<u>Question 1</u>

We have been provided a lot of facts, but we only need a few of them to find our location. We need to know:

1. The date – September 21st
2. We are in the northern hemisphere
3. The time the Sun was highest in the southern sky that day
4. The altitude of the Sun when it is highest in the sky

Part a) We are asked to find our latitude, which can be done in one of two ways:

- Find the angular altitude of the celestial pole in the local sky (in which case that altitude IS the latitude)
- OR where the celestial equator crosses the meridian in the local sky. If that altitude angle is X, then the latitude is 90-X degrees.

Since it is September 21st, which is the autumnal equinox, we know that the Sun is on the celestial equator. This means that the altitude of the Sun at noon is the same as the angle up to the celestial equator. Our latitude is then 90° minus that angle.

The altitude of the Sun at noon is 45° 30 min, which can be written 45.5°, so the latitude is:

$$90° - 45.5° = 44.5°$$

Our latitude is $\mathbf{44.5°}$ N

Part b) Now we just need to know our longitude! We know that the Sun was highest in the sky at 17:06 UT (Universal Time). This means that we are 5 hours and 6 minutes behind the prime meridian (0° longitude near Greenwich, UK). But how do we relate time to longitude? We know that the Sun moves through 360° in 24 hours:

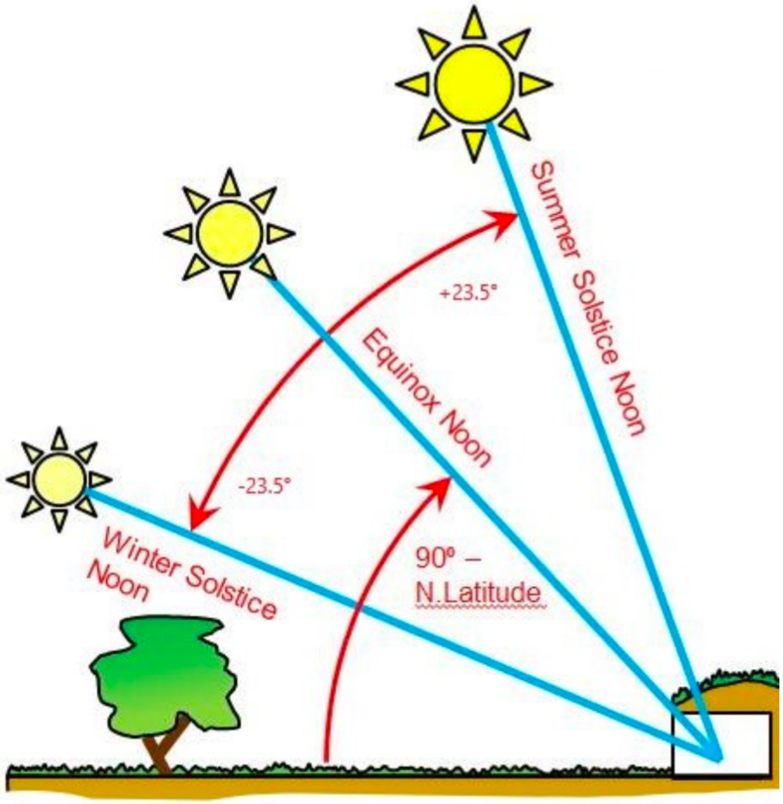
$$\frac{360°}{(24\text{ h})(60\text{ min/h})} = \frac{360°}{1440\text{ min}} = 0.25\ °/\text{min}$$

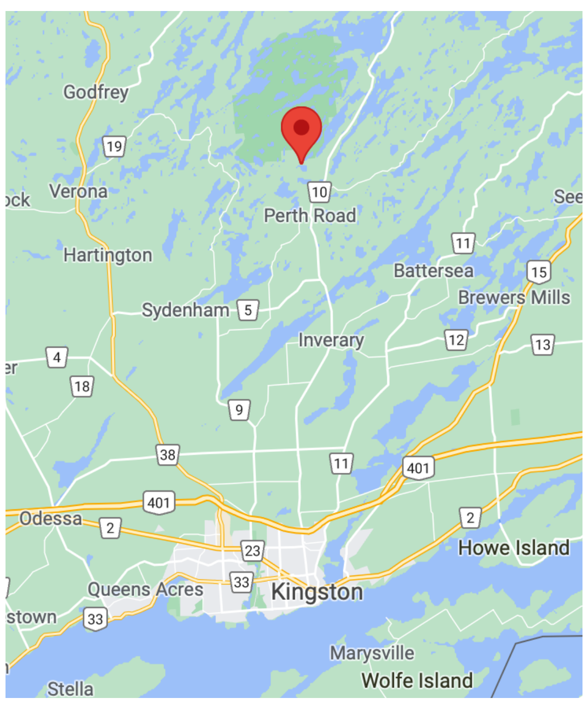
5 hours and 6 minutes is 306 minutes. This gives us:

$$(0.25\ °/\text{min}) \times 306\text{ min} = 76.5°$$

Our longitude is $\mathbf{76.5°}$ W

Part c) Now let's plug our coordinates $(44.5° \text{ N}, 76.5° \text{ W})$ into Google Maps. It looks like we are at the shore of a lovely lake just North of Kingston, Ontario! We need to walk South to get there and find some help.

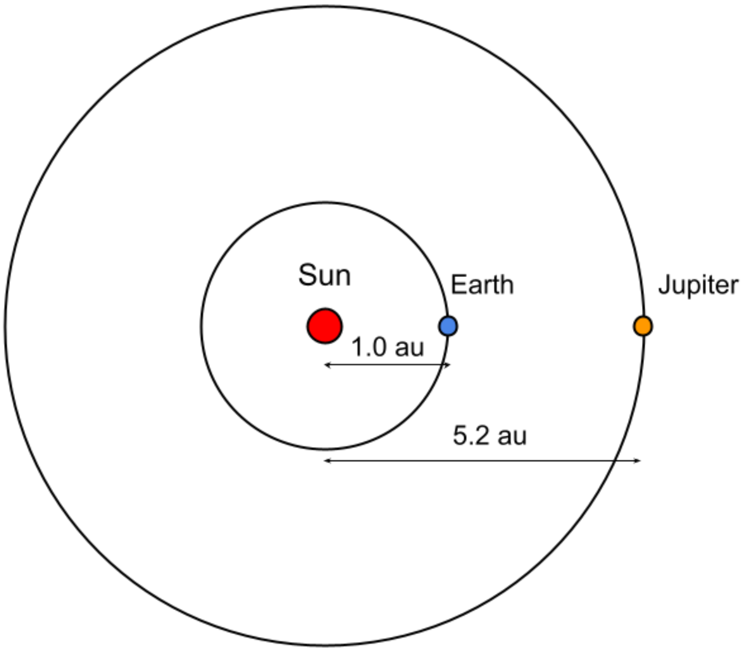




ASTRO 310 - HW 1.2 Solution

Solution

Jupiter's distance from the Sun (semi-major axis) is 5.2 au. Earth is 1.0 au away from the Sun. At the **opposition**, Jupiter and Sun are on opposite sites of the celestial sphere, as shown in the diagram below:

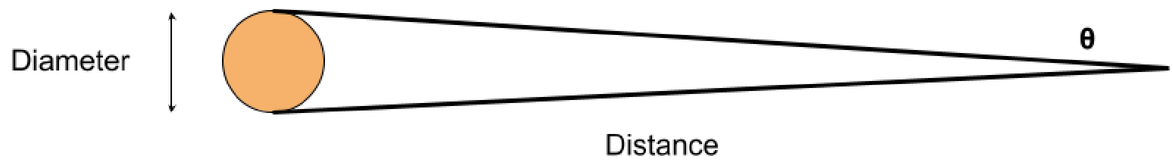


Jupiter's distance from the Earth is therefore:

$$\text{Distance} = 5.2 \text{ - } 1.0 = 4.2 \ \ \text{au}$$

Jupiter's radius is 7 ×10^4 km, so it's diameter is 1.4 ×10^5 km. Convert that to kilometer (1 au = 1.5 ×10^8 km):

$$\text{Diameter} = \frac{1.4 \times 10^5 \text{ km}}{1.5 \times 10^8 \text{ km/au}} = 9.3 \times 10^{-4} \text{ au}$$



The apparent angular diameter of Jupiter when viewed on Earth is given by:

$$
\begin{aligned}
\text{Angular size} = \theta &= \frac{\text{Diameter}}{\text{Distance}} \times \frac{360^\circ}{2\pi} \\
&= \frac{9.3 \times 10^{-4}\ \text{au}}{4.2\ \text{au}} \times \frac{360^\circ}{2\pi} \\
&= 0.013^\circ
\end{aligned}
$$

Convert that to arcsecond (1 degree = 3600 arcsecond)

$$\text{Angular size} = 0.013 \times 3600 = 47''$$

Therefore, Jupiter's angular diameter at that night is 0.013 degrees or 47''.