KINESTHETIC ASTRONOMY™
Written Assessment Options for the *Sky Time* Lesson
Table of Contents

cherilynn.morrow@gmail.com and mjzawaski@gmail.com

Name: _____

WHAT DO YOU KNOW? [p 1 of 3]

1. Draw arrows to connect each box with the correct place on planet Earth.

NORTH AMERICA

NORTH POLE

SOUTH POLE

SOUTH AMERICA

2. Draw the EQUATOR on the Earth cartoon above.

3. Order the objects below from smallest (1) to largest (3).

____ Earth

____ Moon

____ Sun

4. Order the objects below from closest (1) to farthest (3) from Earth.

____ Sun

____ Moon

____ North Star

5. How many stars are in the Solar System? _____

6. How do you think people kept track of time before the invention of clocks, watches, and numbered calendars? What is a day? What is a year?

7. If it is noon where you are, what time is it on the opposite side of Earth?

_____

Name: _____

WHAT DO YOU KNOW? [p 2 of 3]

8. How does the Sun appear to move in the sky during the day? Draw the path of the Sun on the diagram below.

East Looking South West

9. Why do you think the Sun appears to rise in the East and set in the West?

10. Do stars and constellations also appear to rise and set?

Circle one: YES NO

Explain:

11. Does Earth move in space? Circle one: YES NO

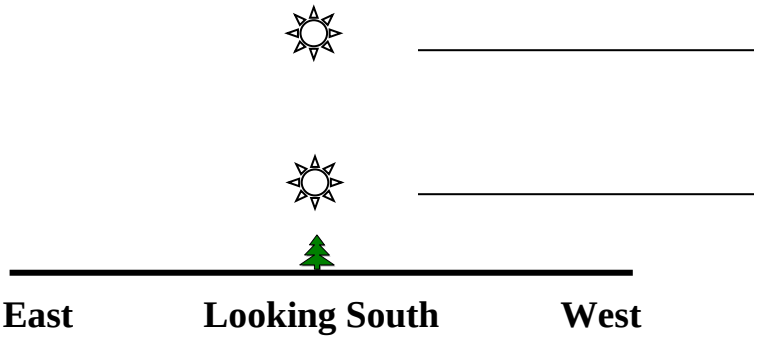
Explain (draw pictures if it helps to explain):

Name: _____

WHAT DO YOU KNOW? [p 3 of 3]

12. How many trips around the Sun have you made in your life? _____

13. Write "summer" next to the sun that represents noon time in the summer. Write "winter" next to the sun that represents noon time in the winter.



14. In what season do we experience the most daylight hours? _____

15. Why is it hotter in summer and colder in winter?
(Use drawings if it helps you to explain)

16. Do we see the same stars and constellations at different times of year?

Circle one: YES NO

Explain (use drawings if it helps you to explain):

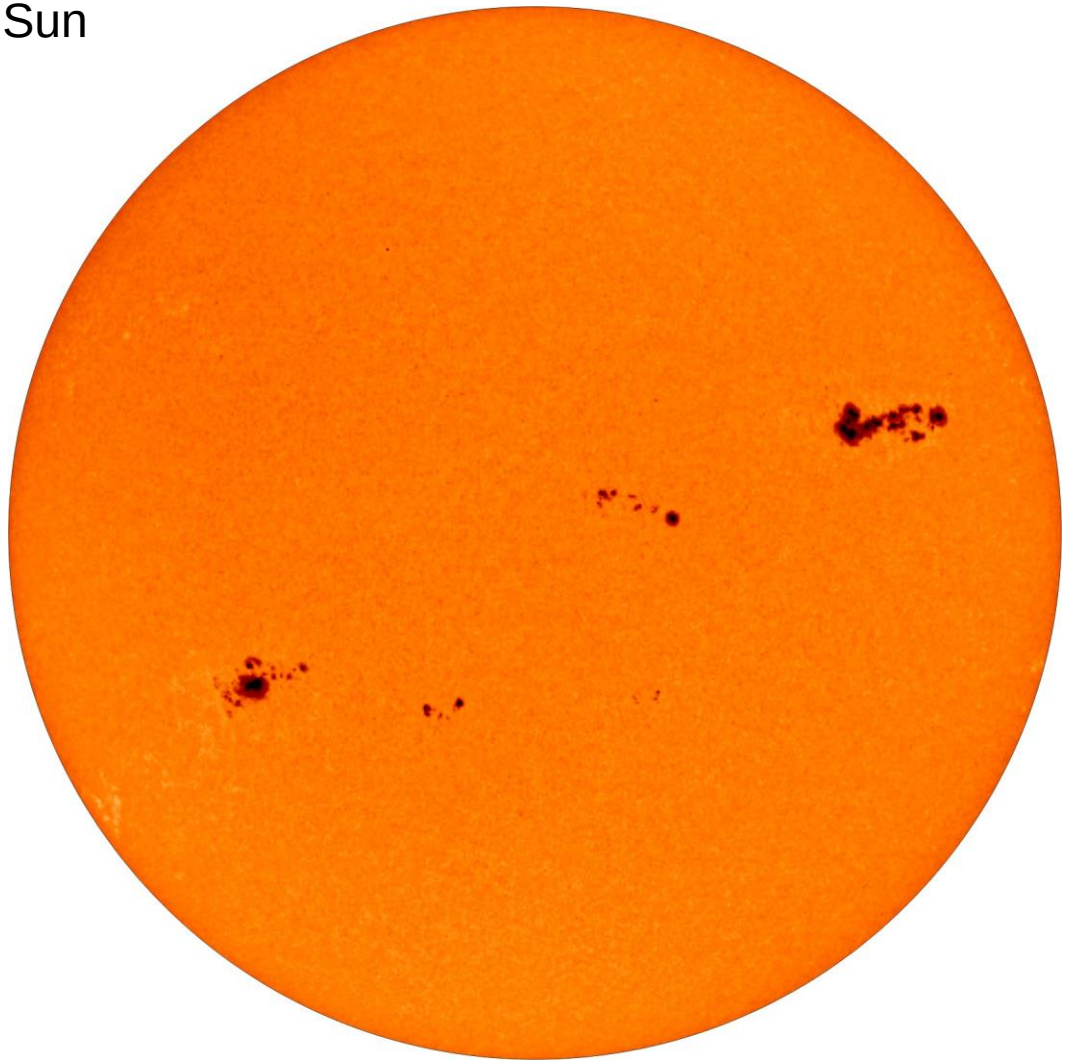
Name: _____

SCALE MODEL OF THE SUN, EARTH AND MOON

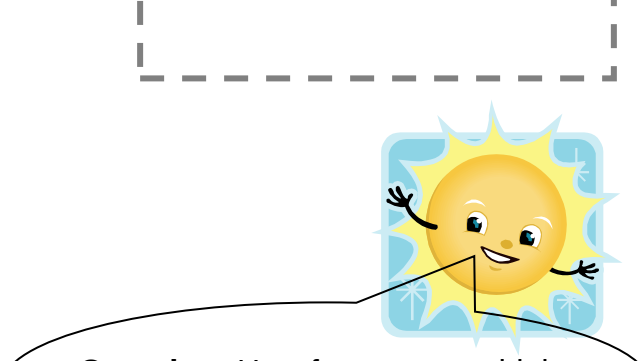
Here are images that show the relative size of the Sun compared to the Earth and Moon. In reality all of these objects are 10 billion times wider. This page is too small to show the properly scaled distance between the Sun and the Earth-Moon system. That part is up to you!

First, cut out the images along the dashed lines. Then **measure about 15 meters (50 ft) from the Sun to the Earth-Moon system.** Now you have your own scale model!

Sun



Moon Earth



Question: How far away would the nearest star to the Sun be in this scale?

Answer: Alpha Centauri would be 4000 km (2500 miles) away in this scale model – like having the cut-out Sun in California and a cut-out star in New York!

cherilynn.morrow@gmail.com and mjzawaski@gmail.com

Name: _____

EXPLORING THE STRUCTURE OF THE UNIVERSE

Fill in the blanks. ~~Cross out~~ the words below as you use them.

asteroids	galaxy	meteoroids	orbit	Solar System	Sun
comets	galaxies	moon	planets	star	Universe
Earth	Jupiter	moons	planets	Sun	100 billion

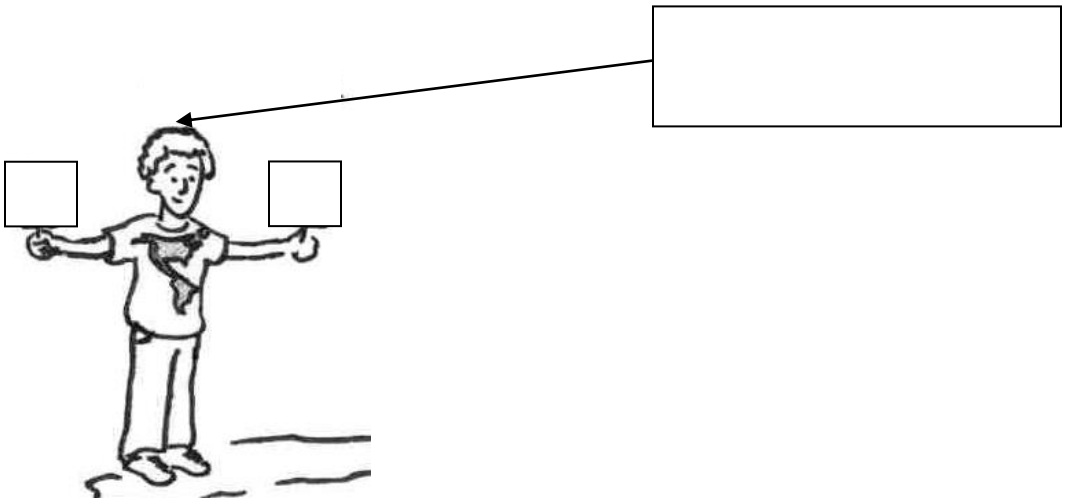
The Sun is a _____ located at the center of our _____. Our home, called _____, is one of at least 8 _____ that orbit around the _____. Earth has one _____ that orbits around it each month, showing different phases. Some planets have many _____ that _____ around them. Mercury and Venus have no moons. In addition to the Sun, planets, and moons the Solar System contains smaller objects such as _____, _____, and _____. Sometimes these smaller objects collide with the larger objects. Most meteors are between the size of a grain of sand and a peanut, but they can make a bright streak across the sky as they travel through Earth's atmosphere. In 1994, astronomers all over the world watched a comet break up and impact the atmosphere of the largest planet in the Solar System called _____. Our _____ is one of about _____ stars contained in the _____ we call the Milky Way. Astronomers are just now discovering Jupiter-sized _____ that orbit around some of those distant stars. Outer space is even bigger yet because the Milky Way is only one of an estimated 100 Billion (100,000,000,000) _____ in the _____!

Name: _____

BODY GEOGRAPHY

DIRECTIONS:

1. Label the North and South Poles by filling in the boxes shown.
2. Fill in the “E” and “W” signs in the student’s hands.
3. Draw the Equator on the boy (whose body represents the whole Earth).



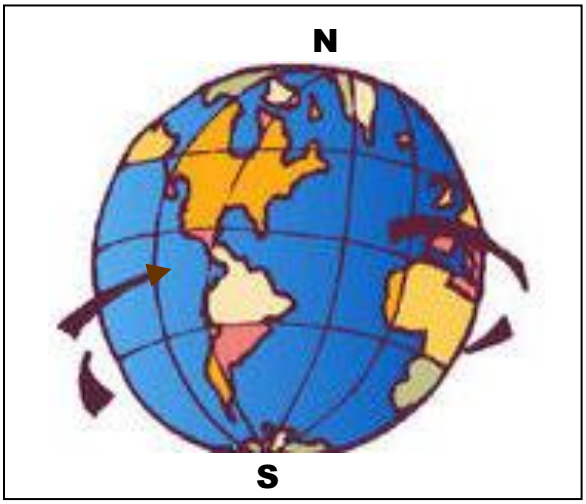
Name: _____

KINESTHETIC TIMES OF DAY

A. Write the correct times of day for someone on the front of the rotating boy
Choose from: **SUNRISE, SUNSET, NOON or MIDNIGHT**

1. _____ **2.** _____ **3.** _____ **4.** _____

B. Fill in the blanks below



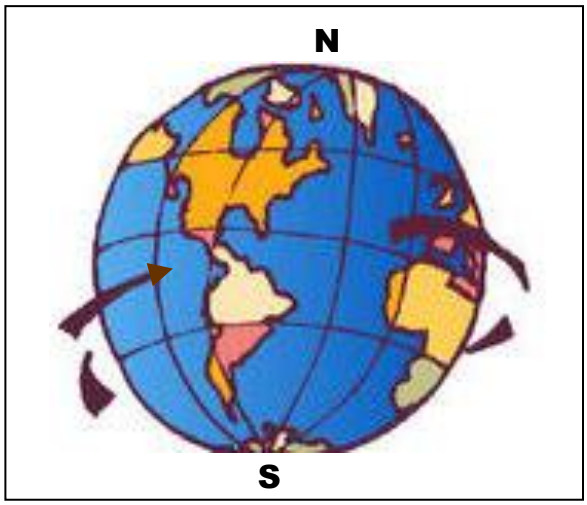
Earth turns about its axis. We call this movement _____.

Earth takes _____ hours to rotate around. We call this length of time Earth's rotational period.

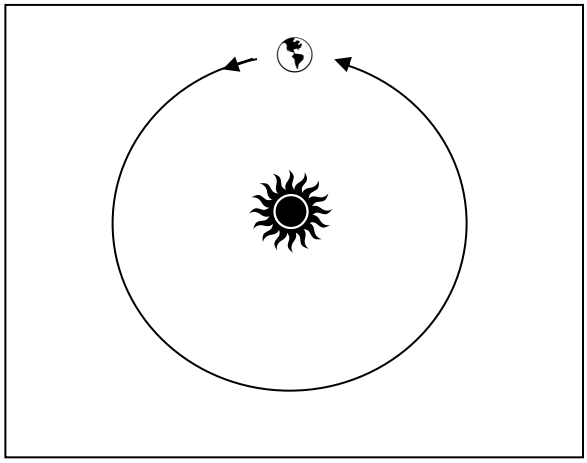
Name: _____

ROTATION VS. ORBIT

Fill in the blanks below



Earth turns about its own axis. We call this movement _____. Earth takes _____ hours to rotate around. We call this length of time Earth's rotational period.



Earth moves around the Sun. We say that Earth _____ the Sun. Earth takes _____days to go once around. We call this length of time Earth's orbital period.

Name: _____

THE "DATING" GAME

Use the diagram below to fill in the *10 blanks* about the kinesthetic times of day and year.

FOR THE BOY

1. What is the time along a line down the middle of the front of his body?

   _____

2. What is the season in North America?

   _____

3. What is the date in North America?

   _____

4. What is the season in South America?

   _____

5. What is the date in South America?

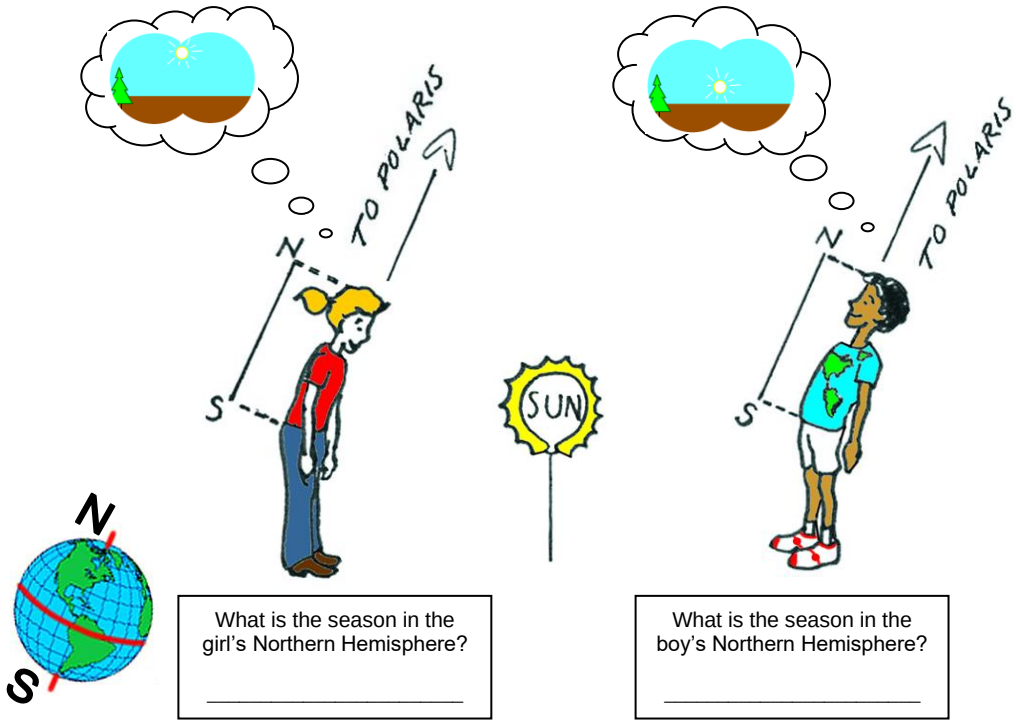
   _____

6. What is the time along a line down the middle of his back?

   _____

7. What is the season on his upper back (China)?

   _____



What is the season in the girl's Northern Hemisphere?

_____

What is the season in the boy's Northern Hemisphere?

_____

CHALLENGE: Can you also answer questions 1-7 for the GIRL?

BONUS: What is the season on the girl's lower back?

_____

KINESTHETIC SEASONS

cherilynn.morrow@gmail.com and mjzawaski@gmail.com
Kinesthetic Astronomy™ -- *The Sky Time Lesson*
September 2010/March 2025

Layout adapted from the *Family Guide to the Sun***

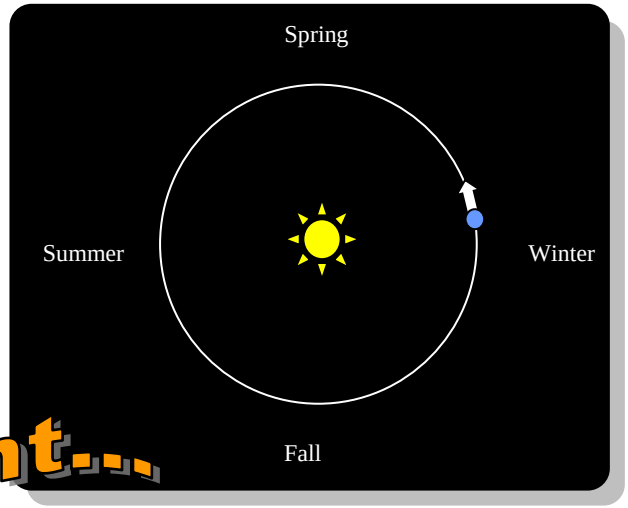
Check it out!

Earth takes one year to orbit the Sun.

Earth's orbit is nearly circular.

So, Earth is about the same distance from the Sun no matter the season (summer, fall, winter, spring).

SO WHY IS IT COLDER IN WINTER?



hint...

When your Northern Hemisphere is leaning away from the Sun, will the Sun appear *higher* or *lower* in the sky?

_____

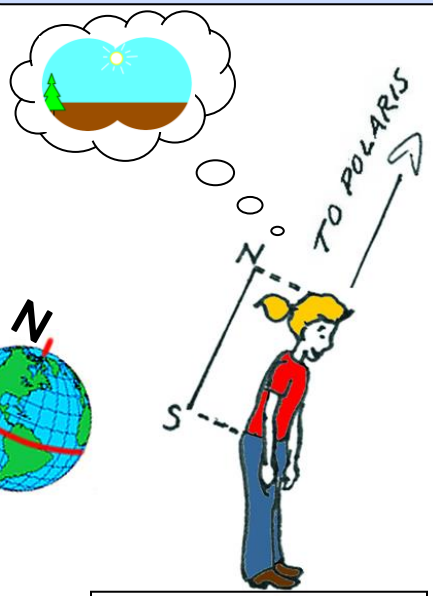
The hemisphere which is leaning away from the Sun is in winter. The Sun appears lower in the sky, giving fewer daylight hours and so less time to heat the planet's surface. This causes colder temperatures.

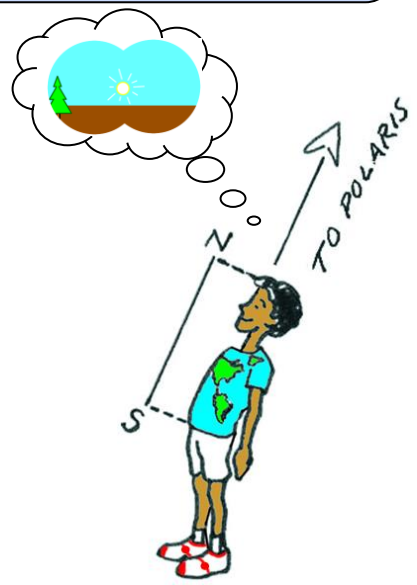
Try this!

1. Pretend your body is Earth in orbit around the Sun. Let a helium balloon be the Sun.

2. The top of your head is Earth's North Pole. Tilt toward Polaris 23.5º like the kids below.

3. Try to rotate around your axis and "orbit" the Sun while keeping your head pointed toward Polaris.





What is the season at the girl's upper chest (North America)?

_____

What is the season at the boy's upper chest (North America)?

_____

What is the season at the girl's upper back (China)?

_____

What is the season at the boy's belly (South America)?

_____

**See http://www.spaceweathercenter.org/resources/04/04.html

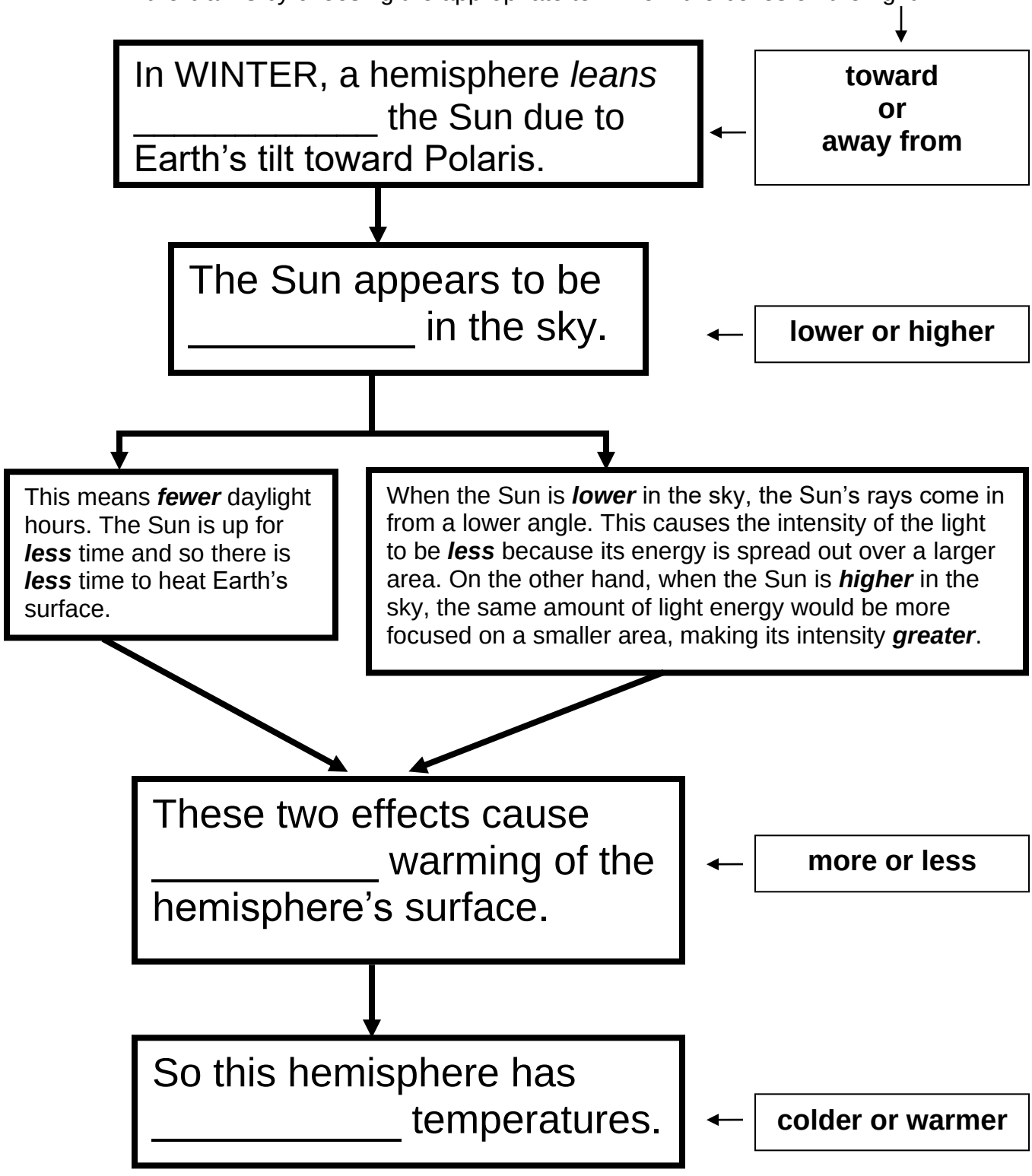
cherilynn.morrow@gmail.com and mjzawaski@gmail.com September 2010/March 2025

Name: _____

REASONS FOR SEASONS CONCEPT MAP ACTIVITY

Seasons Concept Map for **WINTER** **[p 1 of 2]**

Fill in the blanks by choosing the appropriate term from the boxes on the right



Name: _____

REASONS FOR SEASONS CONCEPT MAP ACTIVITY

Seasons Concept Map for **SUMMER** **[p 2 of 2]**

Fill in the blanks by choosing the appropriate term from the boxes on the right

In SUMMER, a hemisphere *leans* _____ the Sun due to Earth's tilt toward Polaris.

← **toward or away from**

The Sun appears to be _____ in the sky.

← **lower or higher**

This means ***more*** daylight hours. The Sun is up for ***more*** time and so there is ***more*** time to heat Earth's surface.

When the Sun is **higher** in the sky, the Sun's rays shine down on us more directly and we feel a **greater** intensity of sunlight. On the other hand, when the Sun is **lower** in the sky, the Sun's rays come in at a lower angle and are spread out over a larger area so that we feel **less** intensity of sunlight.

These two effects cause _____ warming of the hemisphere's surface.

← **more or less**

So this hemisphere has _____ temperatures.

← **colder or warmer**

Name: _____

REASONS FOR SEASONS [p 1 of 2]

Fill in the blanks. ~~Cross out~~ each term below as you use it!

day	Sun	winter	24	colder	axis
year	Polaris	winter	365	warmer	circle
solstice	orbit	summer	23.5	Southern	elliptical
equinoxes	rotates	summer	Hemisphere	Northern	tilt

Planet Earth _____ once around its axis every _____ hours. We call this period of time a _____. There are _____ days in a _____. It takes one year for Earth to _____ once around the _____. If I am _____ years old [enter your own age], then I have made _____ trips around the Sun during my life [enter your own answer].

Earth's orbit around the Sun traces out an almost perfect _____. Thus the distance between the Sun and Earth does not change very much over the course of a year. So the reason that temperatures are _____ in the summer and _____ in the winter is the tilt of Earth's rotation axis. Earth's seasons are NOT caused by being closer or farther from the Sun.

Earth's rotation axis is tilted _____ degrees so that the North Pole points toward a distant star called _____ (the North Star). As Earth moves around the Sun, Earth's North Pole stays pointed toward this star. Polaris is 500 light-years from our solar system. Earth's axis remains tilted toward Polaris, but how Earth is leaning relative to the Sun changes as Earth moves in its orbit around the Sun.

When Earth is located on one side of the Sun, the tilt causes the Northern Hemisphere to be leaning toward the Sun. When Earth is on the opposite side of the Sun, this same _____ toward Polaris causes the Northern Hemisphere to be leaning away from the Sun. When the Northern Hemisphere is leaning toward the Sun, the season is _____ in the _____ Hemisphere and winter in the Southern Hemisphere. When the Northern Hemisphere is leaning away from the Sun, the season is _____ in the Northern _____ and summer in the _____ Hemisphere.

Name: _____

REASONS FOR SEASONS [p 2 of 2]

When we are leaning away from the Sun, as in the season of _____, the Sun appears _____ [higher/lower] in the sky. This means the Sun will spend _____ [less/more] time above the horizons (rising later and setting earlier), and thus there will be fewer daylight hours and less time to warm Earth. The day of the year with the _____ [least/most] daylight hours is December 21st, the first day of winter (in the Northern Hemisphere). This day is also called the Winter Solstice.

When we are leaning toward the Sun, as in the season of _____, the Sun appears _____ [higher/lower] in the sky. This means the Sun will spend _____ [less/more] time above the horizons (rising earlier and setting later), and thus there will be more daylight hours and more time to warm Earth. It is also true, that when the Sun is higher in the sky, the Sun's rays impact Earth at a steeper angle and are _____ [less/more] intense than when the Sun is lower in the sky. This also helps to explain why it is warmer in summer and colder in winter. The day of the year with the _____ [least/most] daylight hours is June 21st, the first day of summer (in the Northern Hemisphere). This day is also called the summer _____.

When Earth is neither leaning toward nor away from the Sun, we have the Fall and Spring _____, when daylight and nighttime hours are about equal.

For Earth, the following phrase is a way to remember the reason for colder and warmer seasons: "Length of "days"; Angle of rays; Nothing to do with how far away". But what about the seasons on Mars? Mars' rotation _____ is tilted about the same amount as Earth's, but Mars' orbit around the Sun is more _____ (like an oval). Thus Mars' distance from the Sun varies a lot more than Earth's distance from the Sun. This means that both the tilt of the Mars' rotation axis and its closer and farther distances from the Sun are important to consider in determining the more extreme nature of Martian seasons.

Name: _____

YOUR BIRTHDAY STARS [p 1 of 2]

Use the *Zodiac Diagram* to answer these questions.

1. Estimate the date at the girl's position: _____.

2. Name a Zodiac constellation that would be visible to her *at midnight*:

   _____

3. Write the names of two Zodiac constellations that would be visible in the night sky *at midnight* on the Summer Solstice (21 June).

   _____ _____

4. Do we see different stars at different times of year?

   Circle one: YES NO

   Explain:

5. Write down your birthdate (day, month, year): _____

6. Mark an "X" on the Diagram to show your birthday position in Earth's orbit around the Sun.

7. Write the names of two constellations that would be visible in the night sky *at midnight* on your birthday:

   _____ _____

8. Can you see the constellation representing your "sign" of the Zodiac in the night sky on your birthday?

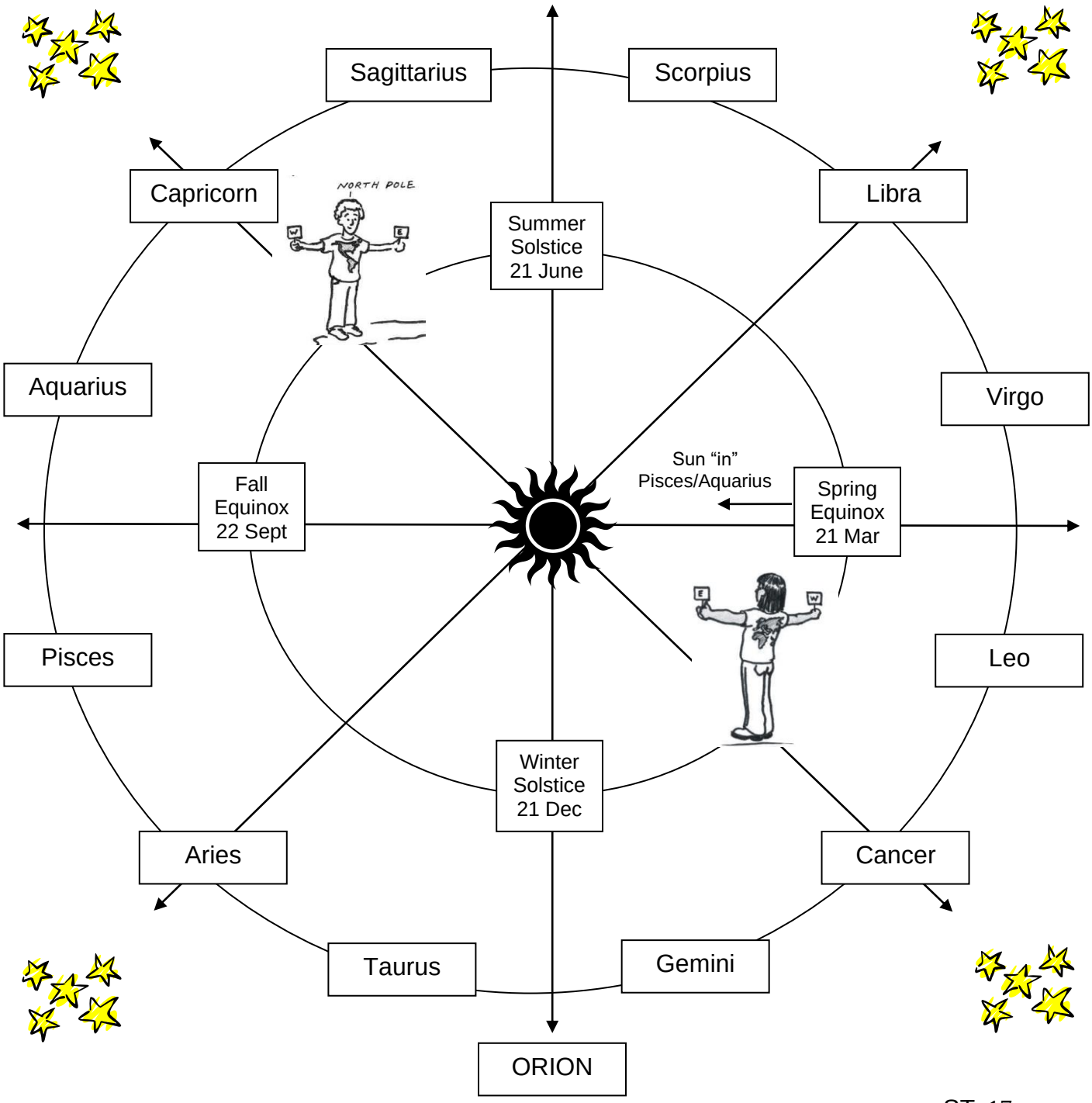
   Circle one: YES NO

   Explain:

THE ZODIAC DIAGRAM [p 2 of 2]

Use this Zodiac Diagram to answer questions.

REMEMBER: During the lesson, you were standing around the inner circle with your body representing Earth in orbit around the Sun.



cherilynn.morrow@gmail.com and mjzawaski@gmail.com

Name: _____

DIFFERENT STARS FOR DIFFERENT SEASONS
FILL-IN-THE-POEM

by Cherilynn Morrow
cheri@KinestheticAstronomy.net

Use the words at the bottom to fill in the blanks of the poem. As you choose your answers, be sure to consider the astronomy you know as well as the rhyming scheme.

Now we KNOW planet __ __ __ __ __, she does circle the __ __ __;.

And it takes her a __ __ __ __ 'til one orbit is done.

She __ __ __ __ __ to a pole star – this causes the __ __ __ __ __ __ __,

And moves through our birthdays with gravity's reason.

There's __ __ __ the lion – we see THIS in the Spring,

But night skies in Fall gives us Pegasus' wings.

In summertime nights we see Cygnus the swan;

In __ __ __ __ __ __, Orion flies dusk until __ __ __ __.

So why DO we not see the same constellations,

As Earth __ __ __ __ __ __ 'round through her seasonal stations?

See, the __ __ __ __ __ side of Earth – without Sun's reflections –

Faces out to the __ __ __ __ __ in different __ __ __ __ __ __ __ __ __ __.

STARS	YEAR	SEASONS
ORBITS	DAWN	WINTER
TILTS	NIGHT	EARTH
DIRECTIONS	LEO	SUN

Name: _____

THE NIGHT SKY IN CHINA

Fill in the answers and design a kinesthetic demonstration

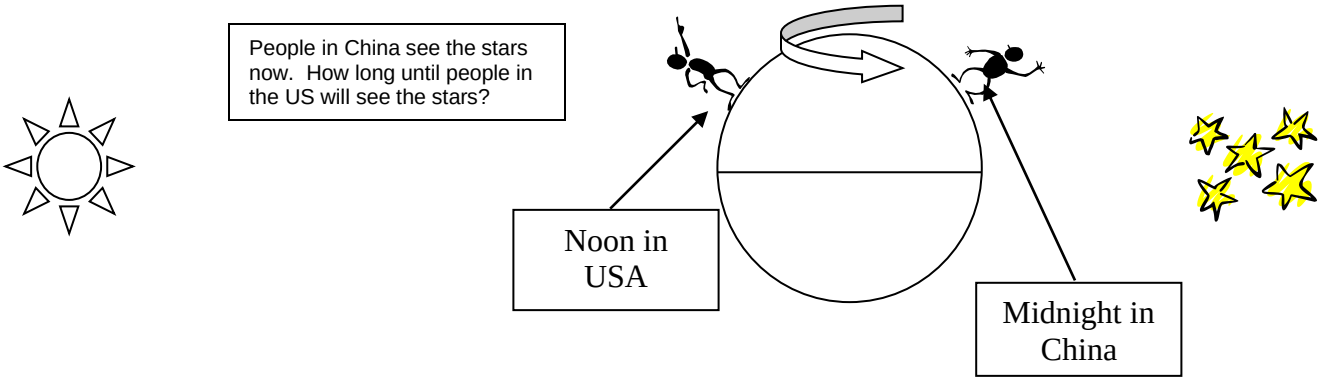
1. Do you think people in the US will see pretty much the same stars tonight as people in China saw 12 hours ago? **Circle one: YES NO**

STOP! RECORD AND KEEP YOUR ANSWER ABOVE. THEN GO ON TO SEE IF YOUR ANSWER CHANGES OR STAYS THE SAME BY THE END. LET'S GO!

2. What is Earth's rotational period (in hours)? _____
3. What is Earth's orbital period around the Sun (in days)? _____
4. How many times does Earth rotate during one orbit of the Sun? _____
5. How many degrees are in a circular orbit? _____º
6. So *about* how many degrees does Earth move in orbit in one day? _____º
   Explain:

7. Look at the diagram. How long will it take for Earth to rotate from noon in the USA (midnight in China) to midnight in the USA (noon in China)? _____hrs?

8. So *about* how far will Earth have moved in its orbit during this time? _____ º



9. Will people in the US see pretty much the same stars tonight as people in China saw 12 hours ago? **Circle one: YES NO**
10. Work in pairs to design a ***kinesthetic demonstration*** that proves your answer.

Name: _____

WHO CAN SEE ORION WHEN?

Find and fill in the ***5 blanks*** using kinesthetic techniques. Confirm the information given in the other boxes.

Orion is not visible at any time because it **rises at sunrise** and **sets at _____.**

Heliacal rise of Orion. Orion visible low in the east for a short time just before _____.

Heliacal set of Orion. Orion visible low in the west for a short time just after sunset

Summer Solstice 21 June

Orion **rises at midnight.** Visible in the eastern sky until it fades away at sunrise. **Sets at noon**.

Fall Equinox 22 Sept

Spring Equinox 21 Mar

Orion **rises at noon**. Only visible in the western sky after sunset. **Sets at _____.**

Orion rises between sunset and midnight and fades away in the western sky at sunrise.

Winter Solstice 21 Dec

Orion rises between noon and sunset. Only visible after sunset until setting in the west in the early AM.

Orion visible the whole night: **rises at _____** and **sets at _____.**

This diagram is NOT to scale. Place the Orion diagram as far away as is practical.

TO ORION

cherilynn.morrow@gmail.com and mjzawaski@gmail.com

Name: _____

COMPARING THE SEASONS ON EARTH AND MARS

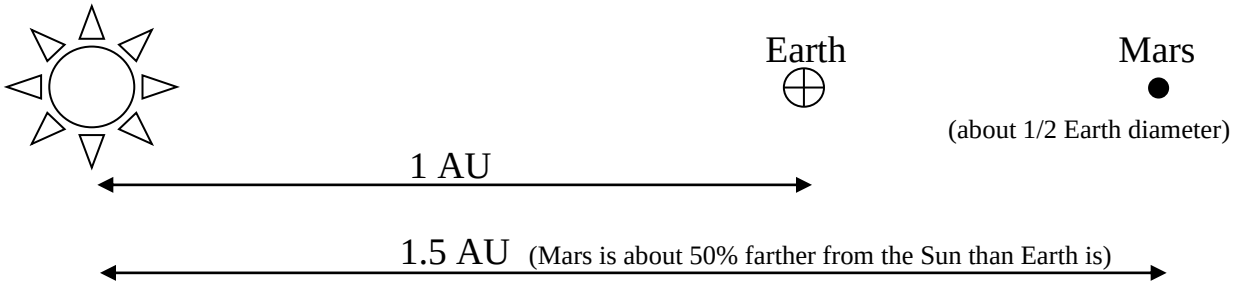
Use the information provided to answer the Student Questions below

Student Questions

1. How long is a Martian day? How does this compare to Earth?
2. How long is a Martian year? How does this compare to Earth?
3. If you lived on Mars, would you have made more or less trips around the Sun? How old would you be in Martian years?
4. How does the tilt of Mars' axis compare to Earth?
5. Will it be generally colder or warmer on Mars compared to Earth? Why?
6. Do you think Mars will have seasons? Why or why not?
7. How long are seasons on Earth? How long would a Martian season be?
8. The Earth's orbit around the Sun is almost perfectly circular, so the Earth-Sun distance is not an important factor in Earth's seasonal changes. Do you think the more elliptical (oval-shaped) orbit of Mars makes the Mars-Sun distance a more important factor in the seasonal temperatures of Mars? Why or why not?

PLANET	Average Distance from Sun	Rotational Period	Orbital Period	Tilt of Axis
Earth	1 AU*	24 hours	1 Earth year	23.5 degrees
Mars	1.5 AU*	24.6 hours	About 2 Earth years (1.88)**	25 degrees***

*1 AU is one Astronomical Unit.
One AU is the average distance between Earth and Sun = 149.6 million km



**The orbit of Mars around the Sun is more elliptical (oval-shaped) than Earth's orbit around the Sun. The Sun-Mars distance varies up to 20% over the course of its year (from about 264 million km to 216 million km). Earth's orbit is much more circular. The distance varies by only about 3% (from 152.1 million km to 147.1 million km).

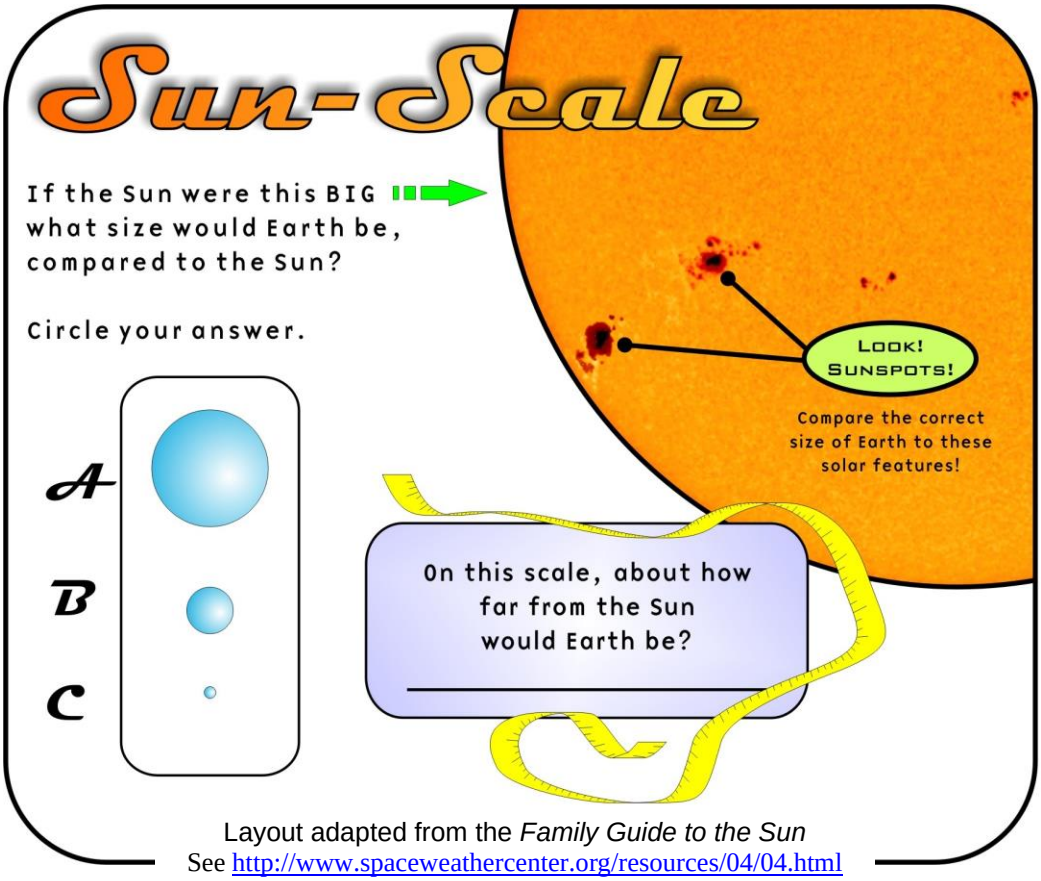
***Mars is closest to the Sun during the winter in the Northern Hemisphere (summer in the Southern Hemisphere). Mars gets about 50% more solar energy when Mars is closest to the Sun compared to when it is farthest away. Because Earth's orbit is more circular, it receives only about 6.6% more solar energy when it is closest to the Sun compared to when it is farthest away.

Name: _____

WHAT HAVE YOU LEARNED? [p 1 of 5]

1. **How many stars are in the Solar System? _____**

2. **Provide the <u>TWO answers</u> requested in the box below:**



Layout adapted from the *Family Guide to the Sun*
See http://www.spaceweathercenter.org/resources/04/04.html

3. Write the correct times of day for someone on the front of the rotating boy.

1. _____ 2. _____ 3. _____ 4. _____

Choose from SUNRISE, SUNSET, NOON or MIDNIGHT.

Name: _____

WHAT HAVE YOU LEARNED? [p 2 of 5]

3. **Do stars appear to rise and set? Why or why not?**

4. **Fill in the blanks below and DRAW PICTURES to show what you mean.**

a) Earth turns about its own axis. It takes _____ hours to turn once around.

We call this movement _____.

DRAWING of Earth doing this movement:

b) Earth moves around the Sun. It takes _____days to go once around.

We say that Earth is in _____ around the Sun. How many trips around the Sun have you made in your life? _____

DRAWING of Earth doing this movement:

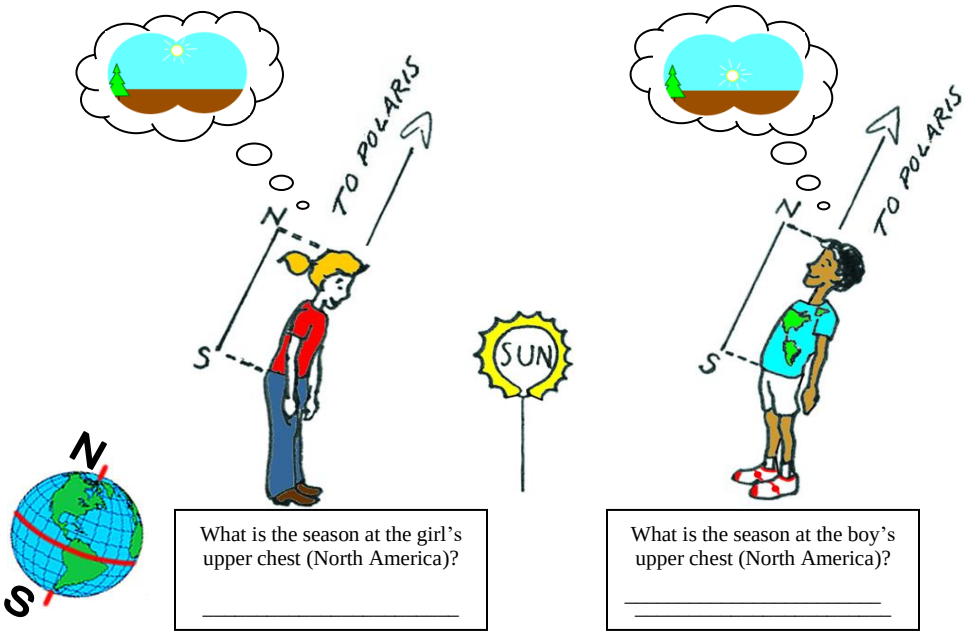
5. **How many times does Earth rotate during one orbit of the Sun? _____**

6. **About how much (out of 360º) does Earth move in orbit in one day? _____º Explain your reasoning:**

Name: _____

WHAT HAVE YOU LEARNED? [p 3 of 5]

7. Fill in the blanks below the girl and boy:



What is the season at the girl's upper chest (North America)?

_____

What is the season at the boy's upper chest (North America)?

_____

What is the season at the girl's upper back (China)?

_____

What is the season at the boy's lower belly (South America)?

_____

8. What time of year do we experience more daylight hours? Why?

9. Why is it hotter in summer and colder in winter on Earth?

Name: _____

WHAT HAVE YOU LEARNED? [p 4 of 5]

10. Refer to the Zodiac Diagram on the next page to answer these questions:

a) Estimate the date at the boy's position: _____.

b) Name a Zodiac constellation that would be visible to him *at midnight*:

_____

c) Estimate the date at the girl's position: _____.

d) Name a Zodiac constellation that would be visible to her *at midnight*:

_____

e) Write the names of two constellations that would be visible in the night sky *at midnight* on the Winter Solstice (21 December).

_____ _____

f) Do we see the same stars at different times of year? Why or why not?

g) Write down the date of your birthday: _____

h) Mark an "X" on the Diagram to show your birthday position in Earth's orbit.

i) Write the names of two constellations that would be visible in the night sky *at midnight* on your birthday.

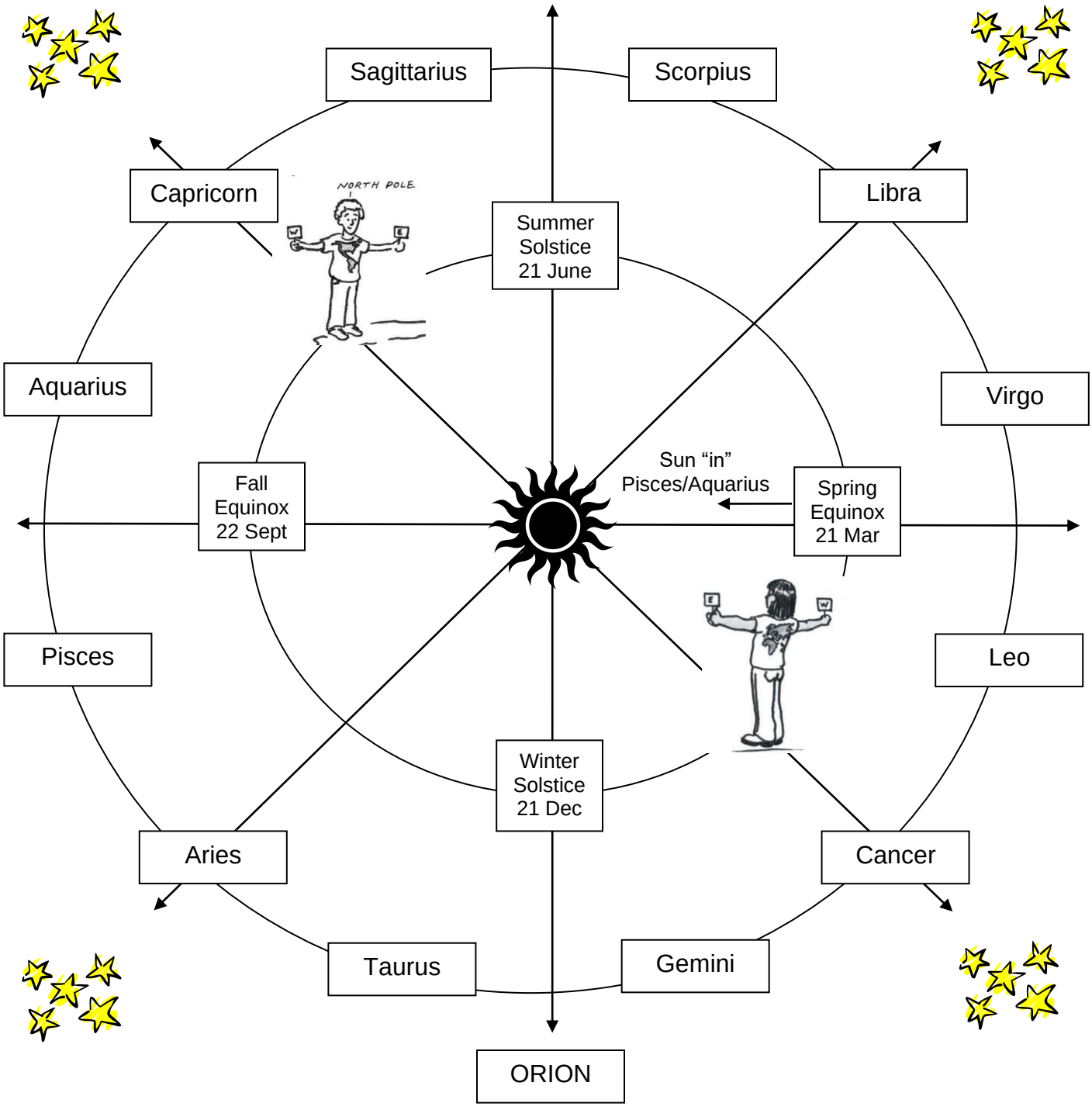
_____ _____

j) **BONUS:** Can you see the constellation representing your "sign" of the Zodiac in the night sky on your birthday? Explain your answer on the back.

THE ZODIAC DIAGRAM [p 5 of 5]

DIRECTIONS: Use this Zodiac Diagram to answer questions.

REMEMBER: During the lesson, you were standing around the inner circle with your body representing Earth in orbit around the Sun.



cherilynn.morrow@gmail.com and mjzawaski@gmail.com