Outreach for the NASA PUNCH mission

AGENDA – LIPS Kinesthetic Astronomy Workshop

2 August 2022 Fiske Planetarium, Boulder CO

12:45 - 1:00 = Gather up in Fiske Planetarium lobby; collect name tags. [Karrie]

1:00-1:30 = Intro to PUNCH Mission & Outreach in Fiske Theatre [Karrie, John, Craig, Cherilynn]

1:30-3:00 = Plenary Kinesthetic Astronomy Session (outside - Kittredge quad) [Cherilynn, Mike, John]

3:00-3:15 = Break [Refreshments served – Fiske Lobby, Karrie]

3:15-4:00 = 3 Breakout Groups working on KA extensions (outside – Kittredge quad) [Cherilynn, Mike, John]

4:00-4:50 = 3 Breakout Group presentations in Fiske Theatre [ALL]

4:50-5:00 = Closing Circle & Evaluation

PAGES to FOLLOW:

KINESTHETIC ASTRONOMY™
Written Assessment Options for the *Sky Time* Lesson
[EXERPT for LIPS Workshop]

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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 _____!

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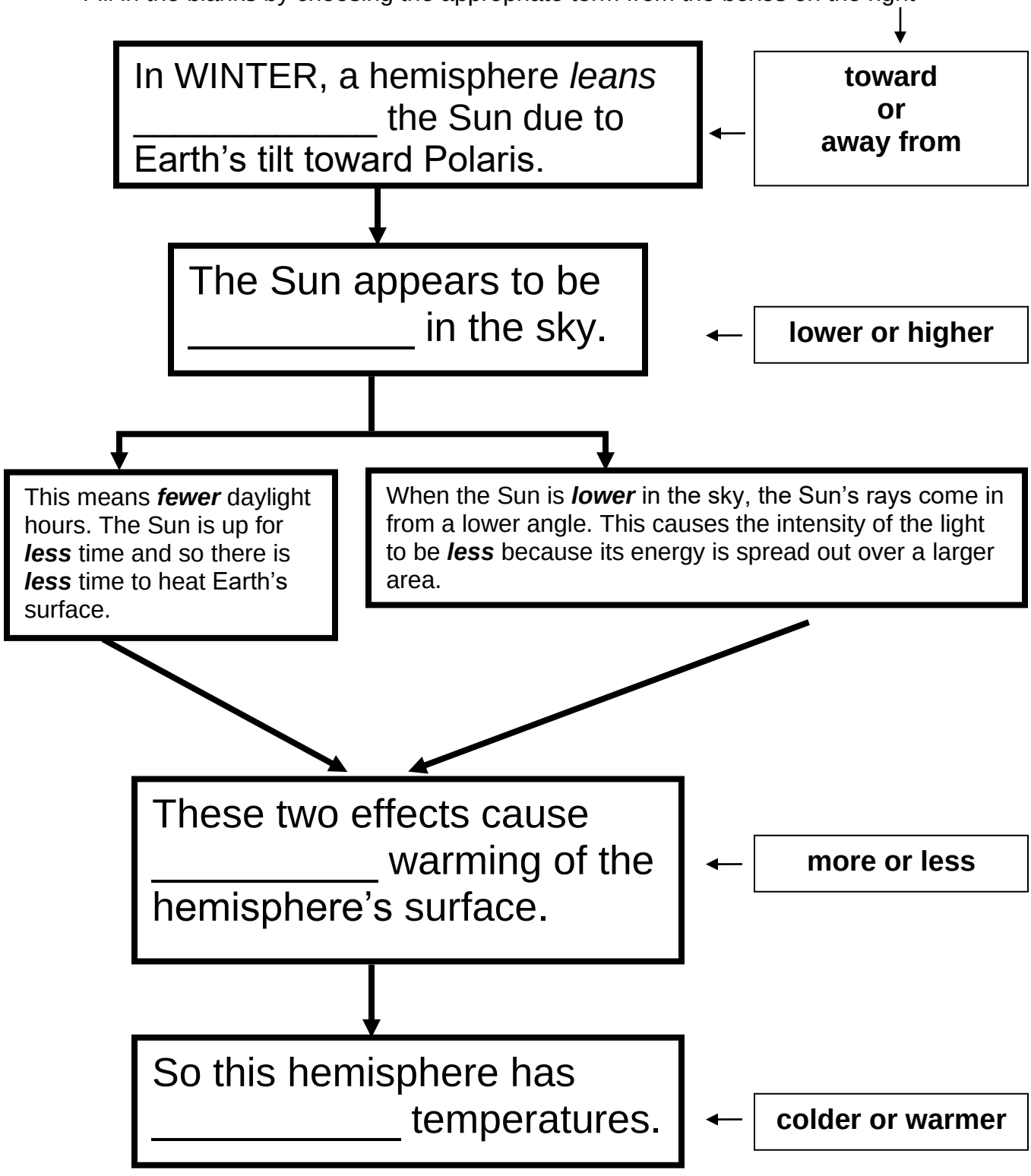
REASONS FOR SEASONS CONCEPT MAP ACTIVITY

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

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



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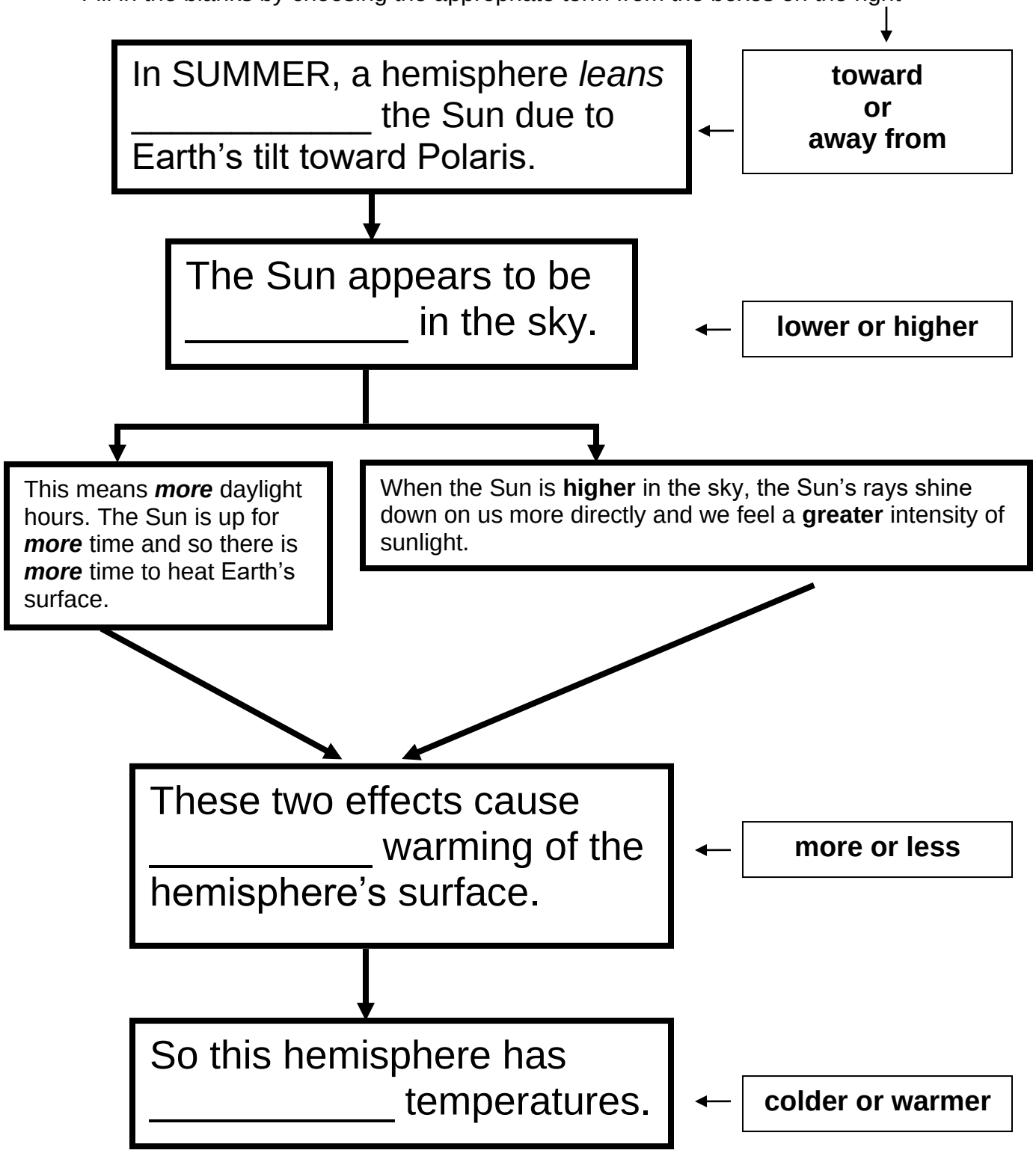
REASONS FOR SEASONS CONCEPT MAP ACTIVITY

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

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



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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.

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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.

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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:

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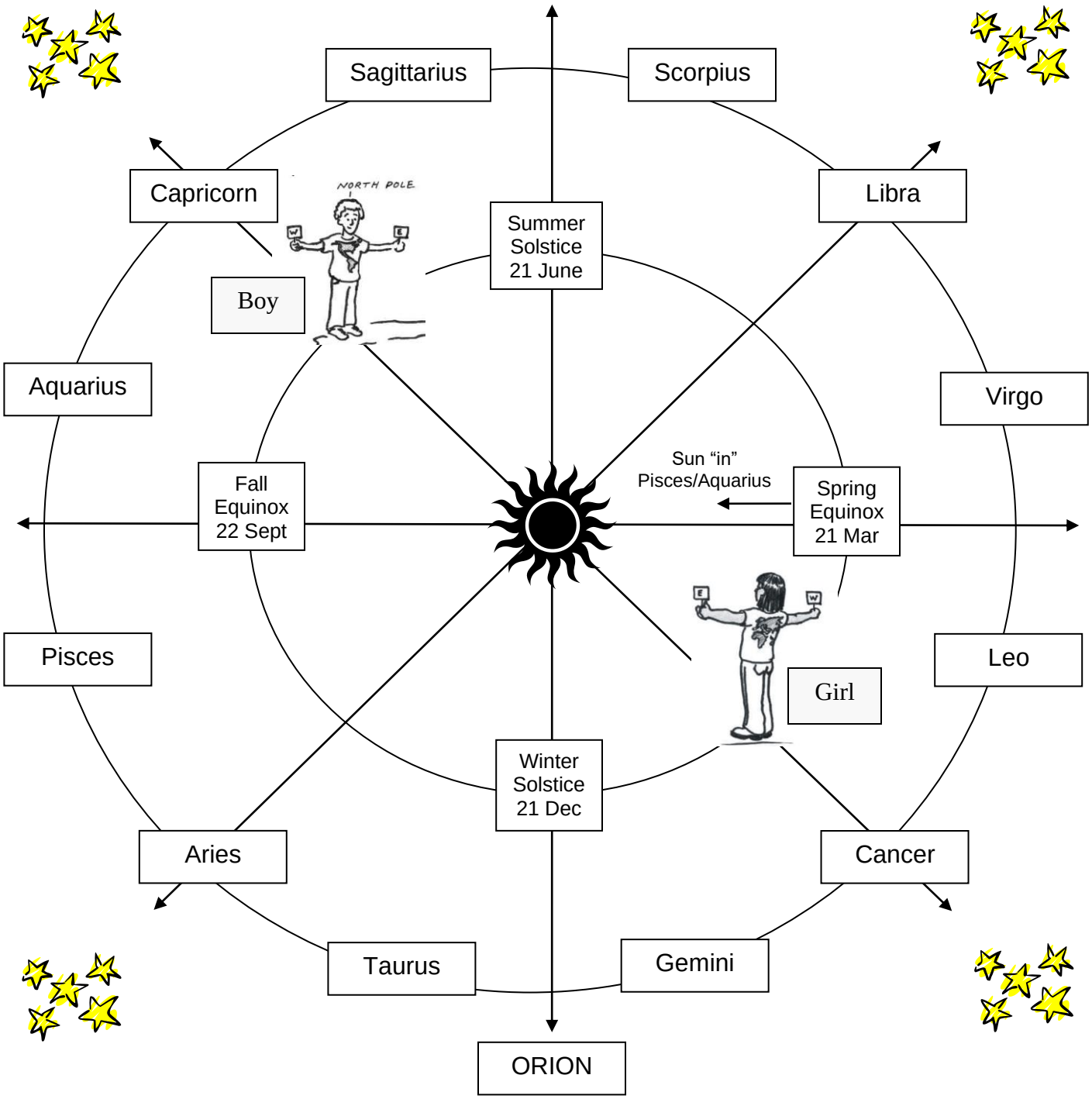
THE ZODIAC DIAGRAM [p 2 of 2]

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.



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Name: _____

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

by Cherilynn Morrow
cherilynn.morrow@gmail.com

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

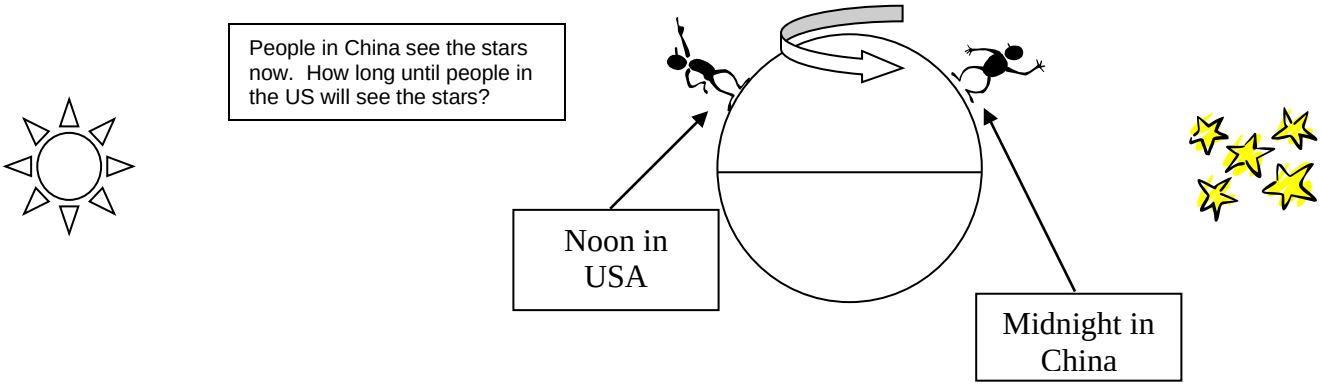
1. Do you think people in the US will see pretty much the same stars tonight as people in China saw 12 hours ago? **Circle one: YES NO**

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 supports your answer.

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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

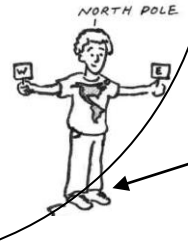
Summer Solstice 21 June

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

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Name: _____

COMPARING THE SEASONS ON EARTH AND MARS

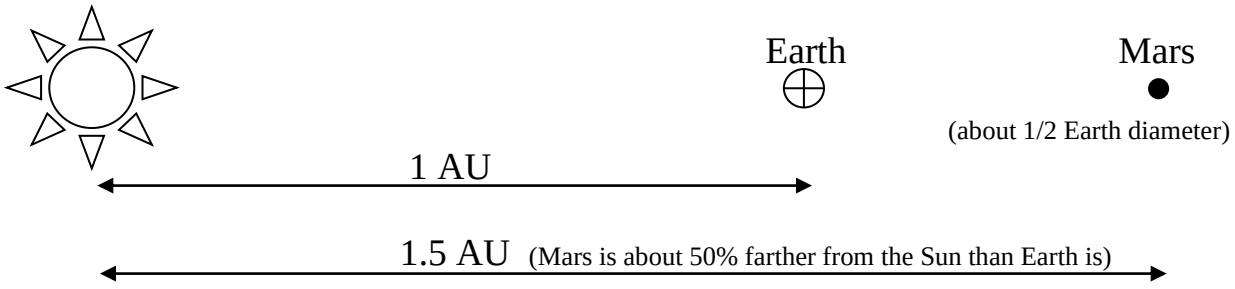
Use the information provided to answer the Student Questions below.
(Use a separate sheet of paper.)

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.

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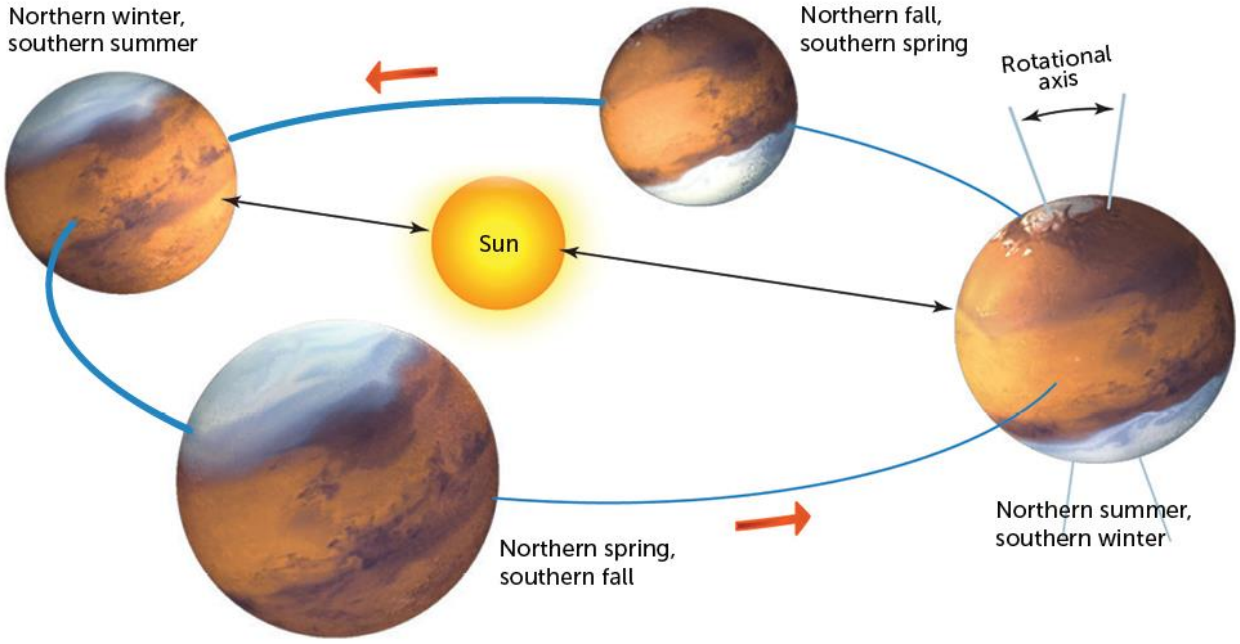
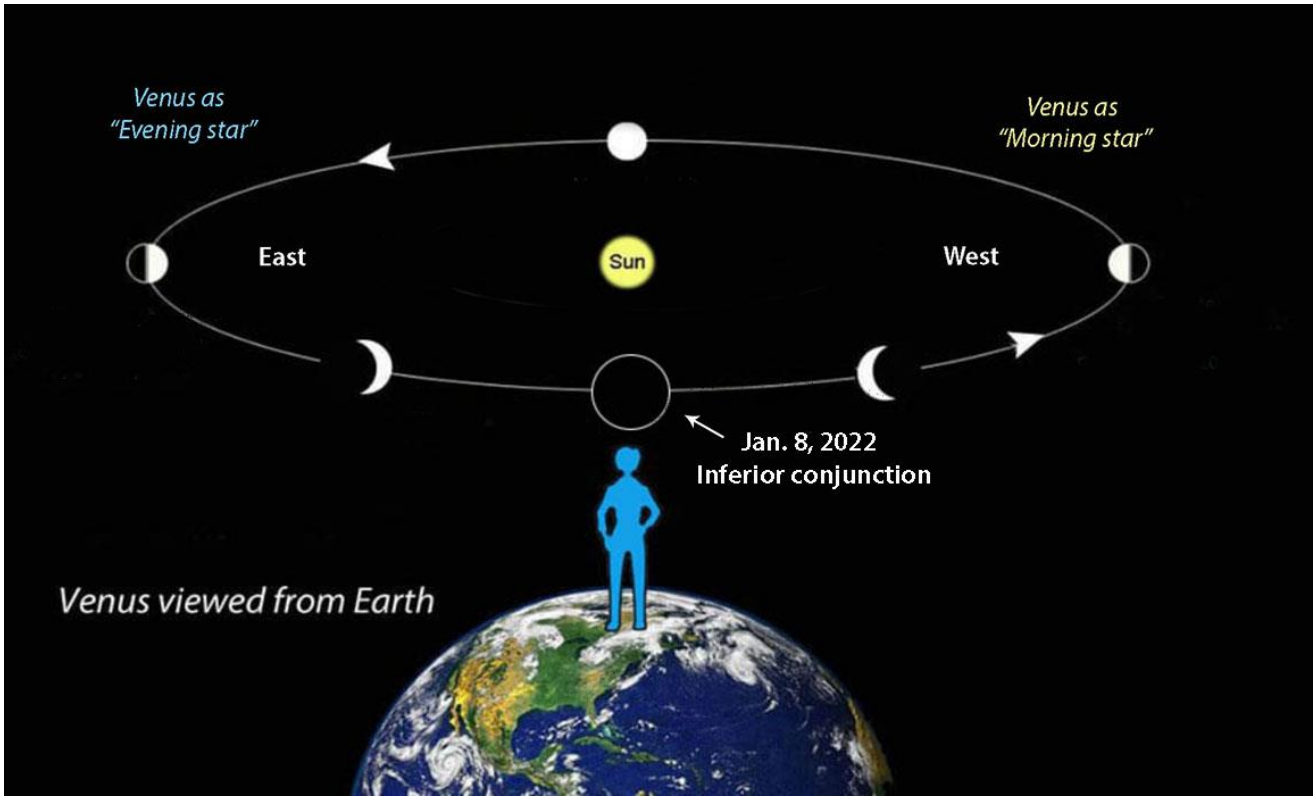
https://www.sciencenews.org/article/perseverance-mars-weather-dust-storms
By Lisa Grossman July 14, 2020





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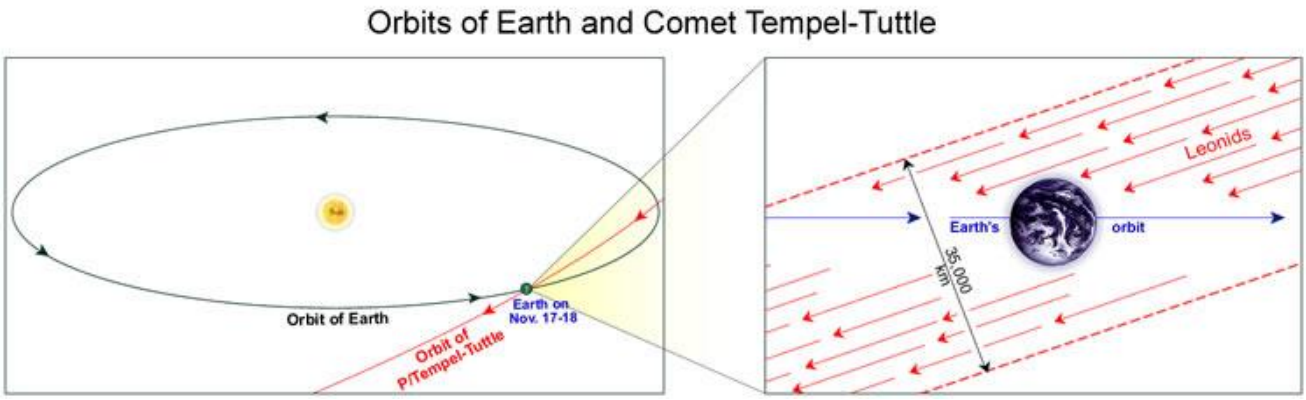
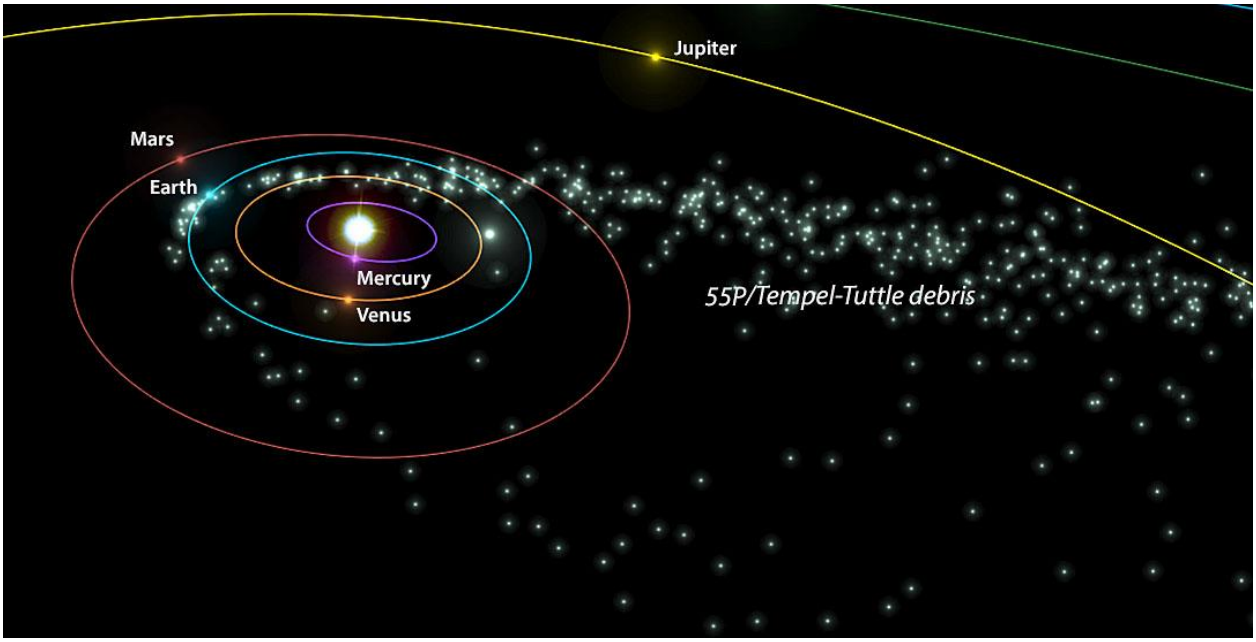
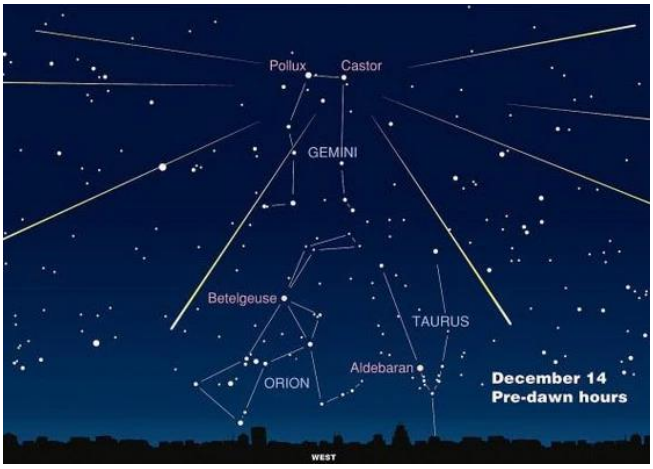
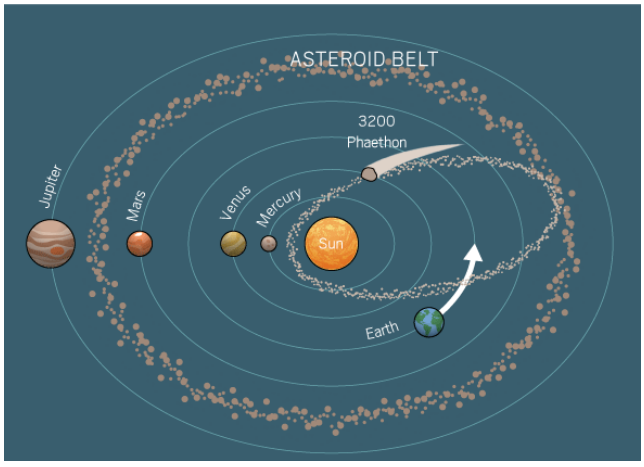
METEOR SHOWER: LEONIDS





METEOR SHOWER: GEMINIDS





Only one apparent Earth orbit crossing of 3200 Phaethon intercepts the ecliptic. The other is out of Earth's orbital plane.

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SOME QUESTIONS an EMBODIED APPROACH CAN ADDRESS

A sample of questions that the embodied approach we call Kinesthetic Astronomy™ can address especially well. **Can you think of others?**

DAY/NIGHT

- What is the difference between "rotation" and "orbit"?
- Why does the Sun appear to rise and set? (Day/night cycle)

STARS

- Do the stars also appear to rise and set like the Sun?
- Why do we see different stars at different times of year?
- Why do the zodiac constellations appear high in the night sky in winter and low in the night sky in summer?
- Do we see our constellation of the Zodiac at night on our birthdays?

SEASONS

- Why is it hotter in summer and cooler in winter? (Seasons)
- Why are the seasons opposite in northern and southern hemispheres?

MOON

- Why does a full moon rise at sunset and set at sunrise?
- Why do other lunar phases rise and set at different times?
- Why does the Moon rise almost an hour later each night?
- Does the Moon rotate?
- Do people living on the other side of Earth see the same moon phases that we do?

PLANETS

- Why don't we see all the planets in the sky every night?
- Why does Venus appear as a morning and evening star?
- Does Mars have seasons like Earth?

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SCAN ME

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