

Gnomon Observation Report

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Tuesday, Sept. 5, 2023

This report contains a correction relative to what we presented in class on Monday, September 4. The height of our gnomon was 27" not 21" as we had presented.

Overview

A gnomon was set up on the basketball court on Sept. 2. Due to clouds, we had to take data on two days. Since we are near the fall equinox, shadows are getting rapidly longer as each day passes. Our late morning data was taken on Sept. 2nd. Our early morning and afternoon data was taken on Sept. 3rd. We expect that the rapid lengthening of shadows from day to day may cause our direction for north to be skewed as much as a few degrees to the west. In the overview photo below, blue tape is for Sept. 2nd data, and orange tape is for Sept. 3rd data.



Determination of East-West and North-South Lines

Rather than drawing a full circle radiating from the gnomon, we established an east-west line by measuring the same distance from the gnomon to two shadows that were symmetrically placed 21 1/2" from the gnomon.

Once we had established the east-west line, we used a carpenter's square to create a north-south line originating from the gnomon. We inked this line on to the basketball court with a Sharpie.

Determination of Gnomon Height

We measured the height of our gnomon. Our measuring stick has markings from each end. We misread the height as 21". When giving our presentation, we had trouble reconciling our result with others' results. Afterwards, we discovered that we should have read 27" as the height.



Determination of Minimum Shadow Length

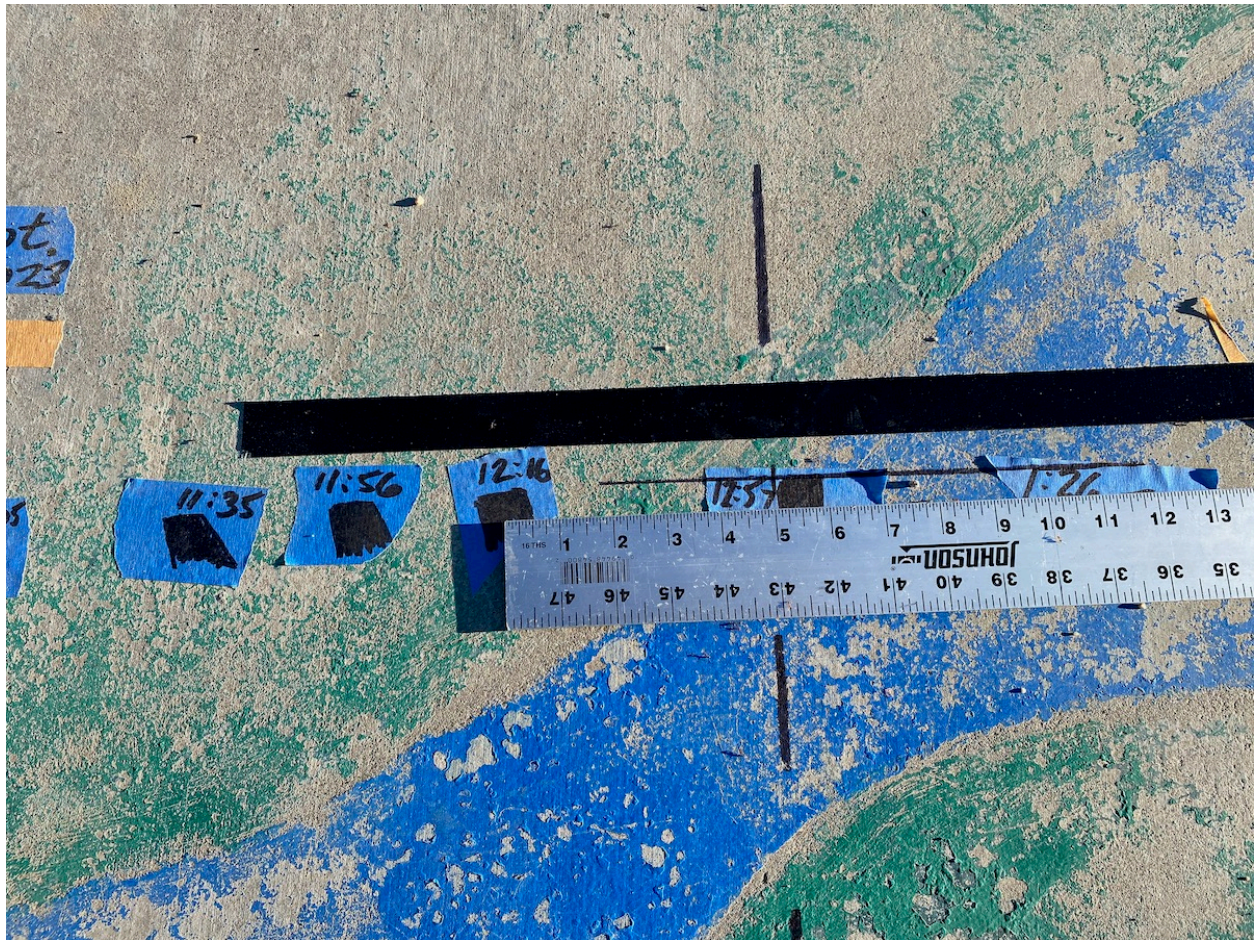
This measurement is 15 1/2".



Determination of Maximum Altitude of Sun

$$\theta = \arctan \frac{27}{15.5} = 60.1^\circ$$

Determination of Local Noon



In the above photo, the shadow at 12:16pm has been placed at 0". At 5.5" is the shadow at 12:57pm. 12:57pm is 41 minutes later than 12:16pm. The North-South line is at 5". So local noon was $5.0/5.5 = 10/11$ of the way from 12:16 to 12:57 or 37 minutes after 12:16 or 12:53pm.

Comparison with Published Results

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September 2023 — Sun in Bishop

< August **September** October >

Month: Year:

2023 Sep	Sunrise/Sunset		Daylength		Astronomical Twilight		Nautical Twilight		Civil Twilight		Solar Noon	
	Sunrise	Sunset	Length	Diff.	Start	End	Start	End	Start	End	Time	Mil. mi
1	6:23 am → (79°)	7:22 pm ← (281°)	12:58:31	-2:17	4:52 am	8:53 pm	5:25 am	8:20 pm	5:57 am	7:49 pm	12:53 pm (60.8°)	93.811
2	6:24 am → (79°)	7:21 pm ← (280°)	12:56:13	-2:17	4:53 am	8:51 pm	5:26 am	8:19 pm	5:58 am	7:47 pm	12:53 pm (60.4°)	93.789
3	6:25 am → (80°)	7:19 pm ← (280°)	12:53:55	-2:18	4:54 am	8:50 pm	5:27 am	8:17 pm	5:59 am	7:46 pm	12:52 pm (60.1°)	93.767
4	6:26 am → (80°)	7:18 pm ← (279°)	12:51:36	-2:18	4:55 am	8:48 pm	5:28 am	8:15 pm	5:59 am	7:44 pm	12:52 pm (59.7°)	93.745

The published local noon in Bishop was at 12:52 or 12:53 on September 3rd and September 2nd respectively.

The published altitude of the sun was 60.4° and 60.1° on those days.

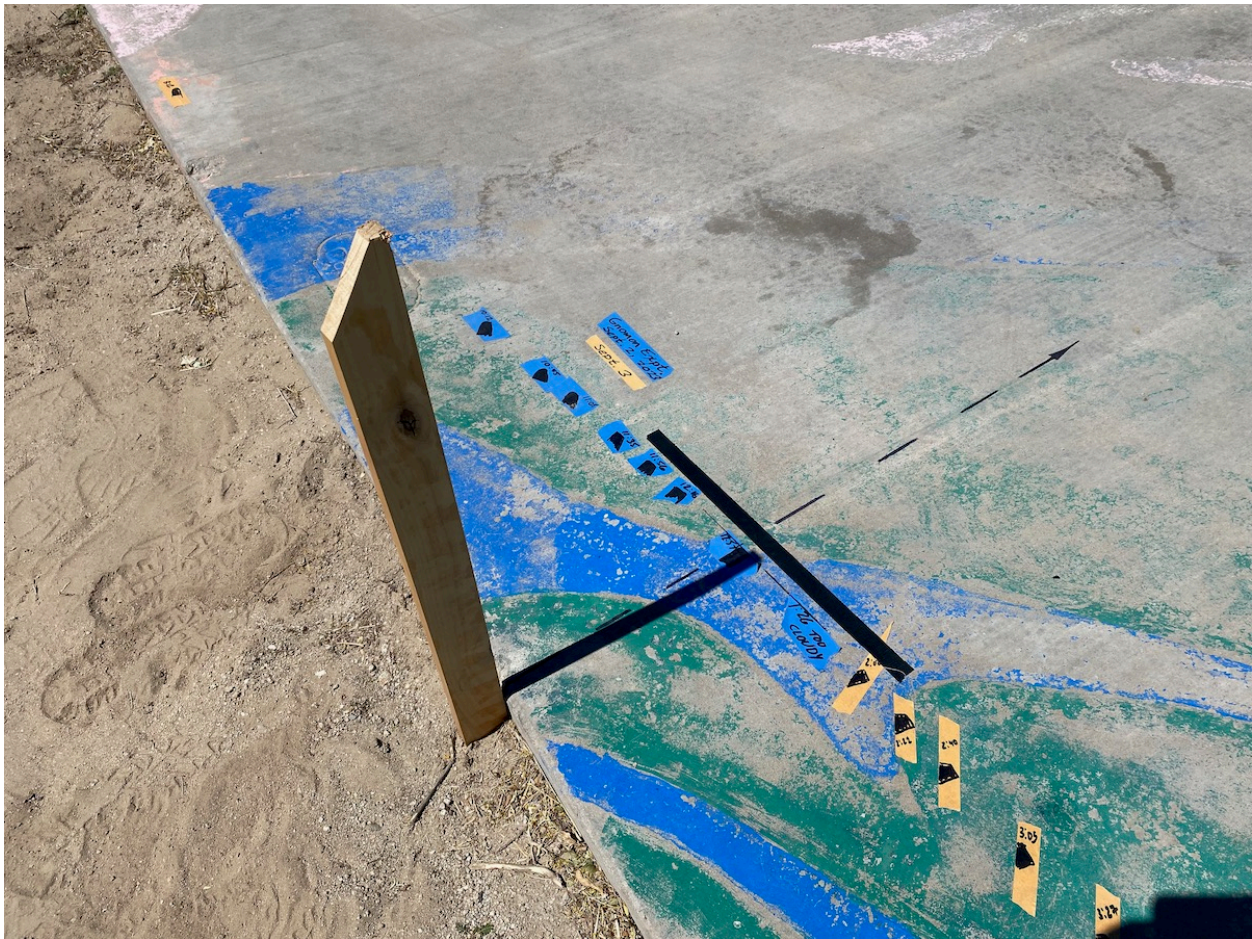
We disagree by at most one minute.

Our altitude was 60.1°. That was for Sept. 2nd, but agrees better with the published result for Sept. 3rd. This is nonetheless good agreement since there are many sources of measurement error that would be expected to affect the third significant figure in our result.

Addendum — What a Difference a Day Makes

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As we were tearing down our apparatus on Sept. 4, we noticed how much longer the shadow was than it was at the same angle on Sept. 2nd. The gnomon had not been bumped (a carpenter's level showed that it was undisturbed). The estimated 1/4" change corresponds to about 1/8" change in shadow length per day.



Determination of Maximum Altitude of Sun on Sept. 4

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We add an estimated 1/4" to the Sept. 2 shadow length and get:

$$\theta = \arctan \frac{27}{15.75} = 59.7^\circ$$

The published value for Bishop for Sept. 4 is also 59.7°. There is a lot of luck in this agreement.