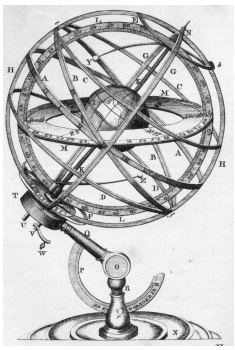
The Path of the Sun

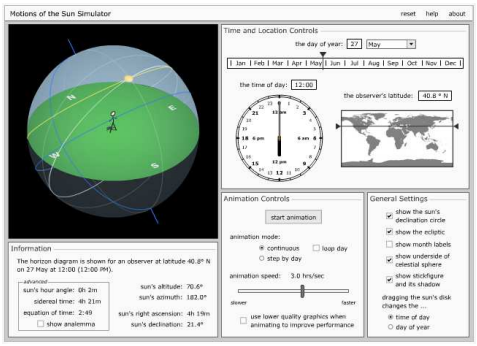
The Sun, stars and planets cross our sky in complicated patterns that depend on the Earth's daily rotation around its tilted axis and its annual revolution of the Earth around the Sun.

For thousands of years, astronomers have watched the sky, figured out the patterns and built "computers" like these so they could predict when and where the Sun, stars and planets rise and set each day.

Stonehenge
c. 2500 BC
(Jason Hawkes, Corbis Images)



Armillary sphere
c. AD 1700
(Wikipedia Commons)



Path of the Sun simulator
Today

In this tutorial, you'll use your 21st Century computer to explore the motion of the Sun.

1. Open your browser to `astro.unl.edu`
2. On the NAAP Labs tab, select Labs - Motions of the Sun.
3. Click the "Paths of the Sun Simulator" link to launch the sim.

Part 1: The Path of the Sun Simulator

Explore the sim with your partners and answer these questions:

An object's **altitude** tells you how high an object is in the sky, from 0° on the horizon to 90° at your zenith. What is the altitude of the Sun at 12:00 noon on Canada Day (July 1), as seen by observers in Vancouver (latitude 49.0°N)?

Challenge question: An object's **azimuth** tells you its direction, like on a compass, from angle 0° (due North) to 90° (due East) to 180° (due South) to 270° (due West) and back to 360° or 0° at North again. How many degrees North of East is the most northerly sunrise for observers in Vancouver?

Part 2: The Path of the Sun Across the Sky

If you were able to answer both those questions, you've probably figured out how to

- drag the Sun
- set the time
- set the latitude
- measure the altitude
- animate the daily motion
- grab and move the sphere
- find the time
- set the date
- measure the azimuth
- what the white, gray, yellow and blue circles are

If you haven't figured these out yet, don't worry. Watch your TA use the simulation to collect data tracking the path of today's Sun. Record the data in the Table:

	Today _____	Autumnal Equinox Sep 22	Winter Solstice Dec 22
Time of sunrise (time when the Sun is at altitude 0°)			
Sun's location on horizon at sunrise, in degrees North or South from East (azimuth 90°)			
Sun's highest altitude of the day, in degrees above Southern horizon			
Time of sunset (time when the Sun is at altitude 0°)			
Sun's location on horizon at sunset, in degrees North or South from West (azimuth 270°)			
Draw the Sun's path on diagram. Label path with date, time of sunrise, time of sunset.			

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If you haven't figured these out yet, don't worry. Watch your TA use the simulation to collect data tracking the path of today's Sun. Record the data in the Table:

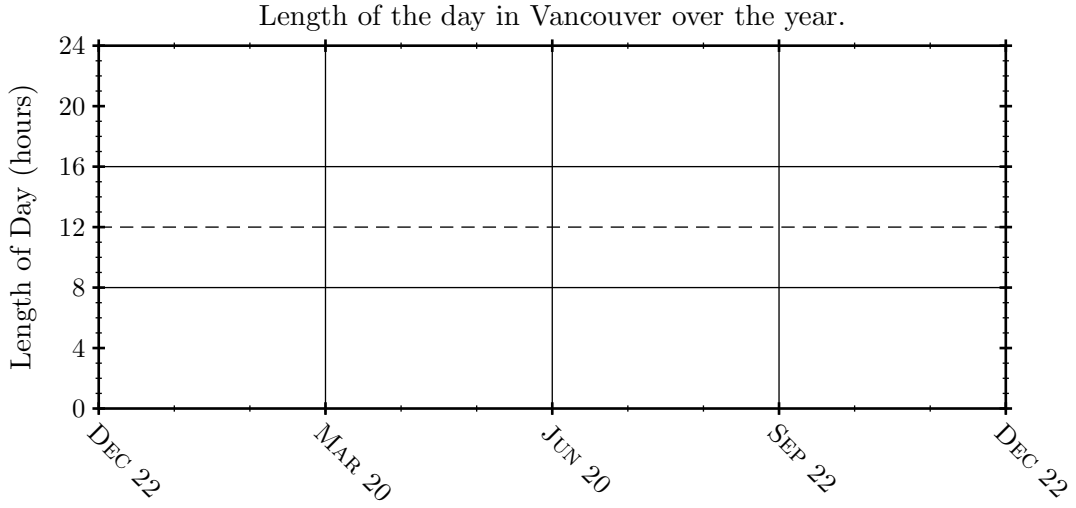
	Today _____	Vernal Equinox Mar 20	Summer Solstice Jun 22
Time of sunrise (time when the Sun is at altitude 0°)			
Sun's location on horizon at sunrise, in degrees North or South from East (azimuth 90°)			
Sun's highest altitude of the day, in degrees above Southern horizon			
Time of sunset (time when the Sun is at altitude 0°)			
Sun's location on horizon at sunset, in degrees North or South from West (azimuth 270°)			
Draw the Sun's path on diagram. Label path with date, time of sunrise, time of sunset.			

Name _____ ID No. _____ Tutorial Day/Time _____

Part 3: Questions

Please hand in this worksheet when you are finished.

1. Use the sunrise and sunset times you collected and from your sky diagram to find the **length of the day** (the number of hours the Sun is up) throughout the year. Put the values on this graph and draw a smooth curve between them. Be sure to include today, too.



2. Shade in the region of the graph in Question 1 that represents the hours of darkness when the Sun is down. What fraction of the graph did you shade in? Answer: _____

3. Change the latitude to 90°N so the sim shows the motion of the Sun for observers **at the North Pole**.

   When does the Sun rise today? _____

   When does the Sun rise on Jun 20? _____

   When does the Sun rise at the North Pole? _____

4. There's something wrong with the equinoxes. In class, we say the Sun rises at 6:00 a.m. and sets at 6:00 p.m. but that's not what you found. Set the simulation for Vancouver again. Write the observations you made earlier and add another observation: the time when the Sun crosses the meridian (at azimuth 180°.) This is what we usually call "noon."

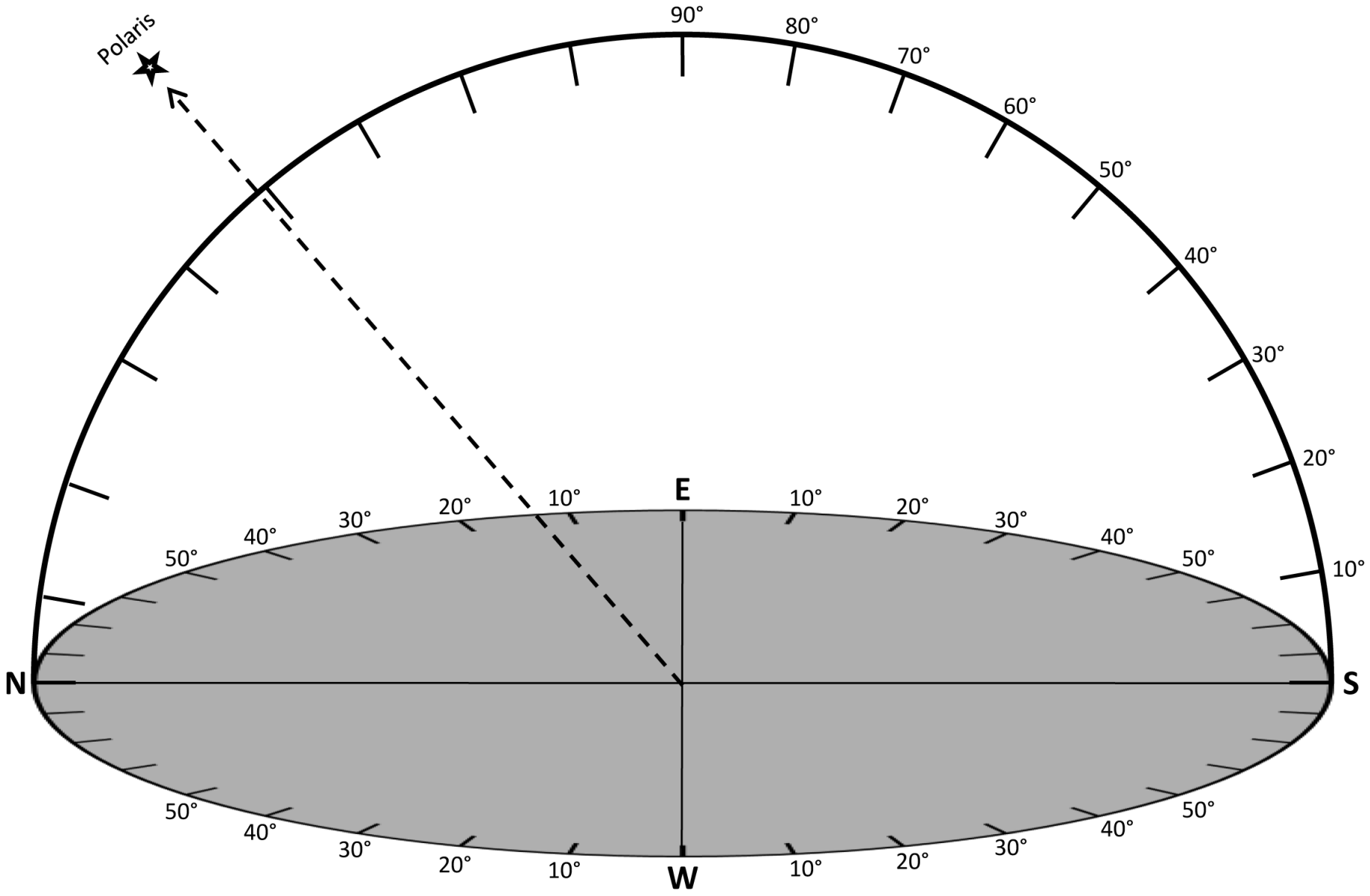
Date	sunrise	noon	sunset
Vernal Equinox			
Autumnal Equinox			

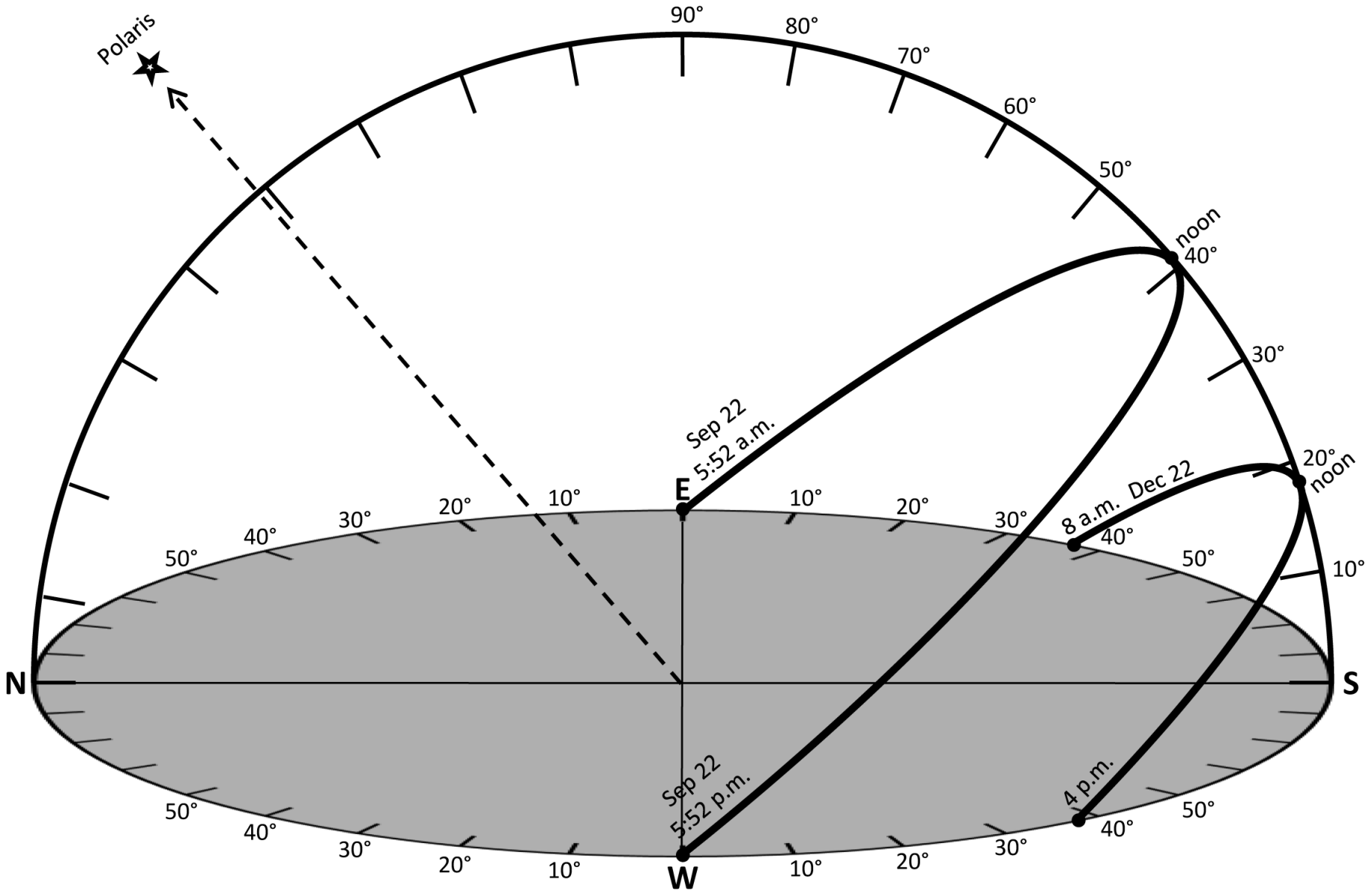
   On the Vernal Equinox, the day is _____ hours long but it's shifted _____

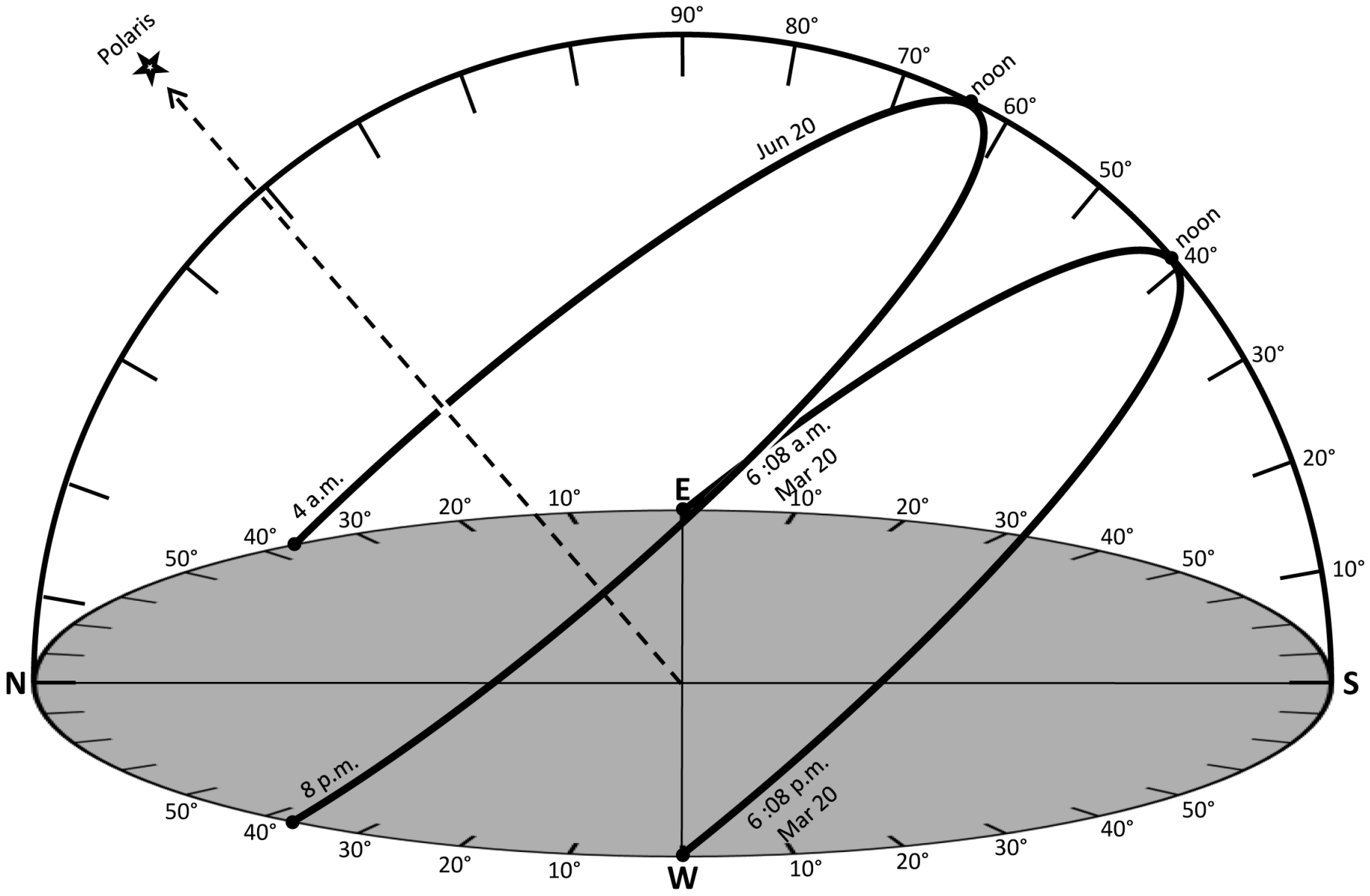
   On the Autumnal Equinox _____

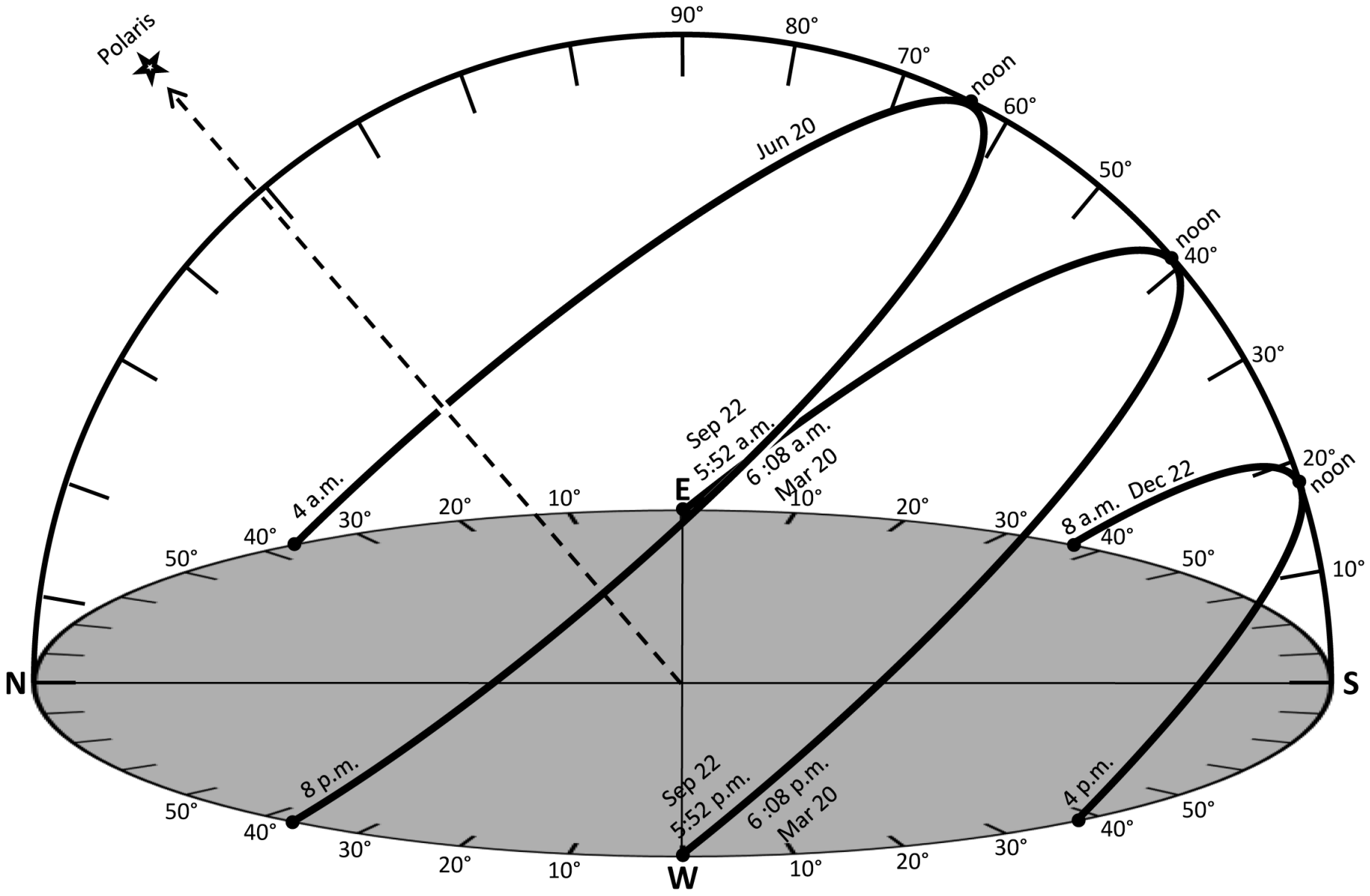
   This unexpected shift will be explained in upcoming classes about Kepler's Laws and the analemma.

Path of the Sun simulator: `astro.unl.edu/naap/motion3/animations/sunmotions.html`


Polaris
90°
80°
70°
60°
50°
40°
30°
20°
10°
E
N
S
W


Polaris
90°
80°
70°
60°
50°
40°
30°
20°
10°
noon
Sep 22
5:52 a.m.
E
8 a.m. Dec 22
noon
N
S
W
Sep 22
5:52 p.m.
4 p.m.


Polaris
90°
80°
70°
noon
60°
Jun 20
50°
noon
40°
30°
20°
10°
6 :08 a.m.
Mar 20
E
4 a.m.
10°
20°
30°
40°
50°
N
S
8 p.m.
6 :08 p.m.
Mar 20
W


Polaris
90°
80°
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Sep 22
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6 :08 a.m.
Mar 20
noon
Dec 22
8 a.m.
4 a.m.
8 p.m.
4 p.m.
Sep 22
5:52 p.m.
6 :08 p.m.
Mar 20
N
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