Lab 5: Human Orrery

AST 105

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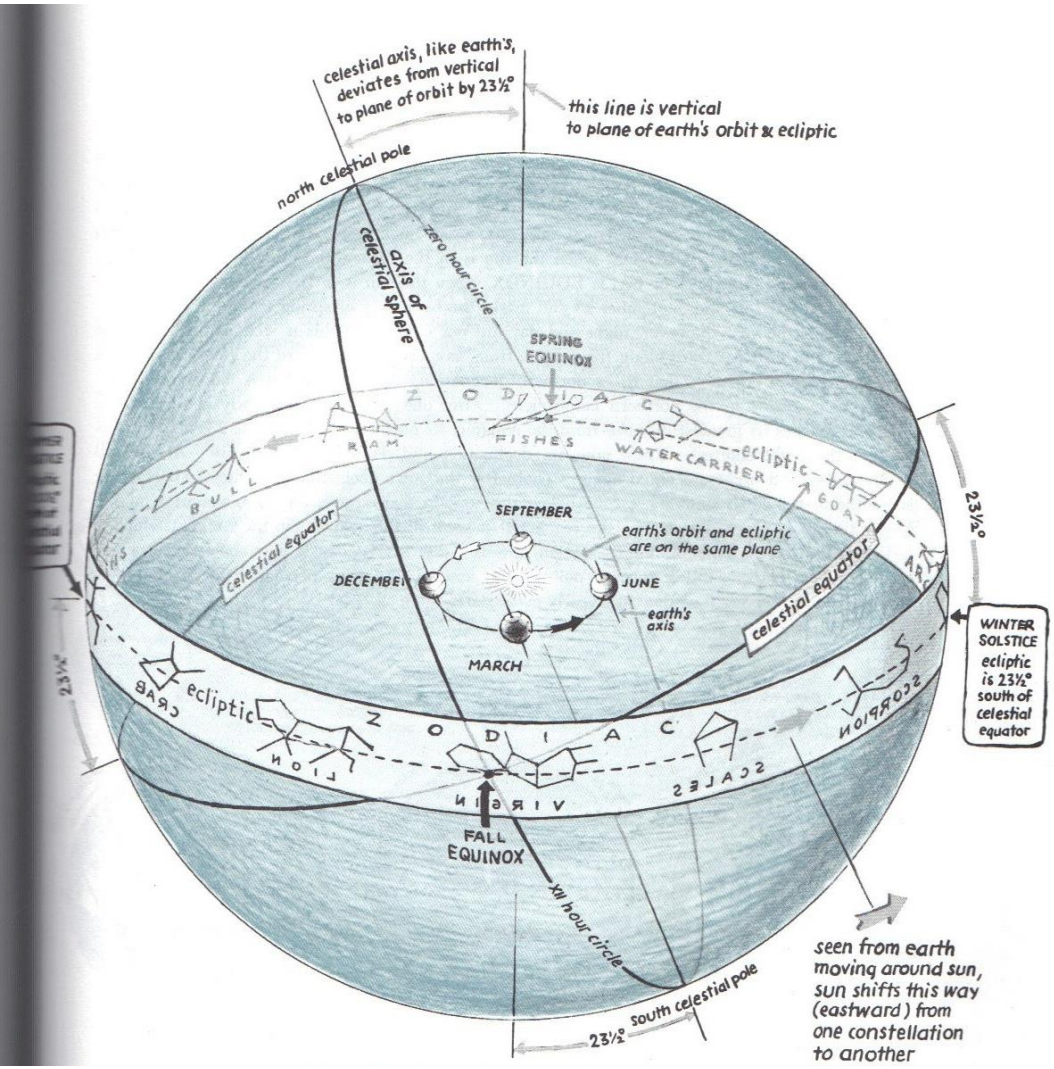
We played around with the **celestial sphere** back in Lab 3, mapping out the sky using a coordinate system based on Earth's rotation axis.

In this lab we're going to map out the sky using a different set of coordinates – this time with the equator based on Earth's orbit around the Sun. In other words, the equator here will be the *ecliptic*: the path through the sky where the sun, moon, and planets travel.

There are 13 constellations that have territory along the ecliptic, and they're all in the PDF associated with this lab. (The PDF also has a 14th constellation: the famous Orion.) These constellations are sometimes collectively called the **zodiac** (with the same root as in *zoology*) because most of them depict animals.

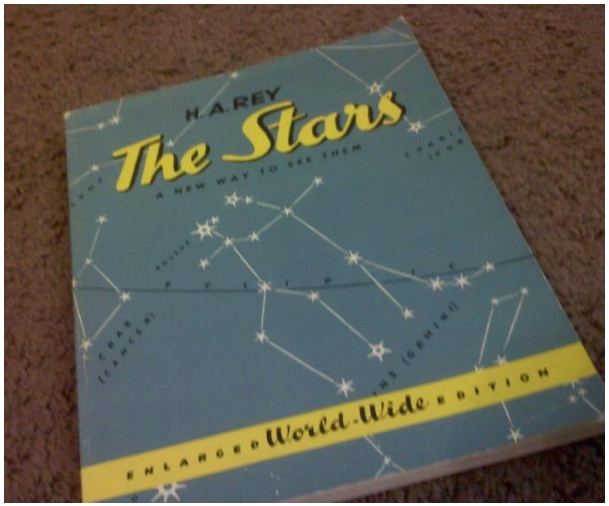


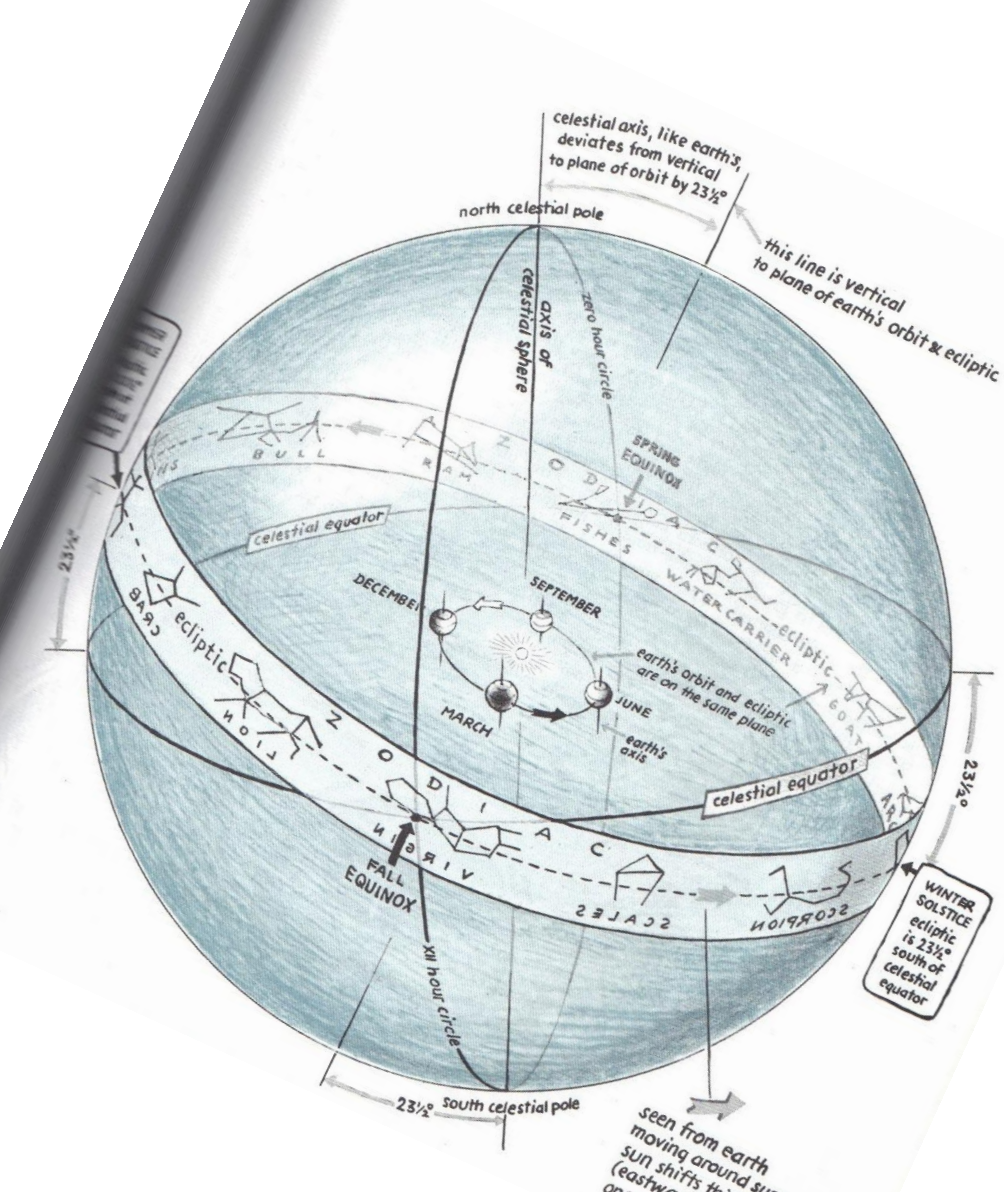
a “celestial sphere” using ecliptic coordinates

This diagram, from *The Stars: A New Way to See Them* by H. A. Rey, shows how the ecliptic is oriented relative to the celestial equator.

Because Earth is tilted by 23½° relative to its orbit, the ecliptic is tilted by that amount relative to the celestial equator.

Tilt your head a little bit to the left and look at this diagram, and you’ll see the classic celestial sphere with the north celestial pole at the top.

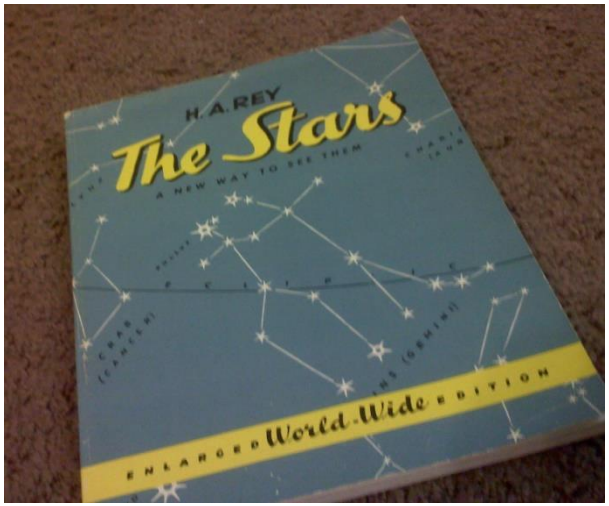




a “celestial sphere” using celestial coordinates, with the north celestial pole at the top and Earth’s axis pointing upward

This diagram, from *The Stars: A New Way to See Them* by H. A. Rey, shows how the ecliptic is oriented relative to the celestial equator.

Because Earth is tilted by 23½° relative to its orbit, the ecliptic is tilted by that amount relative to the celestial equator.



In this lab, we'll be imagining a "celestial sphere" in these ecliptic coordinates, with the constellations of the zodiac going around the middle.

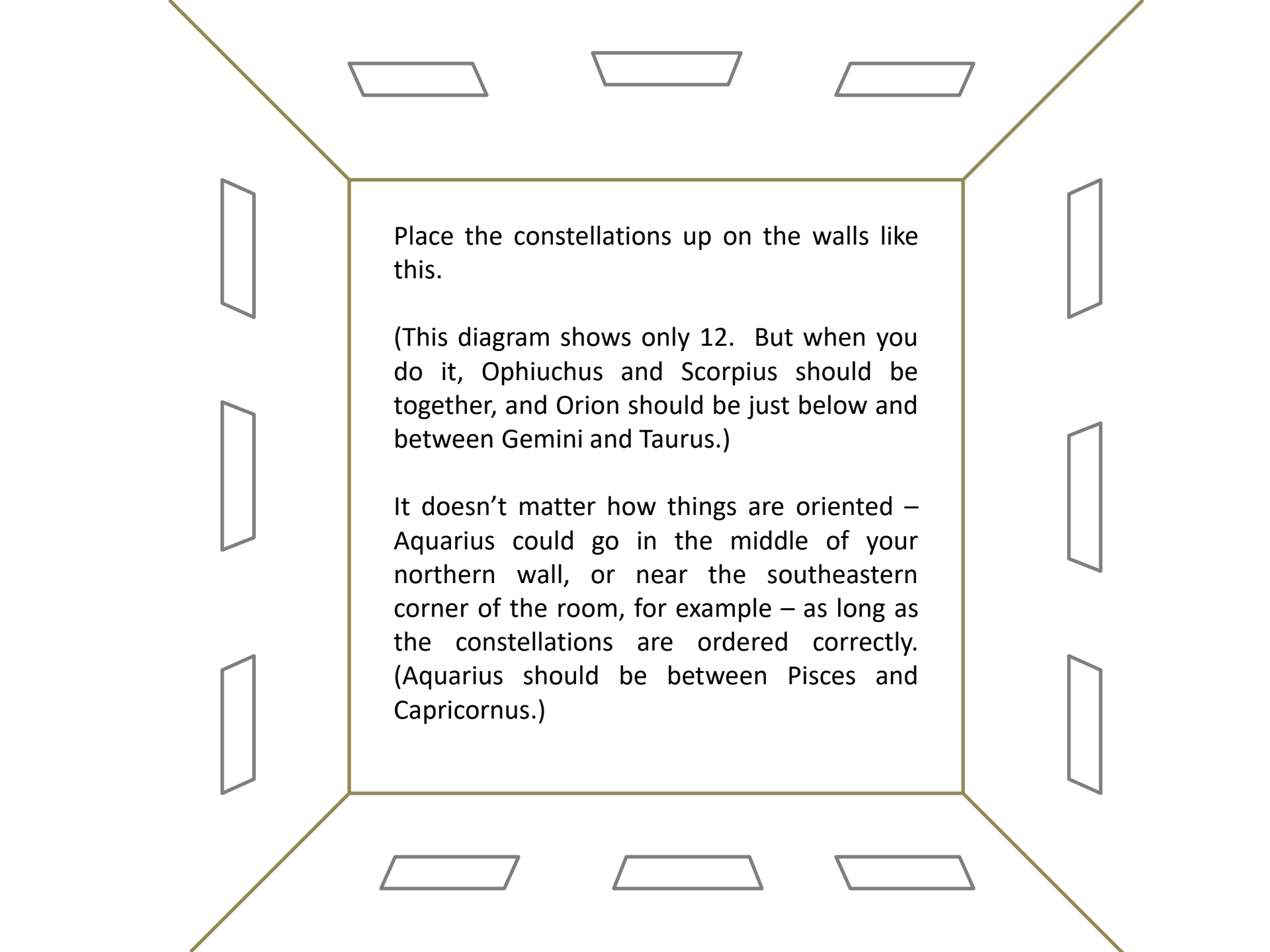
Back in Lab 3, we did a couple exercises in which we imagined various directions in the room were parts of the celestial sphere – "that constellation over there looks like a bathroom door."

Here we're going to do something similar, but this time we'll be using real constellations – you'll be placing the 13 constellations that lie on the ecliptic around the room. (And Orion, as a bonus 14th constellation not on the ecliptic.)

It'll kinda be like decorating a room with glow-in-the-dark stars.

Let’s consider the setup for this lab.

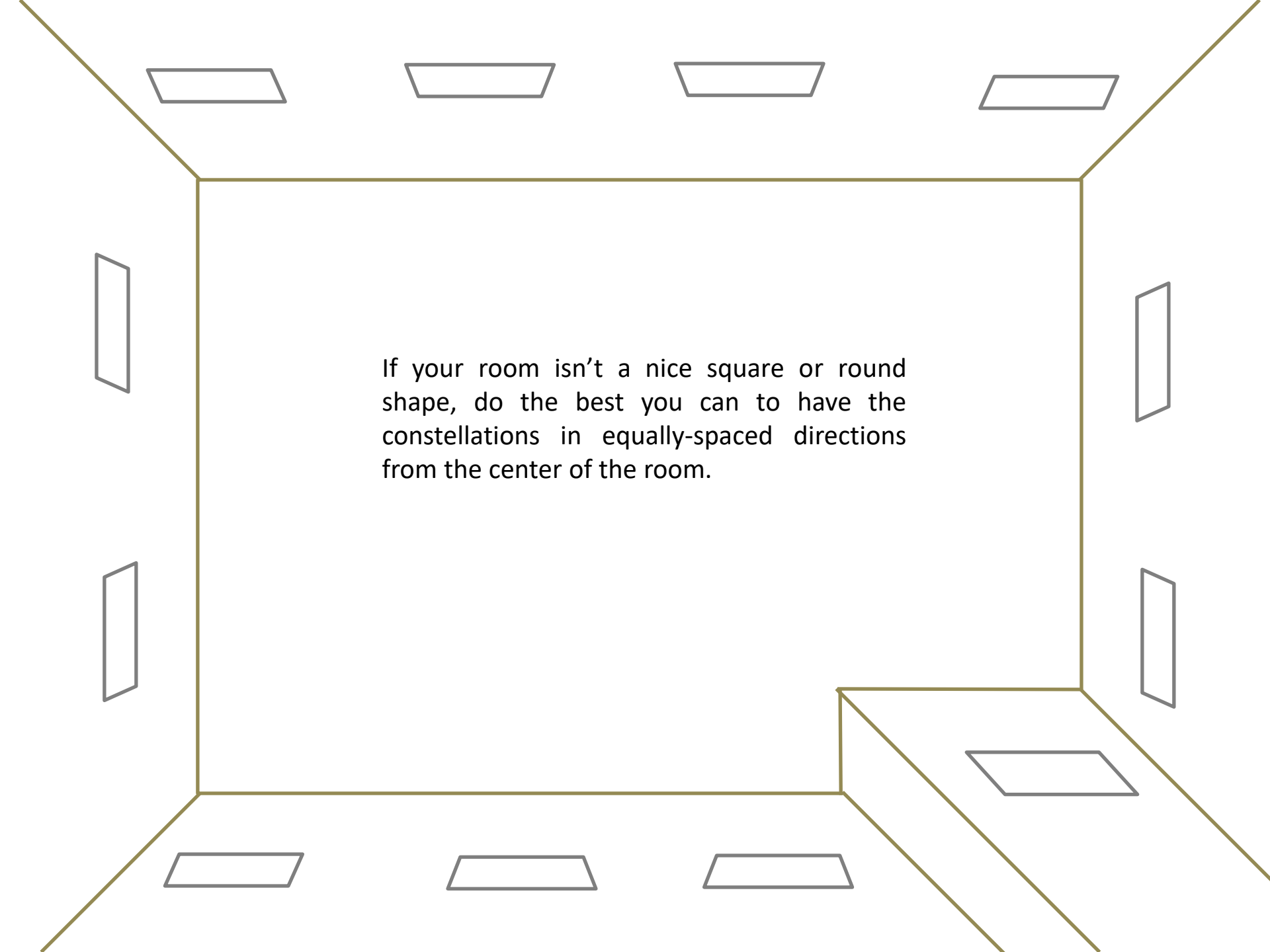
Imagine this diagram is a bird’s-eye view of the room you’re using. We’re looking down on the floor.



Place the constellations up on the walls like this.

(This diagram shows only 12. But when you do it, Ophiuchus and Scorpius should be together, and Orion should be just below and between Gemini and Taurus.)

It doesn't matter how things are oriented – Aquarius could go in the middle of your northern wall, or near the southeastern corner of the room, for example – as long as the constellations are ordered correctly. (Aquarius should be between Pisces and Capricornus.)


If your room isn’t a nice square or round shape, do the best you can to have the constellations in equally-spaced directions from the center of the room.

If you can't put the constellations up on the walls, you can lay them down on the floor. Or otherwise designate different features to represent the constellations: "that window is Aquarius, the bookshelf is Capricornus…"

If your room is too cramped, you might be better off trying this outside where there's more room – with the constellations laid out on the ground roughly in a circle. (Or you can designate objects again: the stop sign is Leo, that red car is Virgo, the mailbox is Libra…)

There are other constellations in the celestial sphere, though we won't be thinking about them in this lab.

But if you want, you can picture the whole room decorated with stars from all the other constellations.

For example, Ursa Minor (the Little Dipper, where the North Celestial Pole is) would be on the ceiling, but closer to Gemini and Taurus instead of in the exact center of the ceiling.

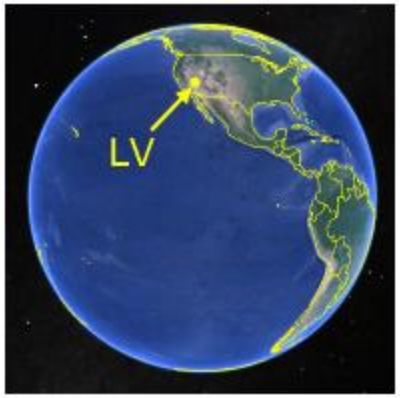
The Summer Triangle – the stars Vega, Deneb, and Altair – would be somewhere high above Capricornus and Sagittarius.

Canis Major would be on the floor near Gemini.

Place an object to represent the Sun in the middle of the room.

You will be representing Earth.

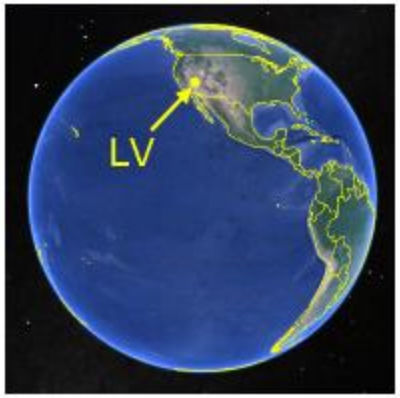
Earth is much closer to the Sun than to the other stars, so ideally you can stand closer to the Sun-object than to the walls. If the constellation pages are only a couple feet away from the Sun, things will get tricky – you might be better off using a small object to represent Earth instead, or relocating to a larger space.



As mentioned before, you are representing Earth.

Las Vegas will be in the middle of your chest. The North Pole is the top of your head, and the South Pole is at the bottom of your feet.

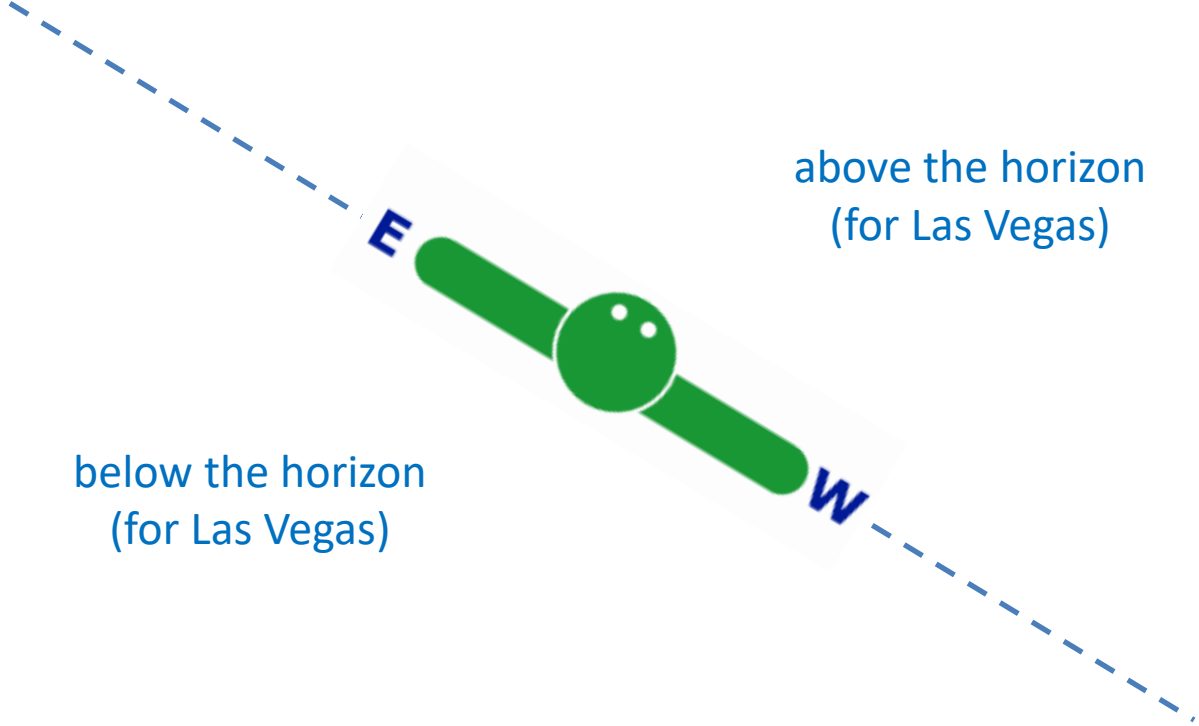
You can imagine some other locations as well: maybe Maine is on your left shoulder, Brazil is your left hip, and India is on your back.



Stretch out your arms to simulate the horizon for someone in Las Vegas. Anything in front of your outstretched arms will be in the sky for someone in Las Vegas, while anything behind them will be below the horizon.

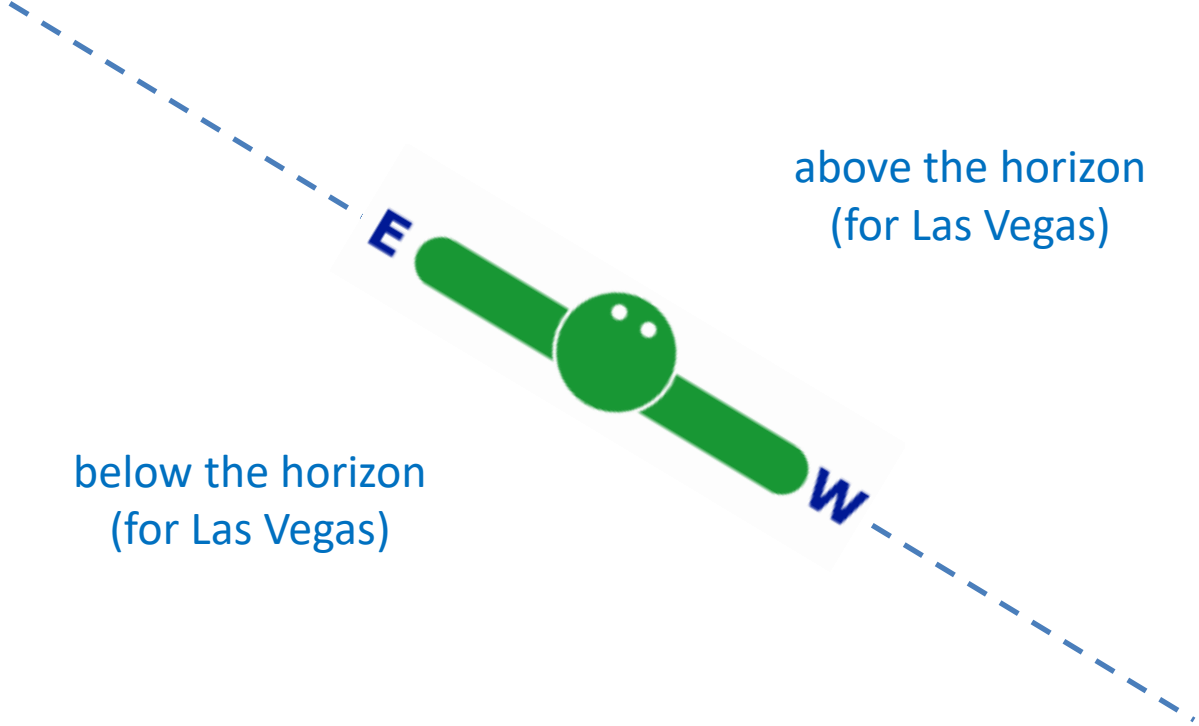
Your right hand is Las Vegas's western horizon, and your left hand is the eastern horizon. (You might want to write a "W" and "E" on those hands or hold labeled scraps of paper, so you don't forget.)

The northern horizon is toward your head and the southern horizon is toward your feet, but they won't be coming up in this lab.



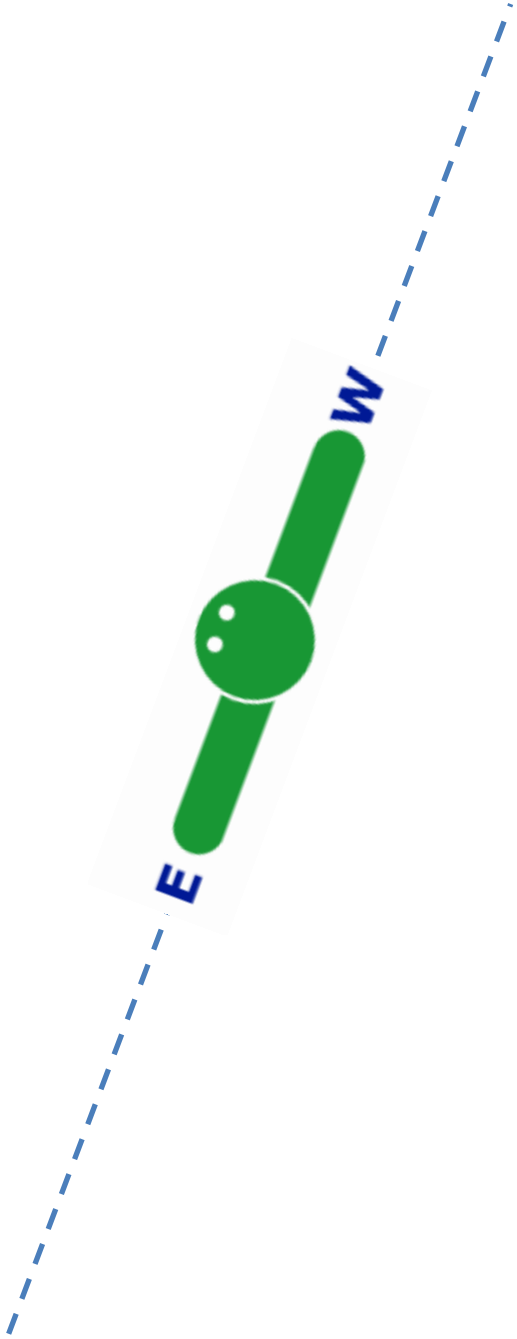
Here's what it looks like as seen from above.

Imagine the line made by your outstretched arms. Everything in front of that line is above the horizon (in other words, up in the sky) for Las Vegas. Everything behind that line is below Las Vegas's horizon (not up in the sky).



This line ideally divides the celestial sphere into two equal halves – so if you're standing near a wall you won't get as accurate a picture.

It is recommended you stand much closer to the Sun than to the walls.



As Earth rotates, different constellations will rise and set. (As you spin in place, different constellations will end up in front of or behind the line made by your arms.)

The part of the room that your chest is currently facing is what will be highest up in Las Vegas's sky.

If something is just barely in front of your right hand, it will be very low in the western sky (but still above the horizon) for Las Vegas.

For other parts of the world, you'll have to imagine what the "horizon line" would be like. For example, for a little tiny person on your right side, their "east" would be in front of you and their "west" would be behind you.

As you turn in place, your position also tells you the time of day in Las Vegas.

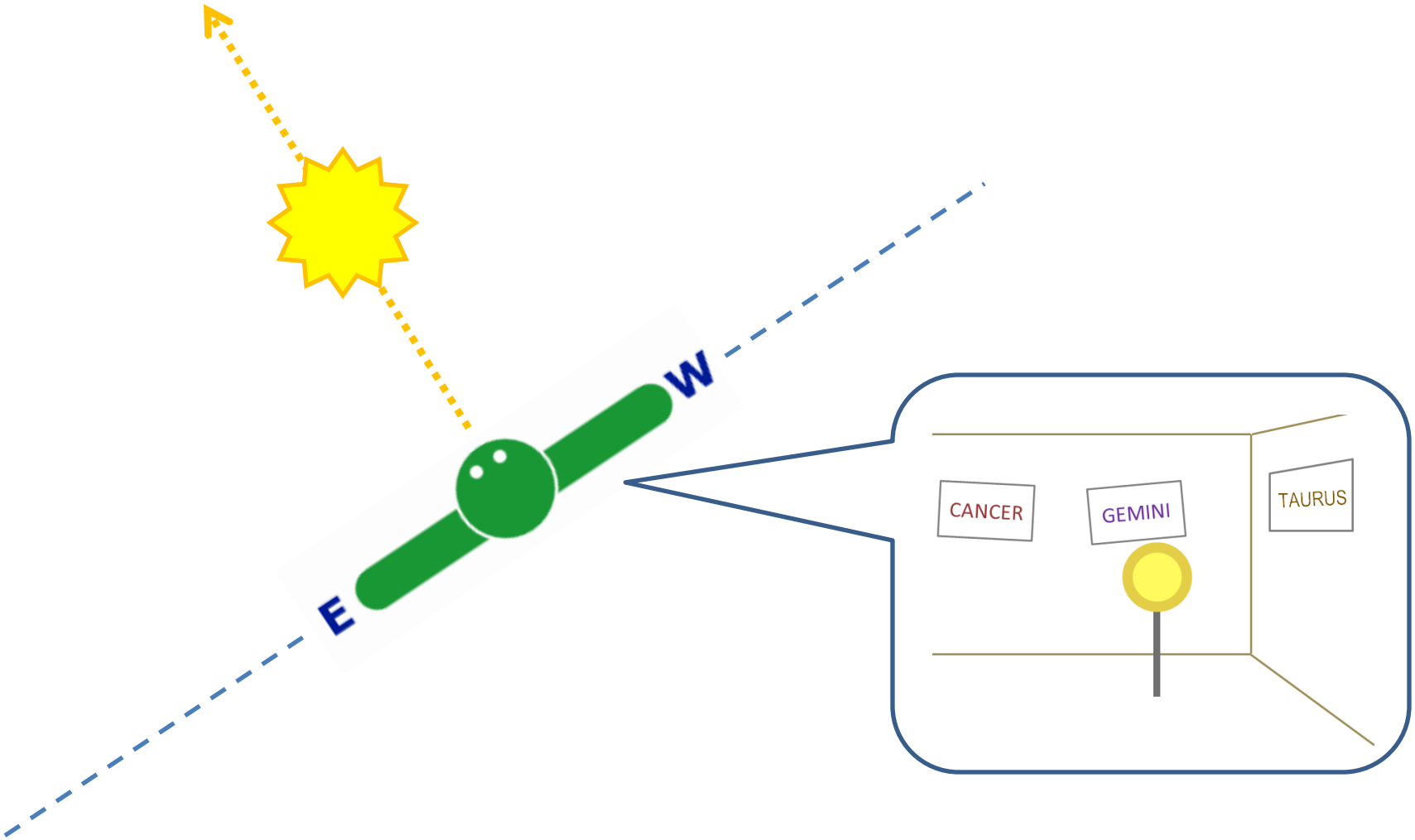
For example, if the Sun is above the horizon, it's daytime. If the Sun is below the horizon, it's nighttime.

If Las Vegas is facing the Sun, it's the middle of the day.

We'll ignore things like seasonal effects, Daylight Saving, and whether Las Vegas is perfectly situated in the right time zone.

We'll keep it simple: the middle of the day (when the sun is highest up) is noon, and the middle of the night is midnight.

Sunset and sunrise are halfway between those times, since we're going to assume every day has 12 hours of sunshine and 12 hours of night.



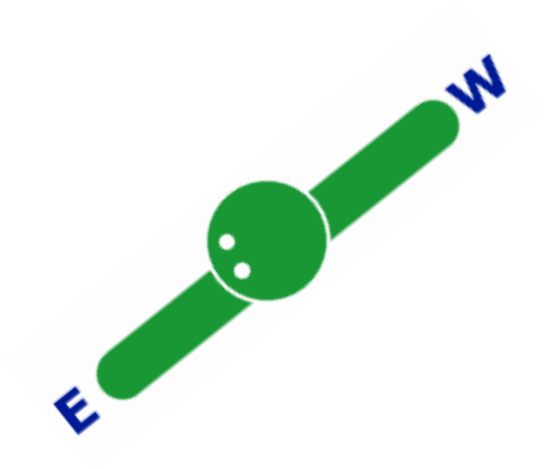
This lab will occasionally ask you about the constellation you see behind the Sun. In this case, you should look in the direction of your Sun object, and see what's on the wall (or floor) behind it.

In the example shown here, the Sun would be in front of the stars of Gemini. (It's also noon in Las Vegas.)

Note that you can look around if you want to see what's in various directions.

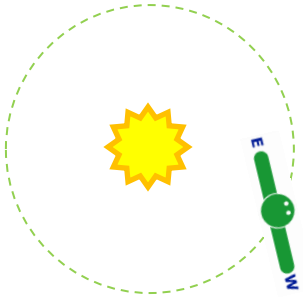
For example, you can turn your head to the left (while keeping the rest of your body still) to check out what's going on in the eastern sky for Las Vegas.

Note that the stars you're looking at aren't necessarily *high up* for Las Vegas at the moment – unless you're looking in the same direction your body is facing.



This will come up sometimes when you are figuring out which constellation is behind the Sun, if the Sun isn't directly in front of you.

In Part 4 of this lab you'll be walking through Earth's orbit around the Sun to see what things are like at different times of year.



Don't forget that things will be much easier if you're much closer to the Sun than to the constellations on the walls – so that the line made by your arms divides the room into two equal halves.