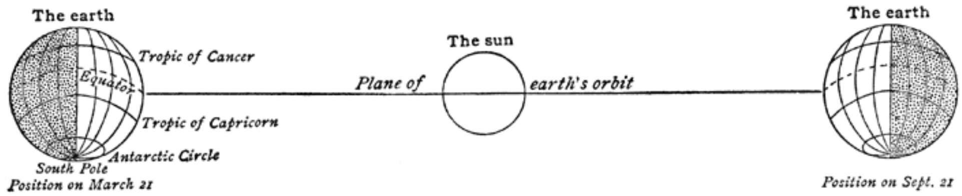
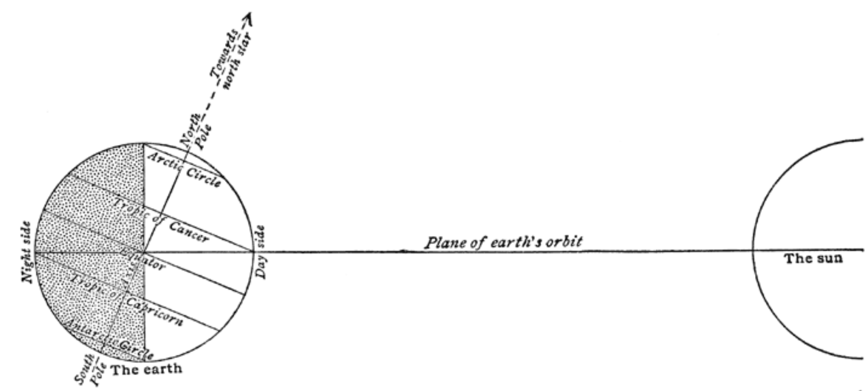
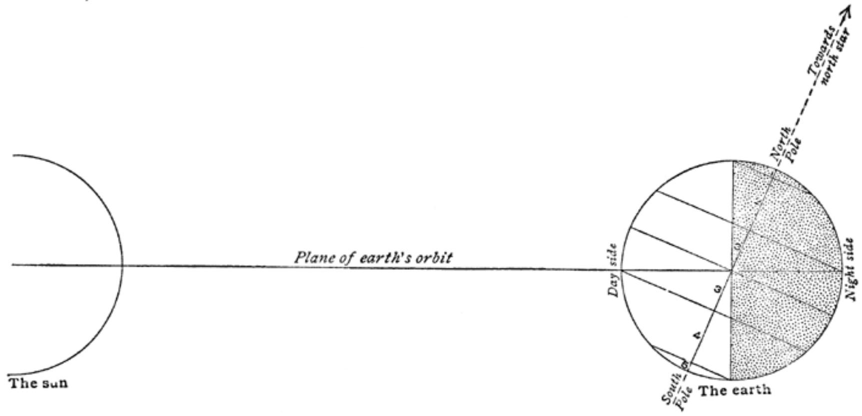
Name ____



Reason for the Seasons Workbook





Clipart from the Florida Center for Instructional Technology (FCIT)

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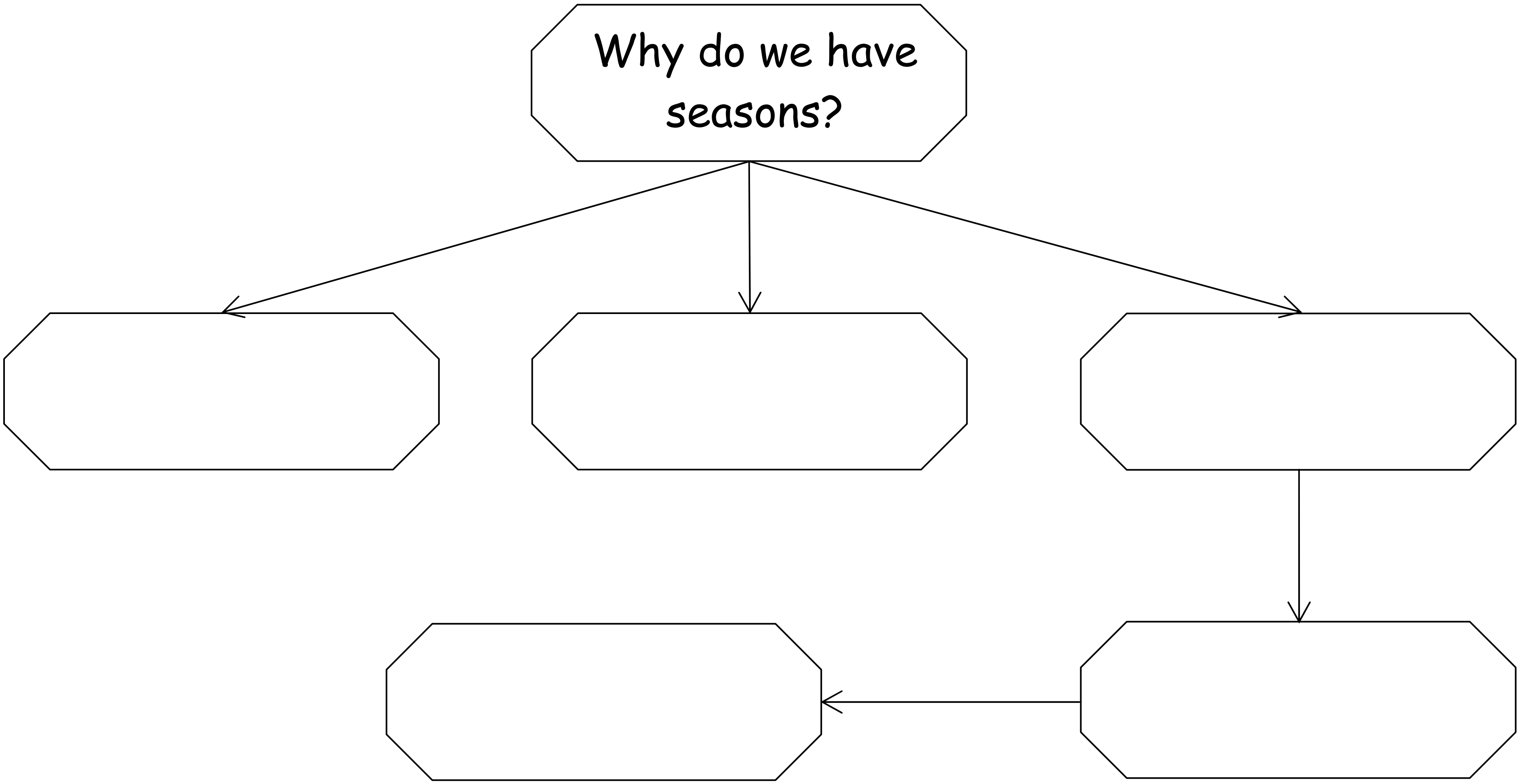

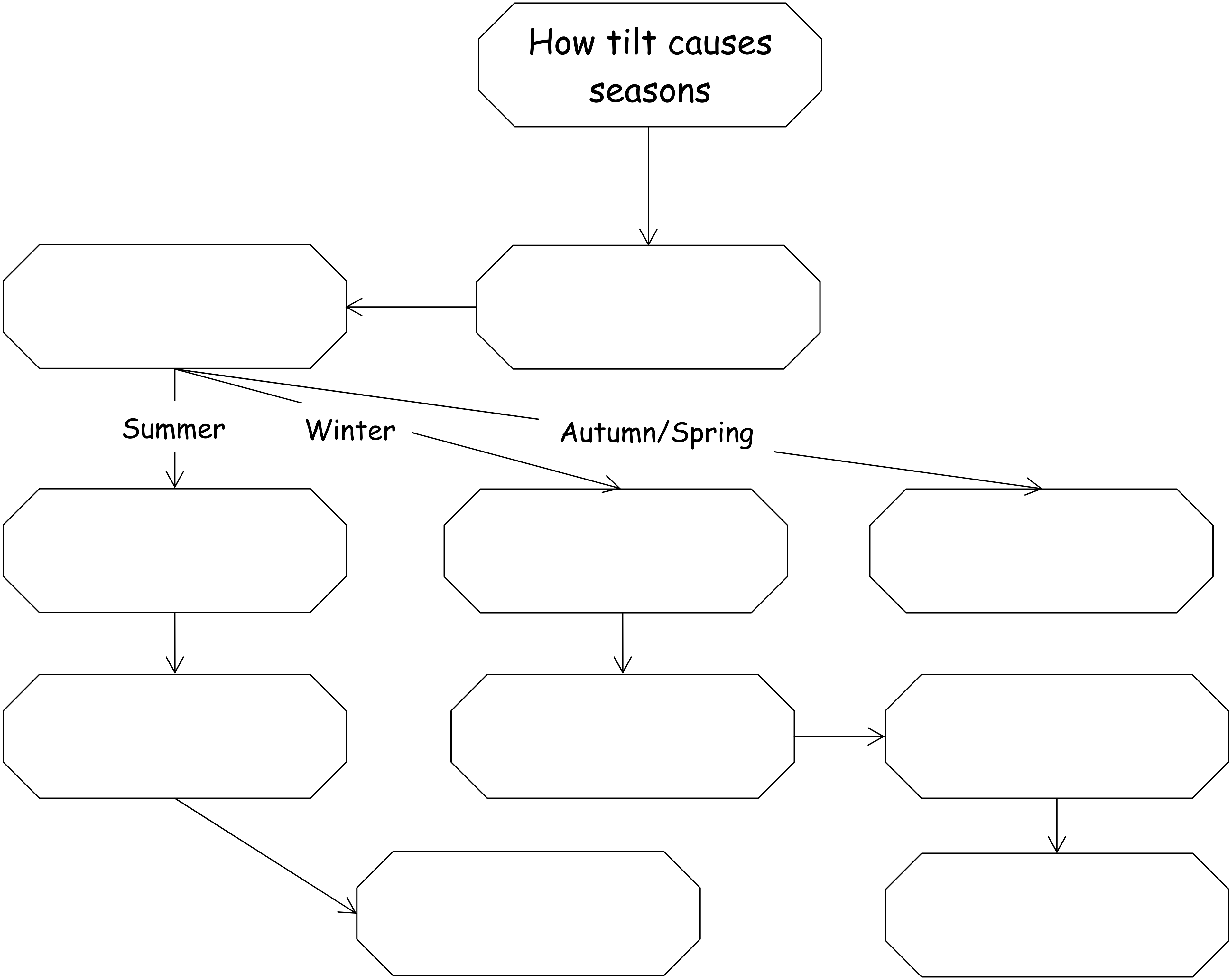
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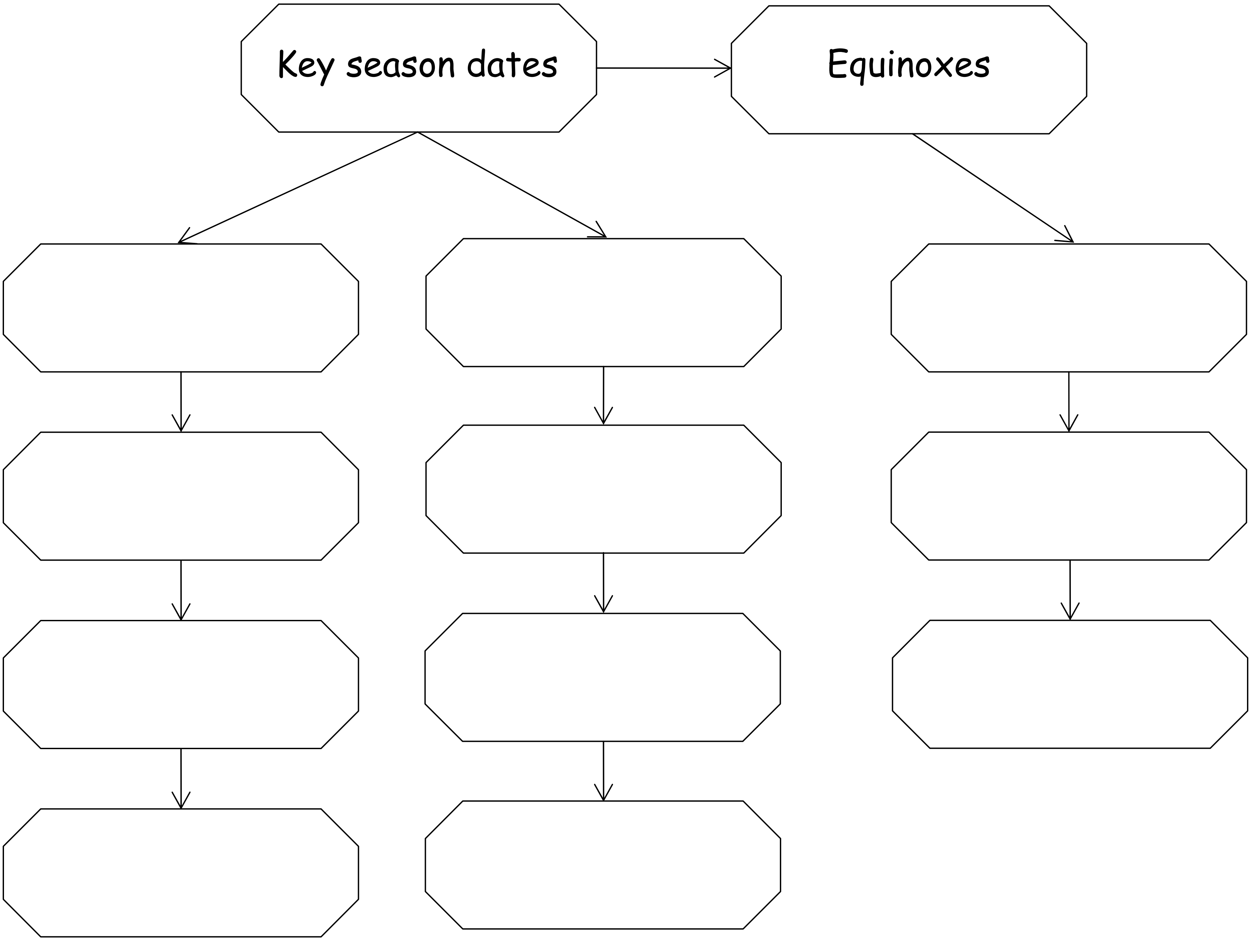
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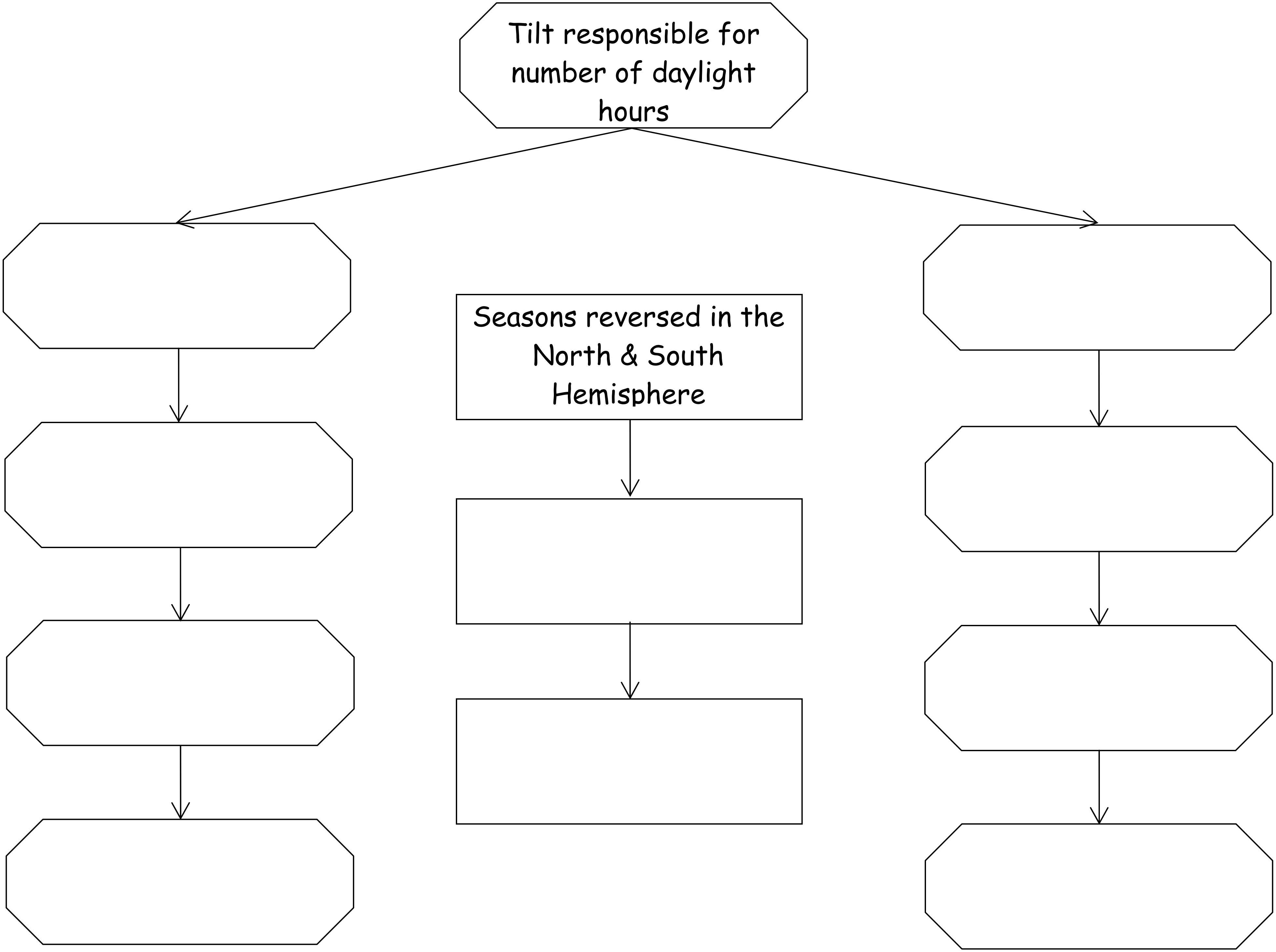
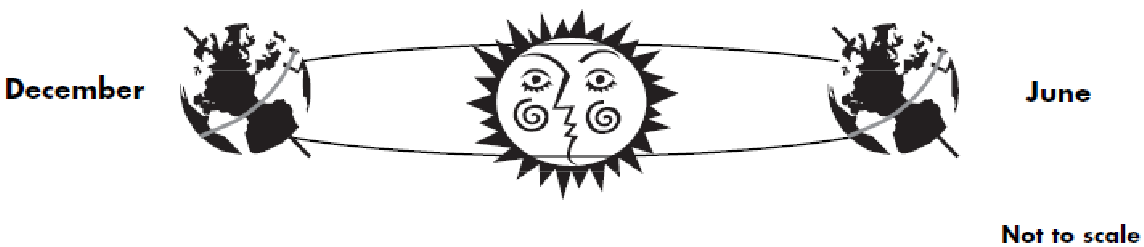

Tilt responsible for number of daylight hours
Seasons reversed in the North & South Hemisphere

What Causes the Seasons Factsheet

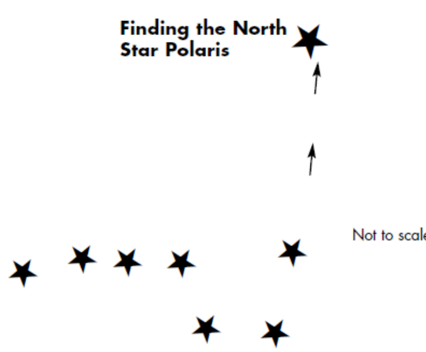
(modified form a lesson from Challenger Center for Space Science Education)

The equator divides the Earth into the Northern Hemisphere and the Southern Hemisphere. When the Northern Hemisphere has summer, the Southern Hemisphere has winter. When continents like Europe and North America have winter, southern continents like Australia have summer. Why does this happen? To understand why we have seasons, imagine yourself looking at Earth from far away.



Each year, the Earth makes one trip, or orbit, around the Sun. When looking down on the north pole, the Earth orbits counterclockwise around the Sun. The Earth's axis is the imaginary line that runs through the Earth from the north pole to the south pole. The Earth's axis is tilted 23.5°. This means that as the Earth travels around the Sun, different parts of the Earth will end up being tilted toward the Sun. In December, the Southern Hemisphere tilts toward the Sun. In June, the Northern Hemisphere tilts toward the Sun.

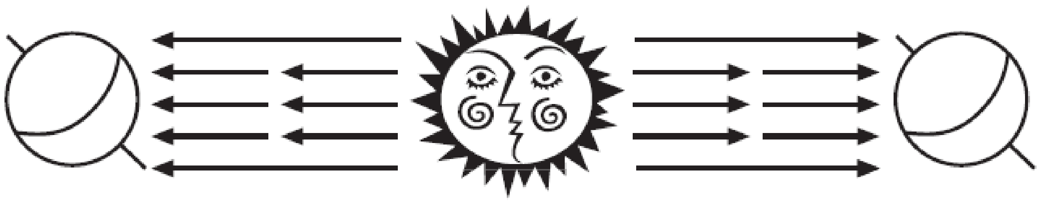
Our Pole Star



If you could extend the Earth's axis into space, the northern end would point toward a star called Polaris (poh-LARE-iss). Polaris means "the pole star." People sometimes call Polaris "The North Star." You can find Polaris at night in the Northern Hemisphere by using the Big Dipper.

Summer Sunlight: Direct and Intense

Being tilted toward the Sun does not make you much closer to the Sun. The reason a tilt toward the Sun causes warmer weather is due to more intense sunlight. When your hemisphere tilts toward the Sun, the rays of sunlight hit the hemisphere more directly. The energy from the sunlight is intense, warming the ground more. In winter, the Sun's rays hit the ground at a greater angle, spreading the sunlight's energy over a larger area.



Another Cause of the Seasons

The tilt of the Earth also has an effect on the length of daylight. When you are tilted toward the Sun in the summer, the Sun rises higher overhead at noon. Days are longer with shorter nights. Longer days mean more hours the sunlight can heat the ground. In the winter, the Sun is not as high in the sky at noon. It rises later and sets earlier. Shorter days mean less time that the Sun's energy can warm the ground, leading to cooler temperatures.

The Land of the Midnight Sun

The changing amount of daylight is extreme in the most northern and southern latitudes. In June, the Northern Hemisphere tilts enough toward the Sun that sunlight can reach all the land north of the Arctic Circle at the same time. As the Earth rotates, the Sun circles the dome of the sky, but never sets. Sometimes the lands far to the north are called "the Land of the Midnight Sun" because during the summer, the Sun will be shining even at midnight.

While the Sun is shining at midnight in northern Alaska, Antarctica has a long, dark winter. With the Southern Hemisphere tilted away from the Sun, most of Antarctica does not get any sunlight in June. Instead, Antarctica has 24 hours of darkness.

Bet Your Family an Ice Cream Sundae!

Bet your family a chocolate sundae with all the trimmings that they do not know the reasons for the seasons and see what happens! Many people believe the whole planet is

closer to the Sun in the summer than in the winter. If that were true, every place on Earth would have winter during the same months!

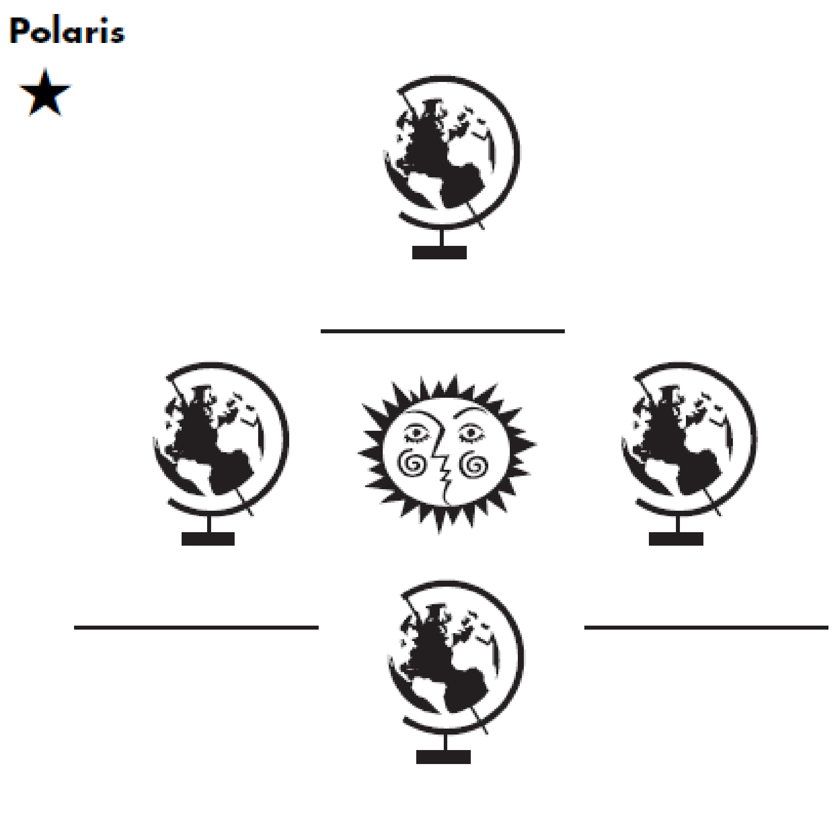
We know the Southern Hemisphere has winter while the Northern Hemisphere has summer. The distance between the Earth and the Sun does change because the Earth's orbit is not perfectly round, but it cannot cause the seasons we observe. Research shows us that the Earth is actually closest to the Sun around January 3 each year—almost the coldest time of year for most of the Northern Hemisphere.

Your Mission

King Caeson and his family have some questions. Is December a good time of year to vacation in Australia? What clothes should they pack?

As Royal Court advisors, study models of the Sun and Earth to figure out the reasons for the seasons and give King Caeson advice about his vacation plans.

1. Label each month, based on the Earth's position:



Warming the Earth

2. Observe the shape and size of the grid boxes for June and December in the Northern Hemisphere and the Southern Hemisphere. Write two observations comparing the grid's boxes.

	June	December
Northern Hemisphere	1. 2.	1. 2.
Southern Hemisphere	1. 2.	1. 2.

3. Which hemisphere gets the most energy from sunlight in…

June?

December?

4. Based on your answers for question 3, where do you think it is usually warmer in December? (circle one)

Continental United States	Australia	It is not warm in in either place.

Angle of Light Rays and Surface Distribution

(a Lesson from *Meteorology Activities for Grades 5-9*, Chapter 4, a NASA publication)

Data Table	
Angle	Diameter (cm)
90°	cm
60°	cm

30°	cm

Examining the Results

1. Did you find any differences in the area covered by the light rays as you varied the angle of the flashlight? Explain.

2. Did you discover other differences in the area covered by the light rays as the angle changed? Explain.

3. Assume that the unit of light coming through the 1.25 cm (0.5 in.) square opening represents a certain unit of energy. At which angle would the surface of the material be receiving the greatest amount of energy?

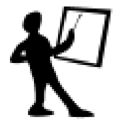
4. At which angle would the surface be receiving the least amount of energy?

5. Over a long exposure to light rays at the various angles, predict which angle would likely have the highest temperature reading. Why?

6. What natural factors cause the Sun's rays to strike the Earth's surface at different angles? How could you find out?

7. Based on the data generated with the activity, what major conclusion did you make?

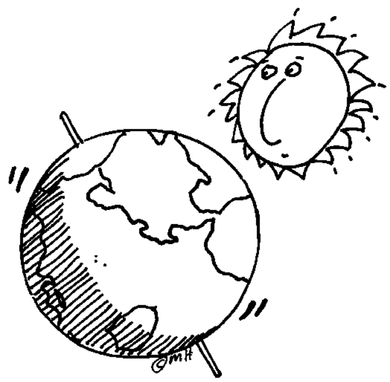
The Shadow Knows



Choose four acute angles (an angle that is between 0° and 90°) and write them on the chart.

Angle of Your Light	Shadow Length in Centimeters

6. Using the data from the chart, write a statement that describes the relationship between the angle of incidence and the shadow.



Reason for the Seasons

Read This First!

Today your group will model the Earth's orbit around the Sun!

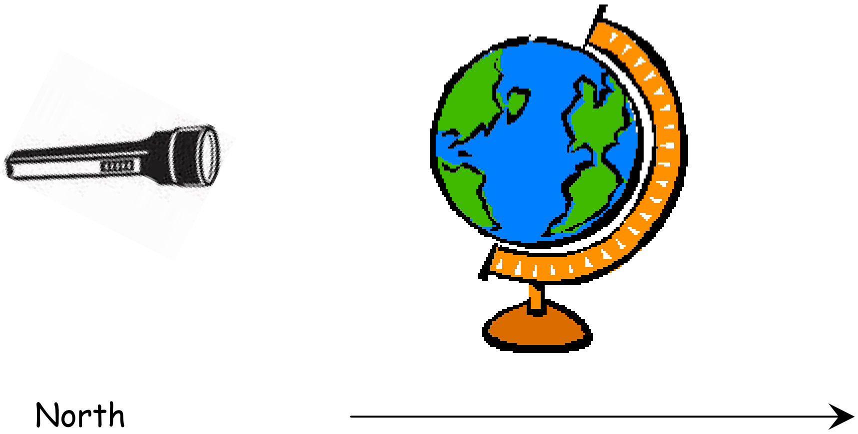
Look at the position of the stickers on the table. Each dot is labeled with a letter, **"A", "B", "C", or "D"**.

Examine the globe on your table. **Notice how the Earth is tilted on its axis**. The Earth ***ALWAYS*** tilts in the same direction on its axis. Make sure that *your* globe is ***ALWAYS*** tilting in the same direction. **For this activity, position the globe so it tilts toward the *north***.

You will be moving the Earth ***COUNTER-CLOCKWISE*** around the flashlight "Sun". Observe the Earth in different positions during its yearly **revolution**. Each time you move the globe into a new position on the table, make sure that the globe ***ALWAYS*** tilts toward the north!

Procedure

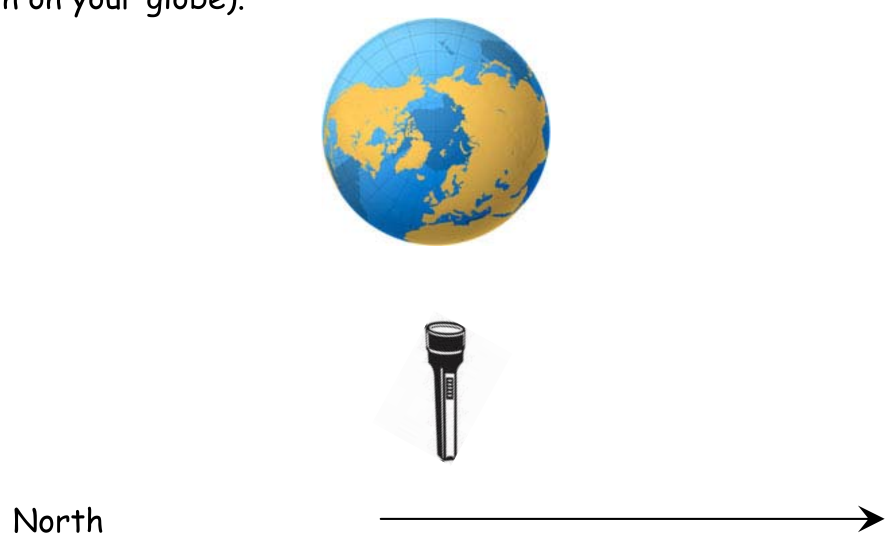
1. Position the Earth so that the Earth's axis is positioned over the dot labeled "**A**". Have a group member point the flashlight at the dot on the globe (see diagram below).



Where does the Sun appear to shine most intensely when the globe is on "A"? Circle the best answer below.

Above the equator **Below the equator** **On the equator**

2. Move the Earth counter-clockwise and place it over the dot labeled "**B**". Remember, ***the globe should be tilted toward the front of the room*** at all times! Turn the globe so the dot is showing. You will be pointing your flashlight at the dot (diagram is as if you are looking down on your globe).

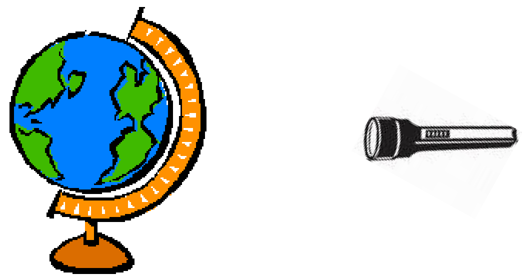


Examine the new position. Where does the Sun appear to shine most intensely when the globe is on dot "B"? Circle the best answer below.

Above the equator **Below the equator** **On the equator**

How many months would it really take the Earth to move $\frac{1}{4}$ of its orbit around the Sun? (Hint: Think of the total number of months in a year). _____ months

3. Move the Earth counter-clockwise again and position the globe so that it is positioned over the dot labeled "***C***". **Remember to keep the globe tilted toward the front of the room at all times**! Turn the globe so the dot is showing. You will be pointing your flashlight at the dot.



North →

Where does the Sun appear to shine most intensely when the globe is on dot "*C*"? Circle the best answer below.

Above the equator **Below the equator** **On the equator**

4. Move the Earth counter-clockwise and place it over the dot labeled "**D**". Remember, ***the globe should be tilted toward the front of the room*** at all times! Turn the globe so the dot is showing. You will be pointing your flashlight at the dot (diagram is as if you are looking down on your globe).

North →

Examine the new position. Where does the Sun appear to shine most intensely when the globe is on dot "S"? Circle the best answer below.

Above the equator **Below the equator** **On the equator**

5. Discuss the following idea with your group. Come write an answer upon which everyone agrees.

In what position (over dot A, B, C, or D) was the globe and the Sun (flashlight) when Brigham City was experiencing summer? How do you know? Explain your answer.

Seasons: Four Times of the Year

(an activity from *Janice Van Cleave's A+ Projects in Astronomy*)

Question

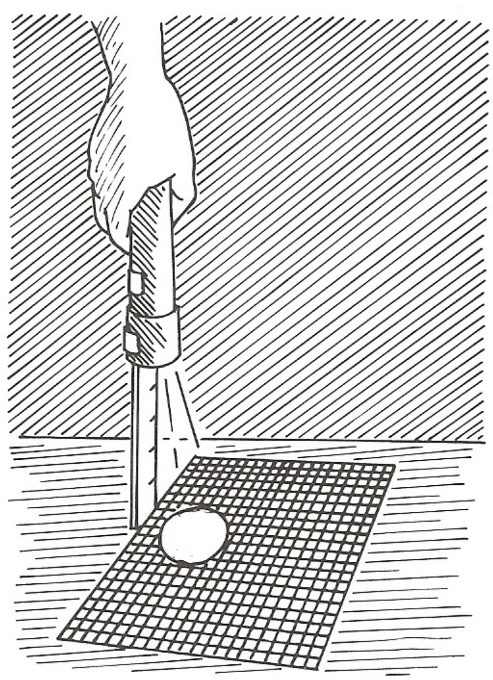
How does the angle of light change the estimated area covered by the light?

Materials

- Light tool
- Graph paper
- Marking pen

Safety Concerns: None.

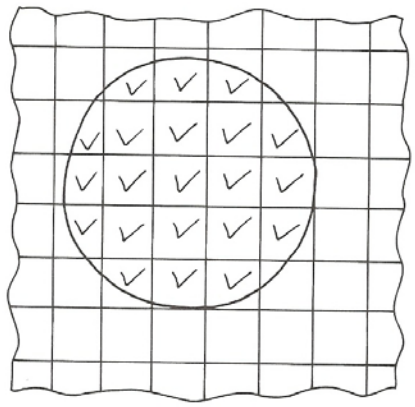
Procedure



1. Lay the graph paper on the table.

2. Turn on the flashlight and hold it so it is pointing ***straight down*** (90°) on the graph paper.

3. Draw around the bright center circle of light you see on the paper.



4. Count all the squares that are at least ***halfway*** in the light. Look again at the example on the other side of the paper.

5. Calculate the estimated area covered by the light. Multiply the number of squares checked by the area of each square (area = length x width). For example:

- Number of squares checked = 21
  - → Area of each grid square = length x width
  - → = .25 inches x .25 inches
  - → = .0625 square inch (.0625 in^2)
- Area of the lighted circle = estimated squares x area of each square
  - → = 21 x .0625 in
  - → = 1.31 in^2

90° Measurement

- Number of squares checked = ________
- Area of the lighted circle = number of squares checked x area of each square
  - → = ________ x .0625 in
  - → = ________ in^2

6. Take the flashlight and bend it at an angle of 45°.

7. Repeat steps 3-5 to calculate the estimated area covered by the light.

45° Measurement

- Number of squares checked = ________
- Area of the lighted circle = number of squares checked x area of each square
  - → = ________ x .0625 in
  - → = ________ in^2

8. Compare your results. Explain why the number is different.

Why is Summer Hot?

(modified from a lesson plan from the Jet Propulsion Laboratory, NASA)

Starting Temperature: Thermometer A _____° Thermometer B _____°

Time	Thermometer A	Thermometer B
5 Minutes	°	°
10 Minutes	°	°
15 Minutes	°	°
20 Minutes	°	°

Which thermometer is hotter, the propped thermometer, or the one lying flat? Explain your results.

Earth's Orbit Around the Sun

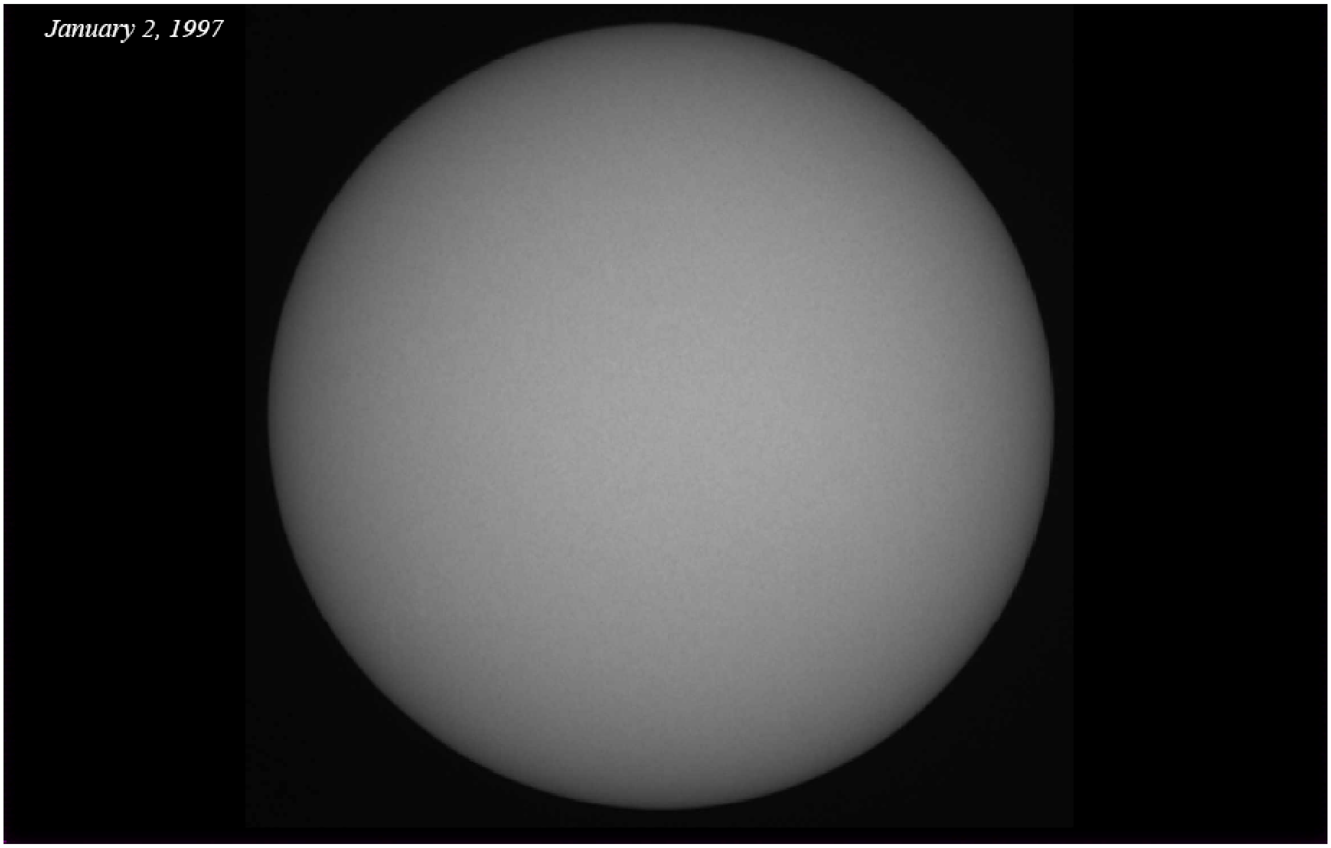
(From the *Real Reasons for the Seasons*)

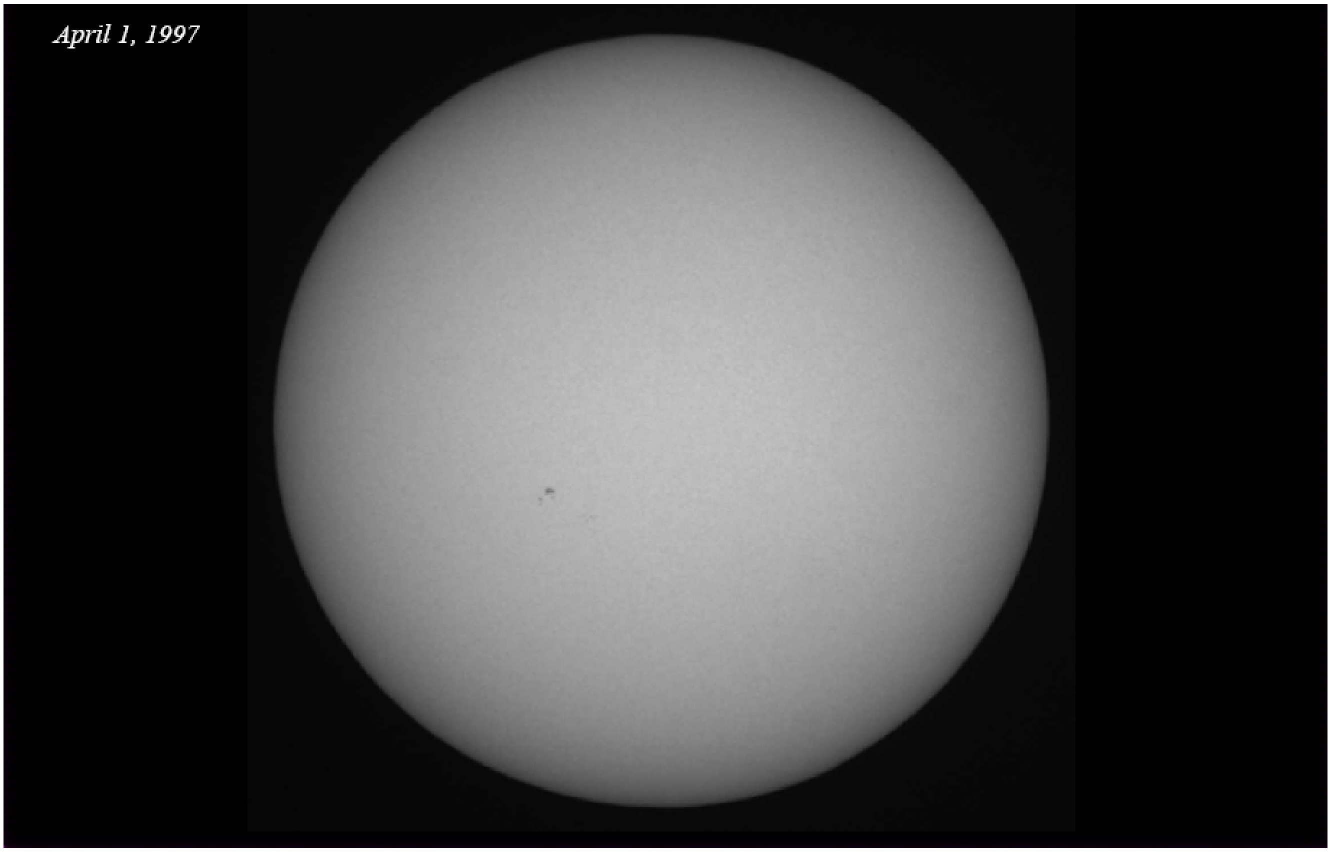
Here are images of the Sun. These were taken in autumn, winter, spring, and fall. Place a ruler horizontally across each image. Measure the largest distance across the middle of the Sun. Compare the measurements for each season.

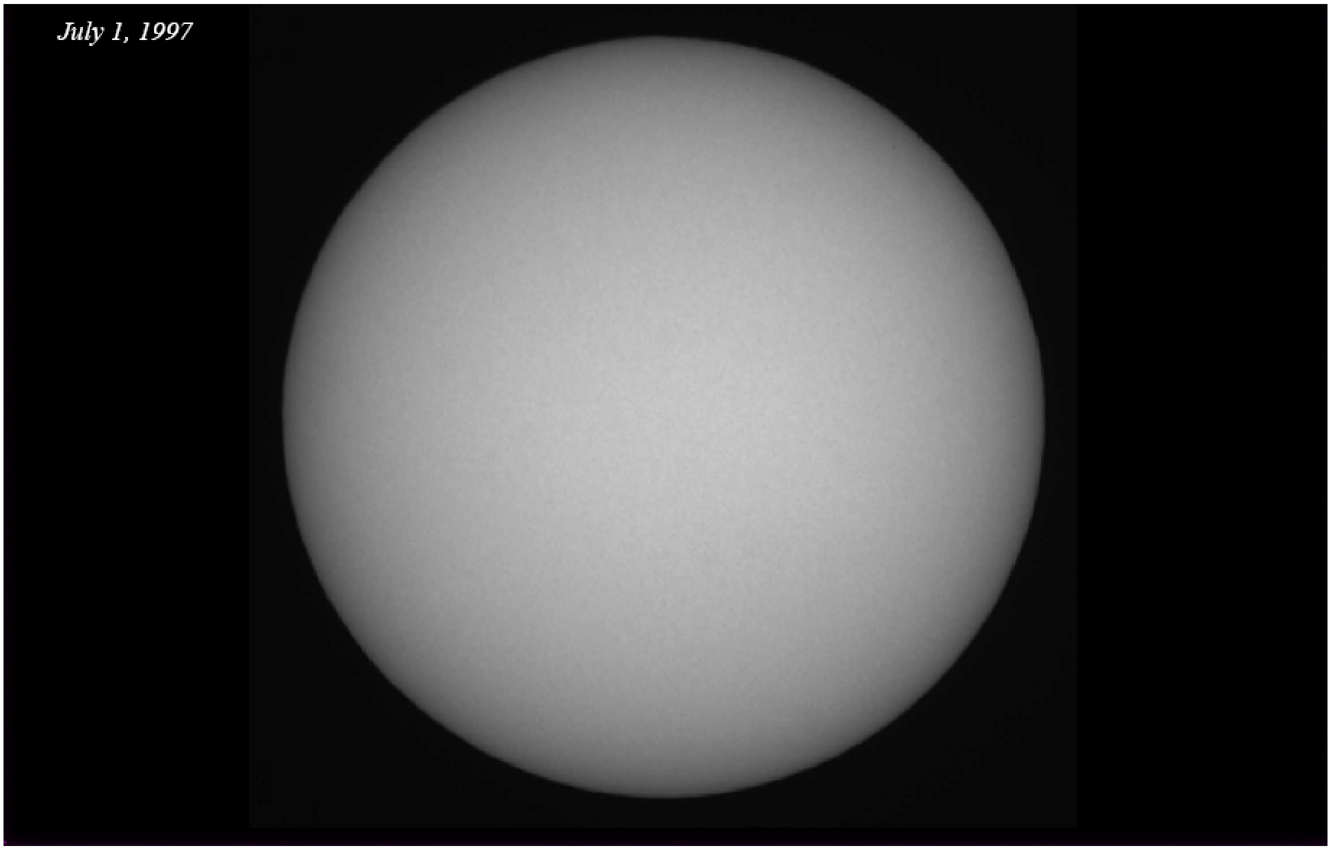
Put your estimate in the table below.

Season	Your Measurement (cm)
Autumn	
Winter	
Spring	
Summer	

Images of the Sun were taken in Hawaii by Dr. Karen Mees of the University of Hawaii.




April 1, 1997


July 1, 1997

Sun Rise, Sunset

Student Information: To solve ***problems*** scientists usually go through the same process. First, they develop a good answer to the problem they are working on (***hypothesis***) and then data needs to be collected in a controlled process or obtained from a reliable source. Data is often organized in a table or chart to aid in analysis of the information.

Procedure: Look closely at the data table below. It shows the rising and setting times of the sun in Salt Lake City.

	Sunrise (a.m.)	**Sunset (p.m.)**
January		
1	7:54	5:08
15	7:52	5:22
February		
1	7:40	5:42
15	7:23	6:00
March		
1	7:03	6:17
15	6:40	6:33
April		
1	6:11	6:52
15	5:50	7:06
May		
1	5:25	7:24
15	5:09	7:39
June		
1	4:56	7:54
15	4:53	8:03
July		
1	4:57	8:05
15	5:06	8:00
August		
1	5:22	7:46
15	5:36	7:28

September		
1	5:53	7:02
15	6:07	6:39
October		
1	6:24	6:11
15	6:39	5:48
November		
1	6:59	5:24
15	7:16	5:08
December		
1	7:34	4:59
15	7:46	4:58

Analysis

1. ***Explai***n the pattern of sunrise times during the year. (Are the days the same length? Does the Sun rise at the same time? Does the Sun rise earlier at certain times of the year and later at other times of the year? etc.)

2. Is the pattern the same for sunset times during the year? ***Explain.***

3. Which month is the number of daylight hours the longest?

4. Which season has the greatest number of daylight hours?

5. Which season has the lowest number of daylight hours?

Tracking Sunrise and Sunset

(from a lesson found at http://www.uen.org)

1. Explain how *you* think sunrise and sunset changes throughout the year.

Using the information on the *Sunrise/Sunset Table,* make a graph on the attached graph paper. Use one color for the time of sunrise and a different color for the time of sunset.

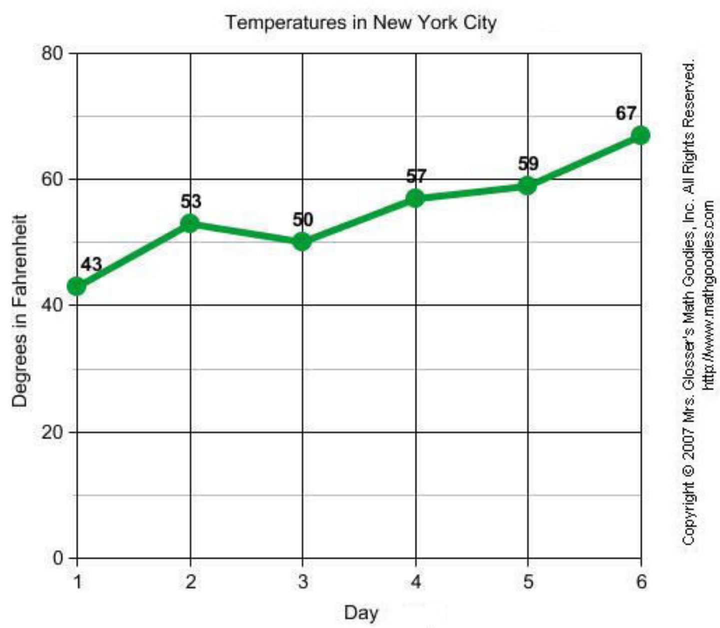
You are going to make a line graph. You start with a data table.

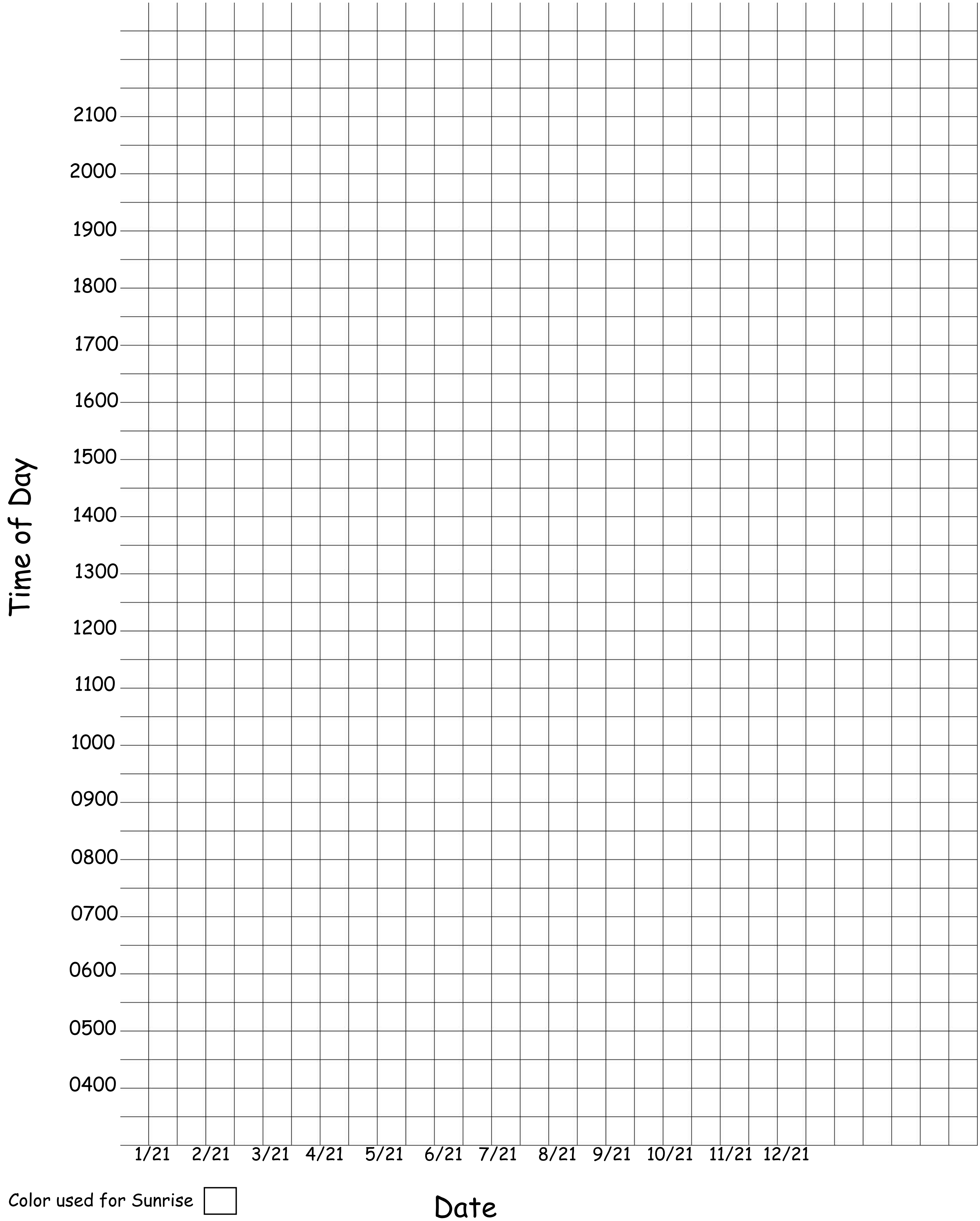
Temperatures In NY City	
Day	**Temperature**
1	43° F
2	53° F
3	50° F
4	57° F
5	59° F
6	67° F

You take the data from the table and use it to make a graph.

To graph the data, you put a dot on the point that matches the information (Day 1, Temp 43° F.). You continue to place your dots on the graph paper until all the data has been marked. Then, you connect the points. Your graph would look something like the graph below.

This is the process you will follow when you graph the sunrise and sunset on the graph paper.





Color used for Sunrise ☐

Color used for Sunset ☐

Answer the following questions using the information from the *Sunrise/Sunset Table* as well as your graph.

1. How does the length of the daylight hours change throughout the year?

2. How does the length of nighttime hours change throughout the year?

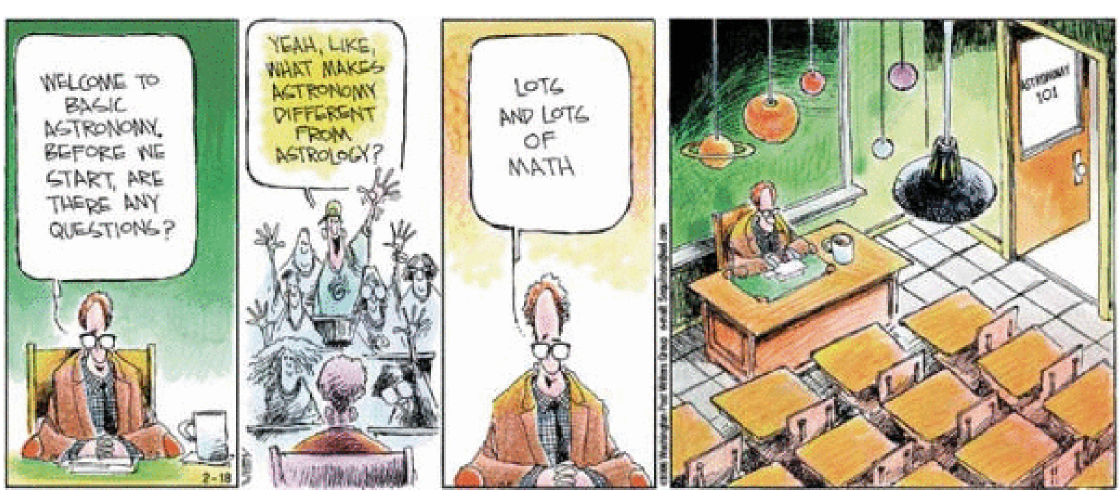
3. How many hours of daylight are there on the following days?

    a. March 21st –

    b. June 21st –

    c. September 21st –

    d. December 21st –



Sunrise/Sunset Table

(Source: Naval Observatory)

Date	Sunrise	Sunset
January 6th	07.92**	17.22
January 21st	07.82	17.50
February 6th	07.58	17.25
February 21st	07.25	18.15
March 6th	06.92	18.28
March 21st	06.48	18.70
April 6th	06.03	18.98
April 21st	05.59	19.25
May 6th	05.27	19.51
May 21st	05.04	19.78
June 6th	04.92	19.98
June 21st	04.92	20.10
July 6th	05.02	20.09
July 21st	05.22	19.92
August 6th	05.48	19.66
August 21st	05.75	19.31
September 6th	06.00	18.87
September 21st	06.25	18.28
October 6th	06.58	18.02
October 21st	06.80	17.62
November 6th	07.12	17.25
November 21st	07.42	17.33
December 6th	07.68	16.96
December 21st	07.85	17.02

To calculate the number of daylight hours, subtract the time of sunset from the time of sunrise. For example, if sunrise is at 07.82 and sunset is at 17.50, you would subtract 17.50 from 07.82: 17.50 - 07.82. This gives you 9.68 hours of daylight.

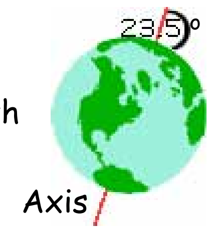
Times are given using a 24-hour clock. After noon, subtract 12 from the time. For example, 1500 would be 3:00 p.m.

***Times are given in are converted to decimals. For example, 7.92 is 7:55 a.m.*

Reasons for the Seasons Notes

Key Terms You Need to Know

Axis of Rotation - An imaginary line going from the north pole to the south pole. The earth spins on this line.



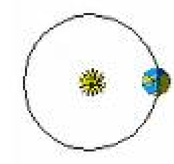
Source: 6th Grade Sci-Ber Text, USOE

Earth's Tilt The earth's axis is not straight up and down, instead it leans at a 23.5° angle.

Orbit - The path that a planet travels as it goes around the sun.

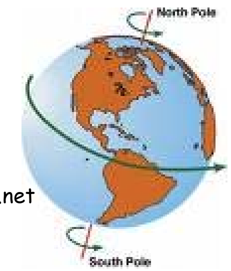
Source: http://indianpolitics.wordpress.com/2006/08/

Revolution - The circling of one object around another object in space. A planet revolves around the sun. A moon revolves around a planet.



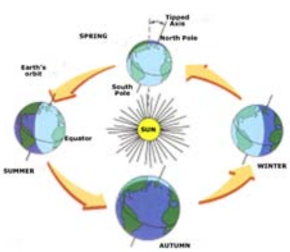
Picture source: http://www.opencourse.info/astronomy/introduction/03.motion_earth/

Rotation - When a planet or moon turns all the way around or spins on its axis one time.



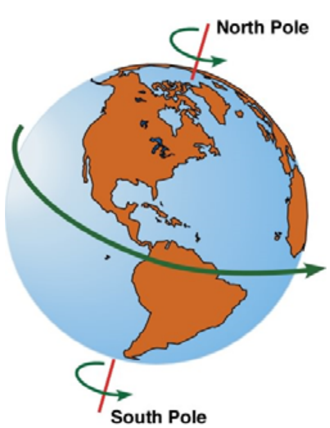
Source: PhysicalGeography.net

Seasons - Due to the tilt of earth as it travels around the sun, we have spring, summer, fall, and winter.



Source: http://www.learner.org

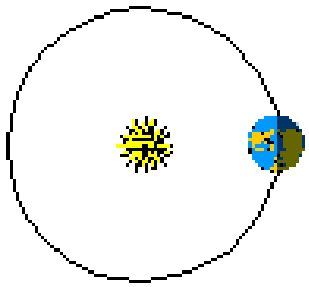
The Earth ***rotates*** counterclockwise on its ***axis***. It rotates once every twenty-four hours (one day).



Source: PhysicalGeography.net

The Sun, Moon, and stars ***appear*** to move in the sky. They are not moving. The Earth is ***rotating***. That is why they look like they are moving.

The Earth ***revolves*** around the Sun. It takes 365¼ days (one year) to ***revolve*** once around the Sun.

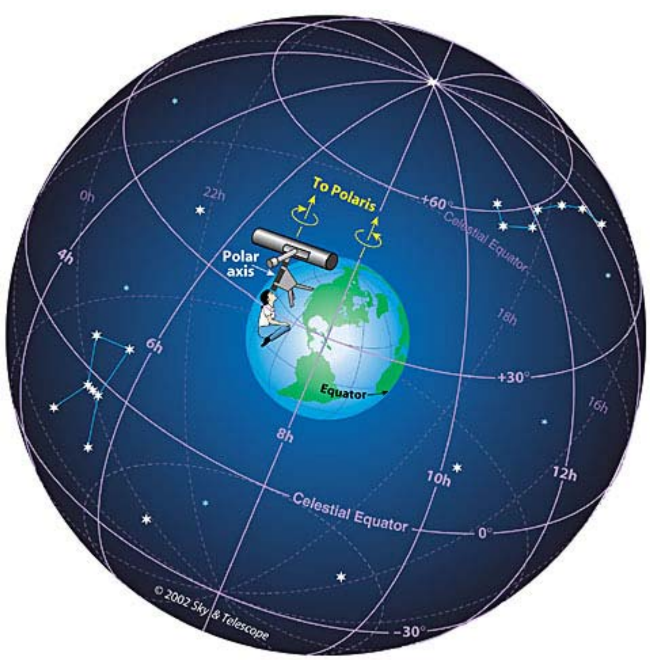


(Source: Open Course – Astronomy – Lesson 3)

The Earth is ***tilted*** 23.5°.

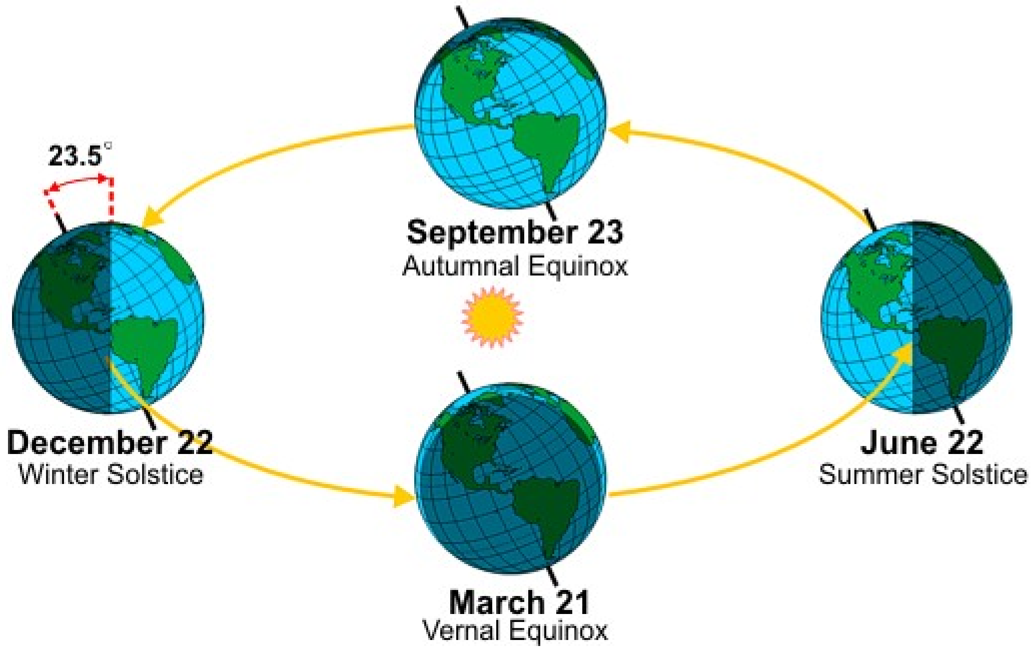
(Source: 6th Grade Sci-Ber Text, Utah Science - State Office of Education)

The ***axis*** is ***always*** pointing to the North Star (Polaris in the handle of the Little Dipper).



Source: skyandtelescope.com

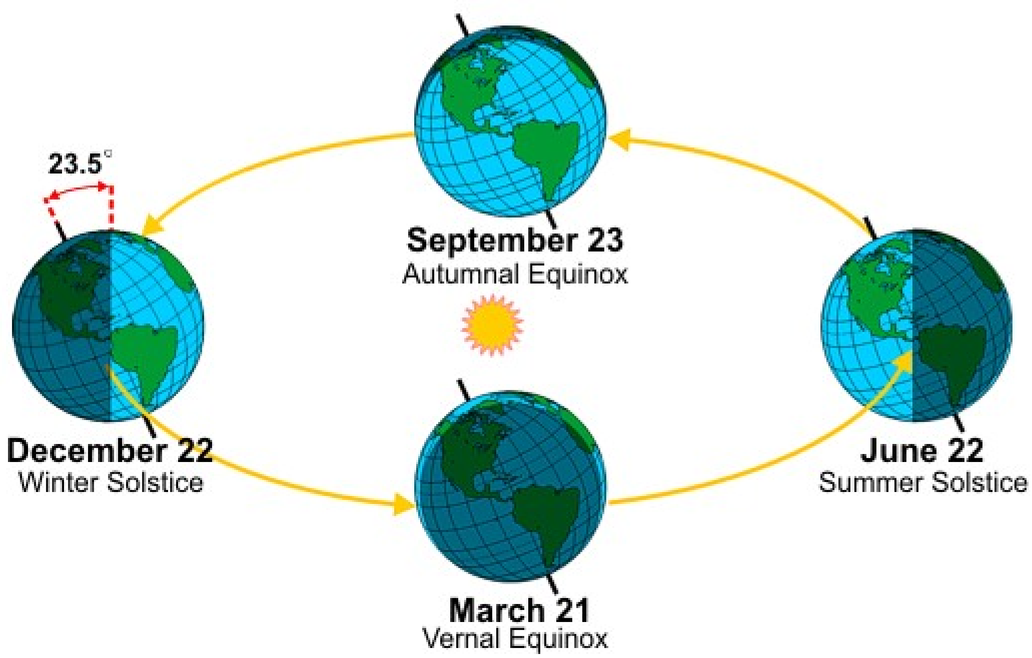
We have seasons because of the Earth's ***tilt***. Here is the Earth's ***orbit*** over one year:



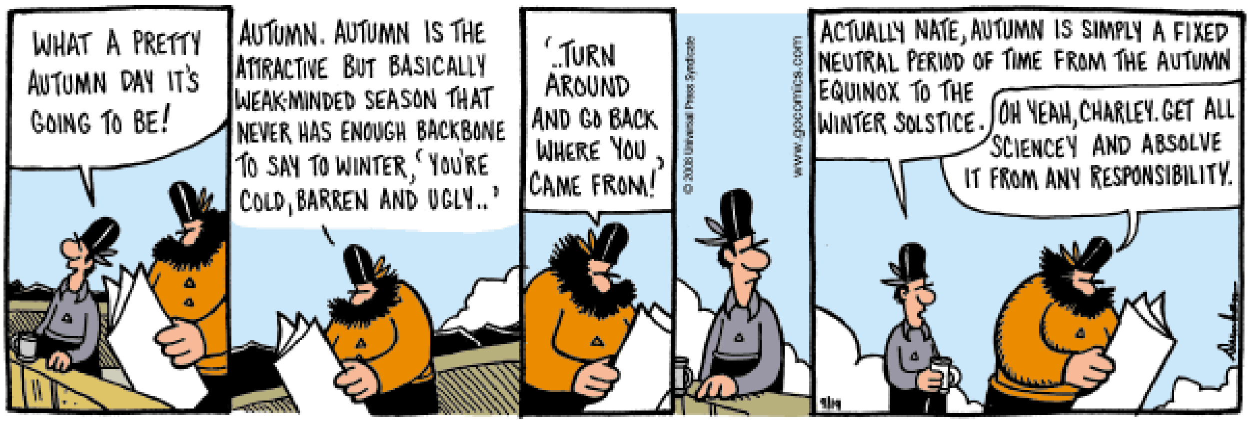
(Source: National Weather Service, http://www.srh.noaa.gov/jetstream/global/global_intro.htm)

When the Earth is ***tilted*** towards the Sun, it is summer in Utah. When the Earth is ***titled*** away from the Sun, it is winter in Utah.

Where the Earth is located as it ***revolves (orbits)*** the Sun determines the season.

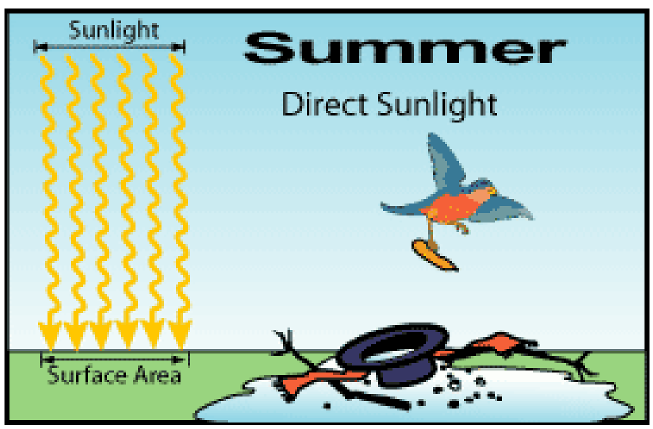


(Source: National Weather Service, http://www.srh.noaa.gov/jetstream/global/global_intro.htm)



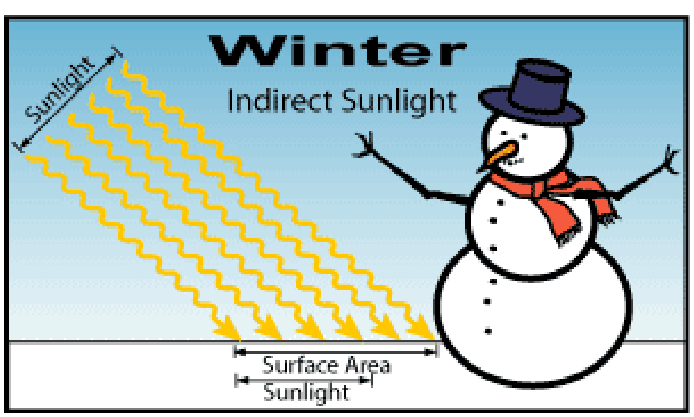
When the Earth is at the Summer Solstice, it is ***tilted*** towards from the Sun. This affects the heat energy we receive from the Sun. The heat energy we receive is called "direct heat energy".

This diagram shows direct heat energy in the summer. It is concentrated and covers a small area.



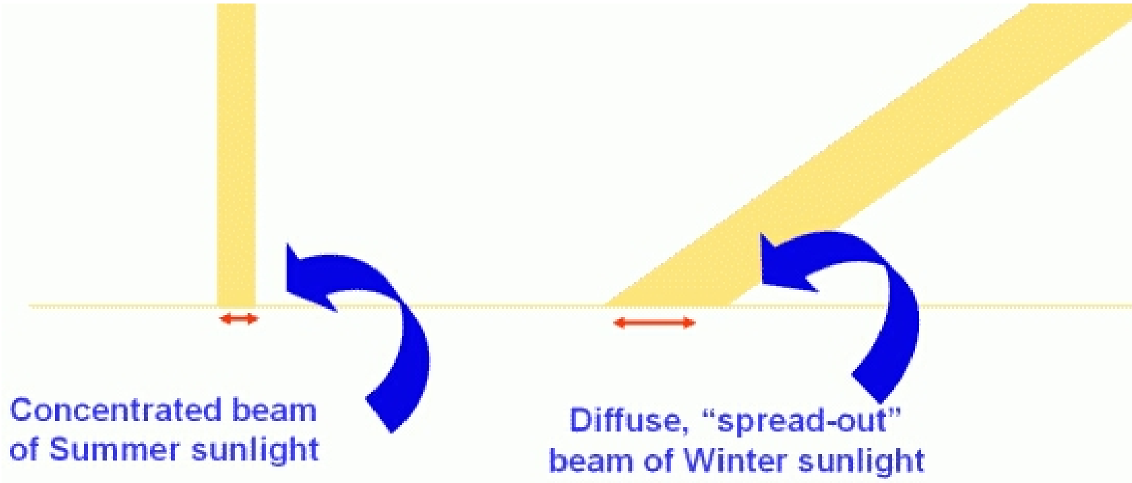
(Source: Office of Naval Research)

Six months later, the Earth is tilted away from the Sun. We receive the same amount of heat energy in winter. Because it is indirect, it covers a larger area. This diagram shows that.



(Source: Office of Naval Research)

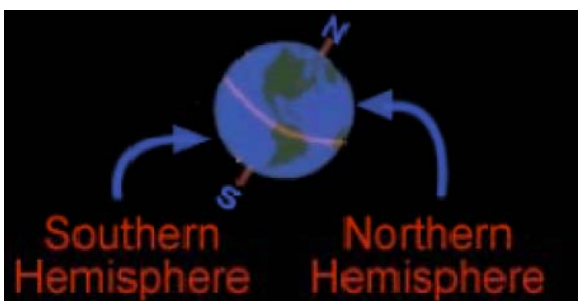
The larger the area the heat energy covers, the cooler it is.



(Source: http://astronomy.swin.edu.au/cosmos/S/Seasons)

Pretend you make a fire in the middle of a classroom (***direct*** heat energy). It keeps the room warm. Now imagine knocking down a wall between two classrooms. The fire stays the same size (***indirect*** heat energy). Now the area it tries to heat is twice as large. Will it be as warm? No. Even though the heat energy is the same, it has to heat twice the space.

Seasons are reversed in the Northern and Southern Hemisphere. Look at this chart.



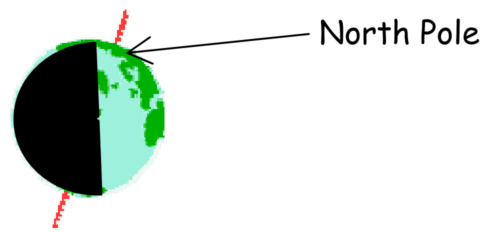
Summer	Winter
Autumn	Spring
Winter	Summer
Spring	Autumn

(Source: http://astronomy.swin.edu.au/cosmos/S/Seasons)

Many people think it is warm in summer because the Earth is closer to the Sun in the summer. In the winter, Earth is farther away from the Sun. Is this correct? ***The answer is no, uh-uh, wrong, incorrect, mistaken, untrue, false, bogus, made-up, fiction …*** Well, you get the point. The distance between the Earth and the Sun has ***absolutely nothing*** to do with why we have seasons. Tattoo this on your forehead! (Just kidding!)

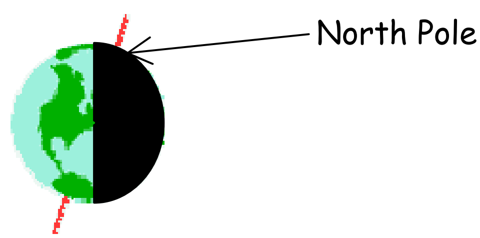
If we have summer when we are closest to the Sun, why is it winter in Australia? Why don't they have summer? Come on. Give me an answer. I'm waiting. Ha! I didn't think you could give me an answer!

Here is what the Earth looks like when we are ***titled*** towards the Sun. It is summer in Utah.



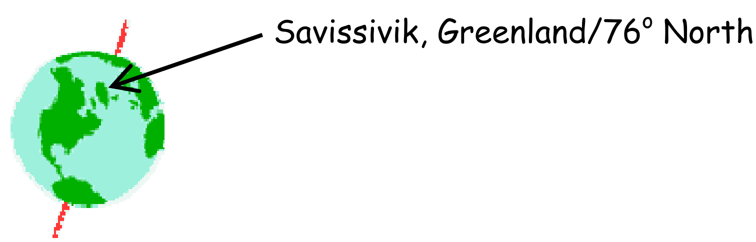
Look at the North Pole. You will see it has twenty-four hours of sunlight. In summer, the farther north you are from the Equator, the ***more*** hours of sunlight you will have.

Here is what the Earth looks like if we are ***titled*** away from the Sun. It is winter in Utah.



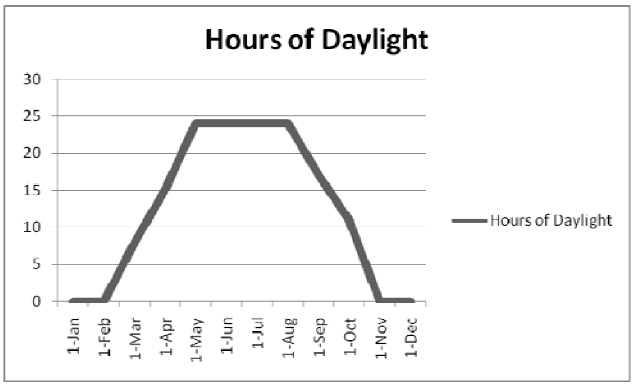
Look at the North Pole. You will see it has twenty-four hours of darkness. In winter, the farther north you are from the Equator, the ***fewer*** hours of sunlight you will have.

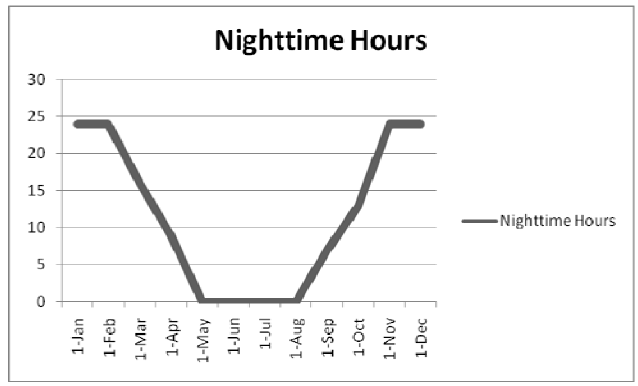
The tables and graphs below show how the tilt affects the number of daylight/evening hours throughout the year.



Savissivik, Greenland (near the North Pole)

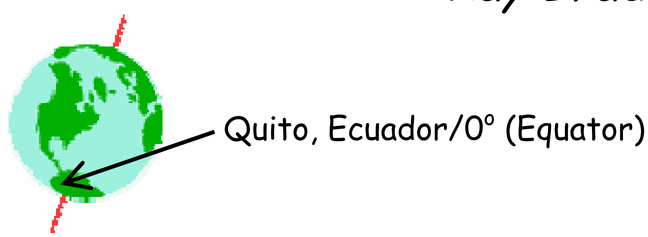
	Sunrise	Sunset	Hours Daylight		Sunrise	Sunset	Hours Daylight
1-Jan	0	0	0	1-Jul	0	0	0
1-Feb	0	0	0	1-Aug	0	0	0
1-Mar	12.4	20.8	8.4	1-Sep	17	23	6
1-Apr	8.87	24	15.13	1-Oct	12.12	27.42	15.3
1-May	0	24	24	1-Nov	0	24	24
1-Jun	0	24	24	1-Dec	0	24	24





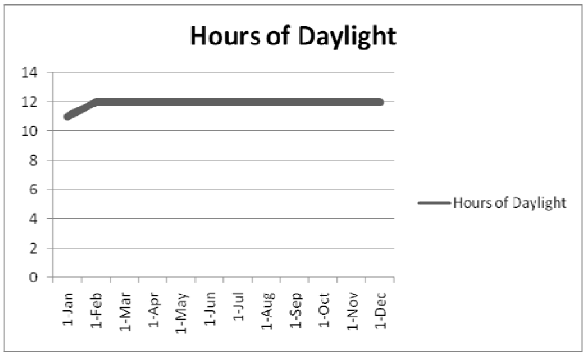
Touch a scientist and you touch a child.

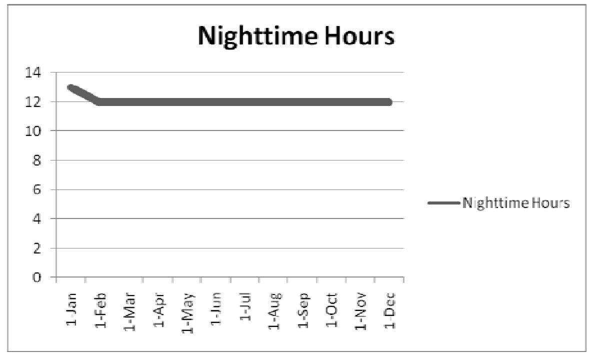
-Ray Bradbury



Quito, Ecuador

	Sunrise	Sunset	Hours Daylight		Sunrise	Sunset	Hours Daylight
1-Jan	11.23	22.37	11.4	1-Jul	11.25	23.37	12.12
1-Feb	11.4	23.5	12.1	1-Aug	11.28	23.4	12.12
1-Mar	11.4	23.5	12.1	1-Sep	11.18	23.28	12.1
1-Apr	11.25	23.35	12.1	1-Oct	11	23.17	12.17
1-May	11.13	23.23	12.1	1-Nov	10.9	23.03	12.13
1-Jun	11.13	23.25	12.12	1-Dec	11	23.13	12.13





Somewhere, something incredible is waiting to be known.

-Carl Sagan

Salt Lake City, UT

	Sunrise	Sunset	Hours Daylight		Sunrise	Sunset	Hours Daylight
1-Jan	7.87	17.18	9.31	1-Jul	5	21.05	16.05
1-Feb	7.63	17.75	10.12	1-Aug	5.4	19.72	14.32
1-Mar	7	18.32	11.32	1-Sep	5.9	19	13.1
1-Apr	6.18	18.87	12.69	1-Oct	6.4	18.1	11.7
1-May	5.42	19.4	13.98	1-Nov	7	17.45	10.45
1-Jun	5	19.88	14.88	1-Dec	7.5	17	9.5