12.A56 Assignment 1

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1 Data collection

The following data in fig. 1 and fig. 2 are collected by measuring the length of a 8.2-cm chalk's shadow in the Killian court on September 25 around noon time.

Time	Length
12:11	7.95
12:15	7.92
12:22	7.75
12:30	7.72
12:34	7.72
12:36	7.62
12:38	7.78
12:42	7.8
12:47	7.9

Figure 1: Collected data.

2 Latitude

According to fig. 3, in which ϕ stands for the latitude, θ stands for the angle between Earth's orbital plane and the equator plane (declination angle), and L_s and L_c stand for the shadow's length at noon and the chalk's length respectively, we have

$$\frac{L_s}{L_c} = \tan(\theta + \phi)$$

Because the measurements were taken on September 25, 3 days after the Equinox, we have [1]

[1] http://www.pveducation.org/pvcdrom/properties-of-sunlight/declination-angle

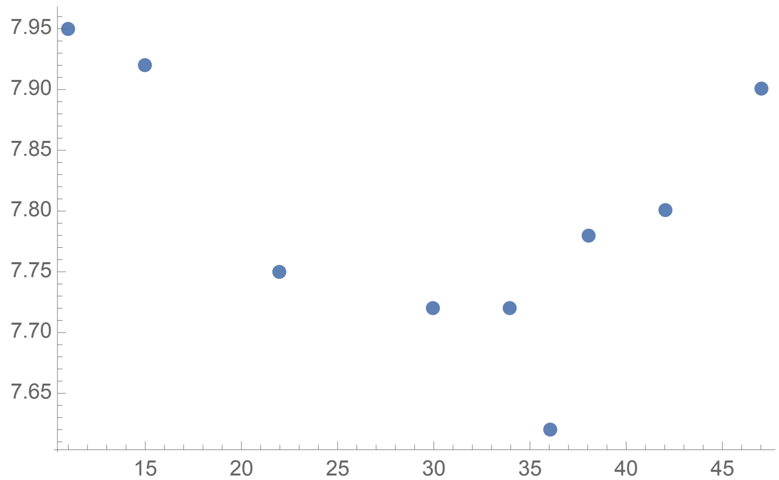

Figure 2: Data plot.

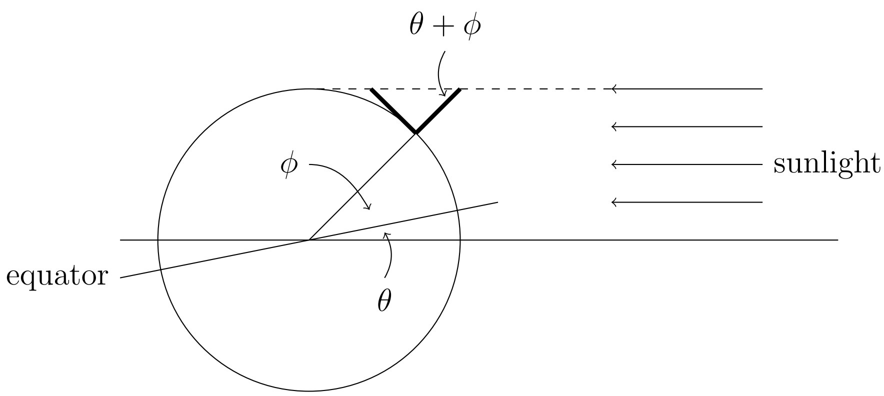

Figure 3: Diagram for latitude calculation.

$$\theta = \arcsin(\sin(23.5°) \cdot \sin(2\pi * \frac{3}{365})) = 1.179°$$

Plug in $L_s = 7.62$, $L_c = 8.2$, and we have

$$\theta + \phi = 43°$$

Anticipating reasonable errors, the latitude ϕ is approximately

$$\phi \approx 42°$$

3 Longitude

From the data it is clear that the shortest shadow length occurs around 12:36.

Since the noon at Greenwich is exactly 12:00 UTC, and the noon in Cambridge is 12:36 UTC-4, the time difference between Greenwich and Cambridge is 4 hours and 36 minutes.

But according to the equation of time, the actual sun clock was 8 minutes ahead on September 25.[2] Therefore the corrected difference is 4 hours and 44 minutes. And since an hour is $15°$, the calculated longitude is $71°W$.

[2]http://www.sundials.co.uk/equation.htm