion!

http://web.me.com/davgen1/ILS/Earths_Orbit.html

Diagram is not to scale

Evidence #2: The Earth's relationship with the sun also creates seasons. The Earth's axis tips a little -- about 23.5 degrees. One hemisphere points toward the sun as the other points away.

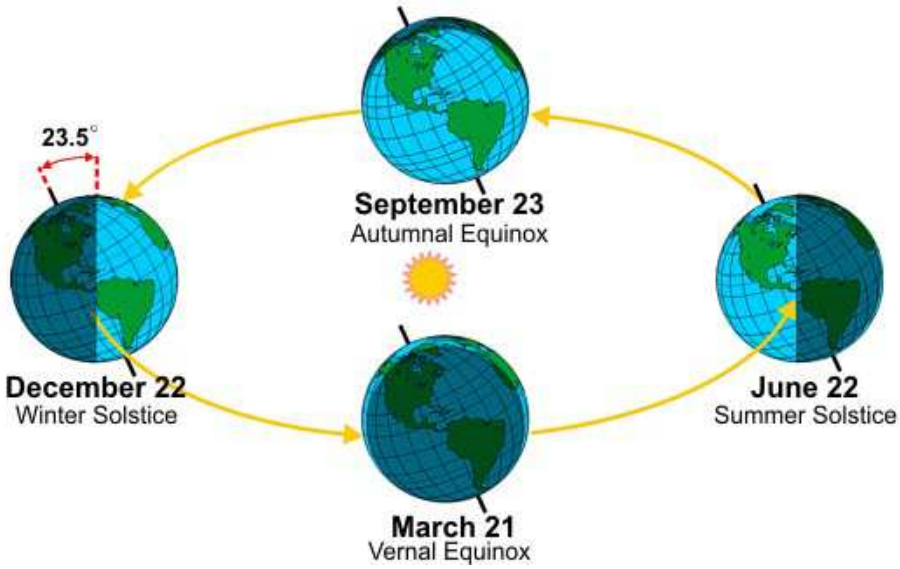
Some of the sun's biggest impacts on our planet are also its most obvious. As the Earth spins on its axis, parts of the planet are in the sun while others are in the shade. In other words, the sun appears to rise and set. The parts of the world that are in daylight get warmer while the parts that are dark gradually lose the heat they absorbed during the day.

You can get a sense of how much the sun affects the Earth's temperature by standing outside on a partly cloudy day. When the sun is behind a cloud, you feel noticeably cooler than when it isn't. The surface of our planet absorbs this heat from the sun and emits it the same way that pavement continues to give off heat in the summer after the sun goes down. Our atmosphere does the same thing -- it absorbs the heat that the ground emits and sends some of it back to the Earth.

The Earth's relationship with the sun also creates seasons. The Earth's axis tips a little -- about 23.5 degrees. One hemisphere points toward the sun as the other points away. The hemisphere that points toward the sun is warmer and gets more light -- it's summer there, and in the other hemisphere it's winter. This effect is less dramatic near the equator than at the poles, since the equator receives about the same amount of sunlight all year. The poles, on the other hand, receive no sunlight at all during their winter months, which is part of the reason why they're frozen.

http://science.howstuffworks.com/environmental/earth/geophysics/earth2.htm

Photo courtesy NOAA



Evidence #3: As Earth orbits the Sun, but tilted a bit and always with the axis pointed in the same direction. Different parts of Earth get the Sun's direct rays as we travel through the year causing different seasons.

Earth has seasons because sometime early in its long history, something very big hit the young Earth to knock it off-kilter. So instead of rotating with its axis perpendicular to its orbital plane, it is tilted 23.45 degrees from the perpendicular.

Incidentally, that big something that hit Earth also knocked a chunk of it out that became our Moon. At least that is generally accepted theory.

So, here we are, orbiting the Sun, but tilted a bit and always with the axis pointed in the same direction. So different parts of Earth get the Sun's direct rays as we travel through the year.

Thus, sometimes it is the North Pole tilting toward the Sun (like in June) and sometimes it is the South Pole tilting toward the Sun (like in December). Hence, the seasons. It is summer in June in the Northern Hemisphere because the Sun's rays hit that part of Earth more directly than at any other point in Earth's orbit - or, in other words, more directly than at any other time of the year. It is winter in December in the Northern Hemisphere, because that is when it is the South Pole's turn to be tilted toward the Sun.

It follows that if you live in North America, during the winter the Sun's path across the sky is more toward the south, rising in the southeast and setting in the southwest. During the summer, the Sun tracks more directly overhead, rising in the east, overhead at noon, and setting in the west. If you live in the Southern Hemisphere, the Sun will be more northerly in the sky during the winter (that is, June, July, and August).

http://scijinks.jpl.nasa.gov/earths-seasons

Evidence #4 Earth has seasons because its axis is tilted. Earth rotates on its axis as it orbits the Sun, but the axis always points in the same direction.
http://scijinks.jpl.nasa.gov/earths-seasons