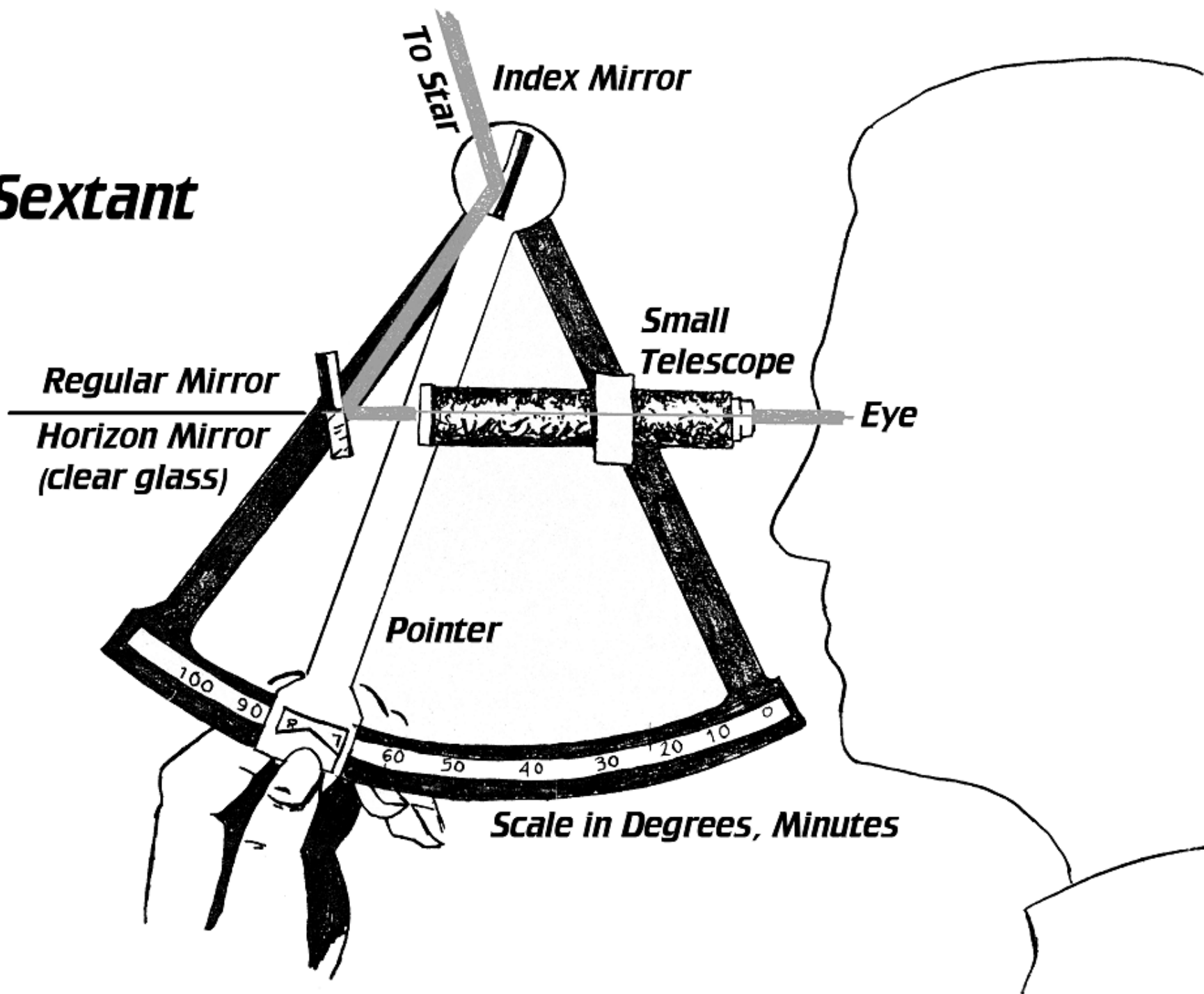
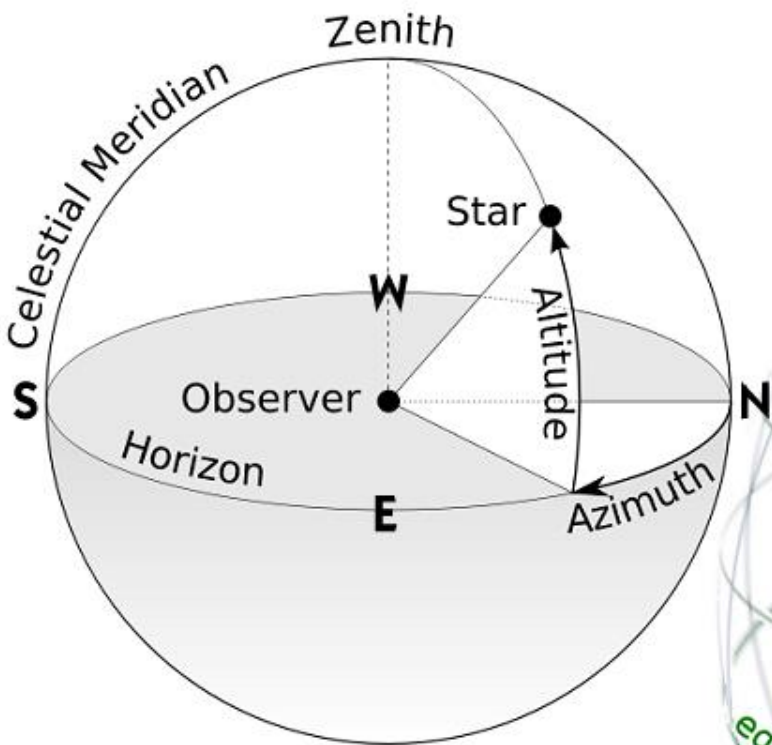


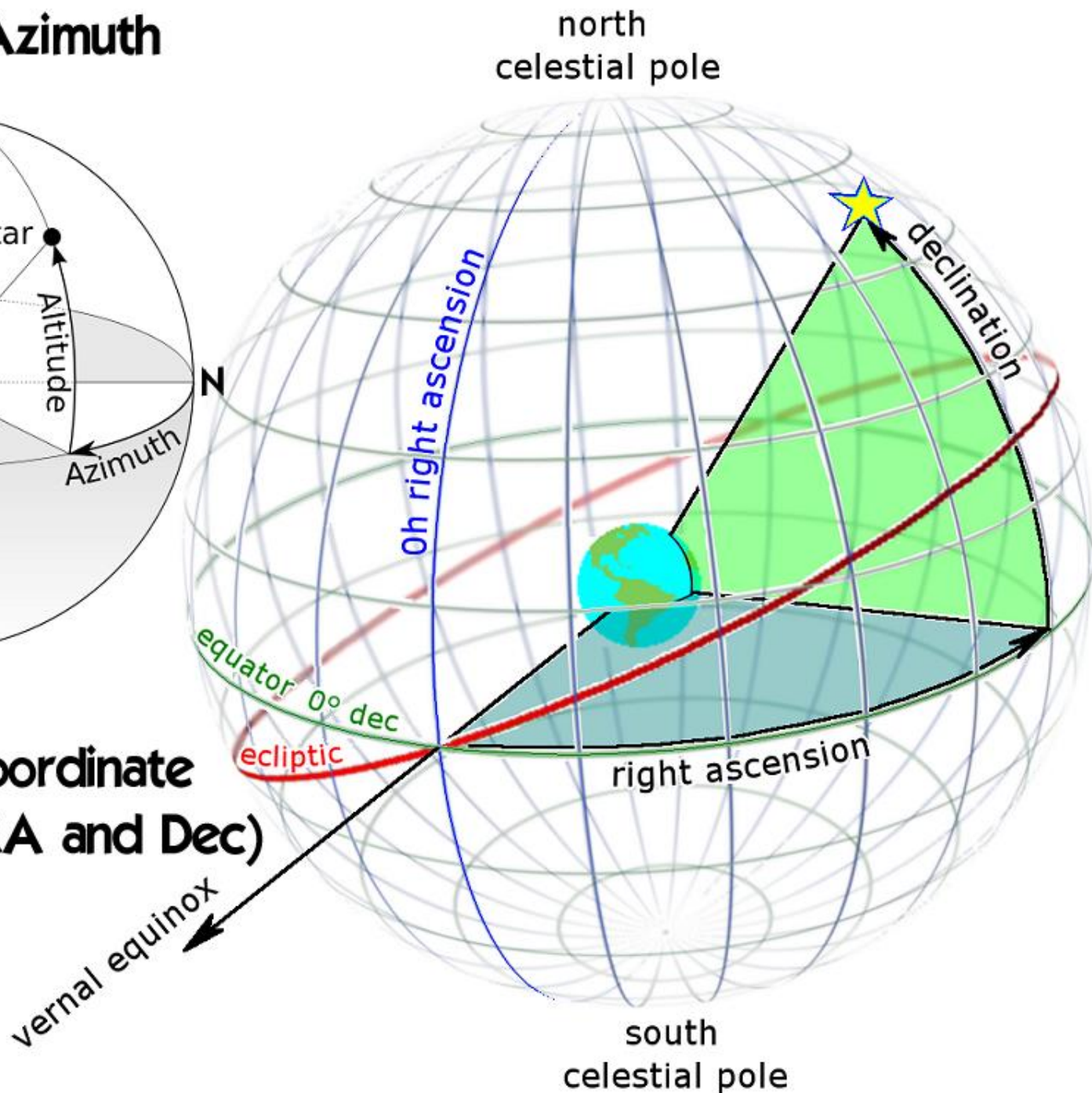
Sextant



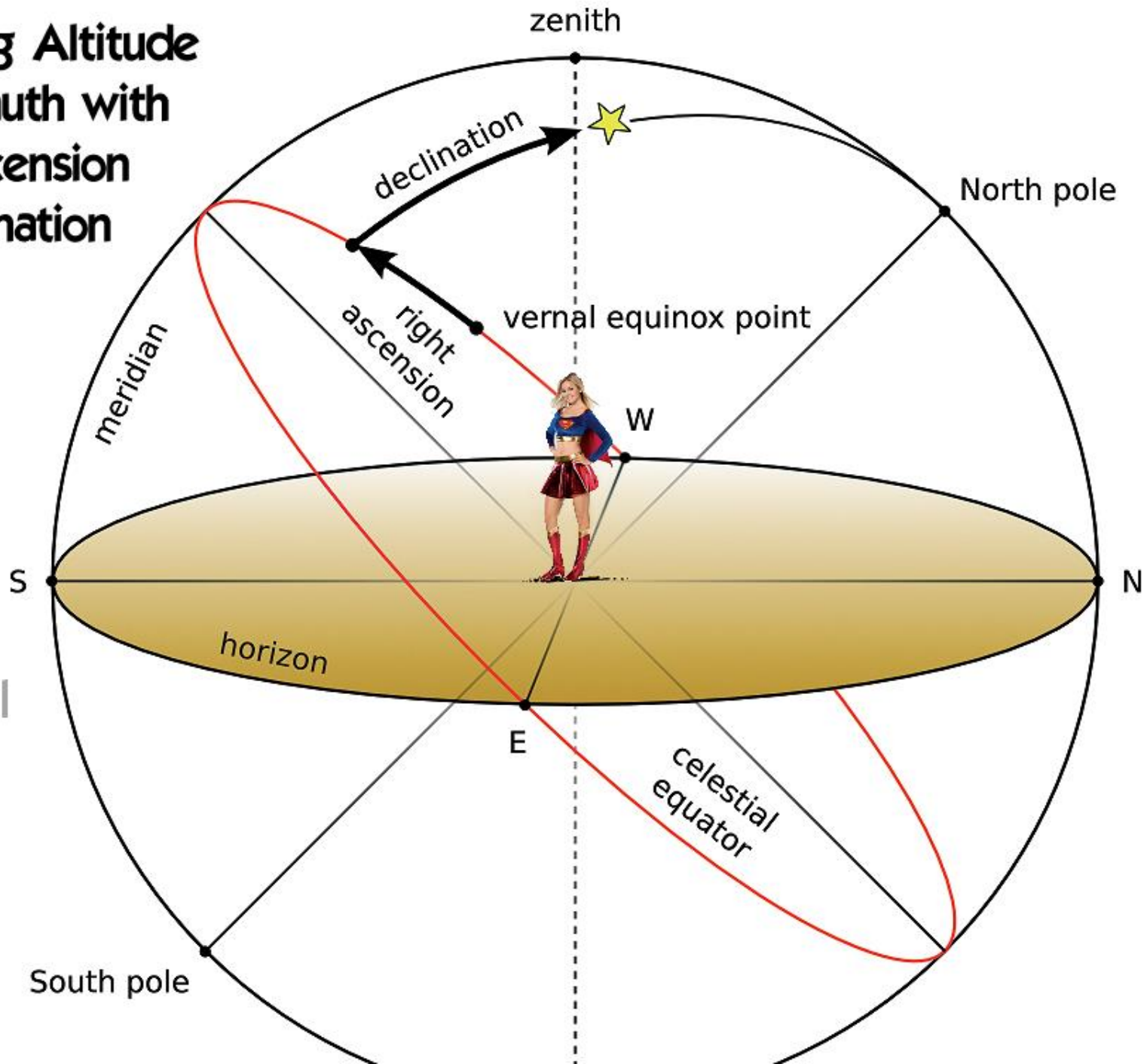
Altitude and Azimuth



Equatorial Coordinate System (RA and Dec)



Combining Altitude and Azimuth with Right Ascension and Declination



Equatorial
with
Local

THE MORAVIAN PLOT THICKENS
(Practice Problem)

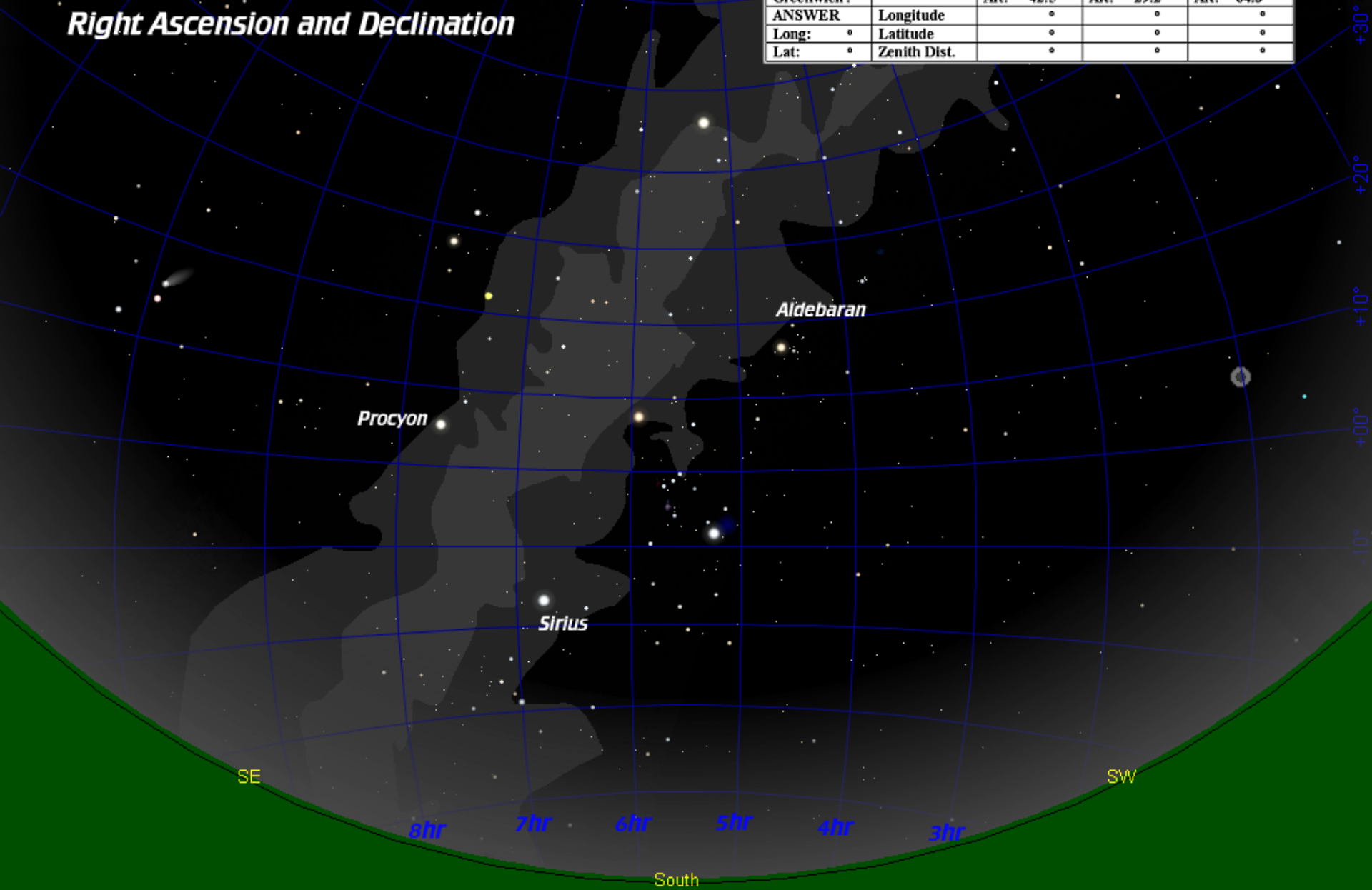
An astronomy teacher in a small liberal arts college on the East Coast assigns his astronomy class a navigational exercise after a fairly lengthy and animated discussion about coordinate systems which is given during a local planetarium presentation. “Find your position on the Earth. Then take me to your leader,” he says. The following data for the stars, including the sidereal time at Greenwich, England, are noted below.

Problem 0	Sidereal Time at Greenwich	Star A Procyon	Star B Sirius	Star C Aldebaran
The given stars	10:20	RA: 07:39	RA: 06:46	RA: 04:36
are E or W of		Dec: +05.2°	Dec: -16.7°	Dec: +16.5°
Greenwich?		Alt: 42.5°	Alt: 29.2°	Alt: 64.3°
ANSWER	Longitude	°	°	°
Long: °	Latitude	°	°	°
Lat: °	Zenith Dist.	°	°	°

Show all work below. Do not forget to submit your labeled, scaled, and titled graph.

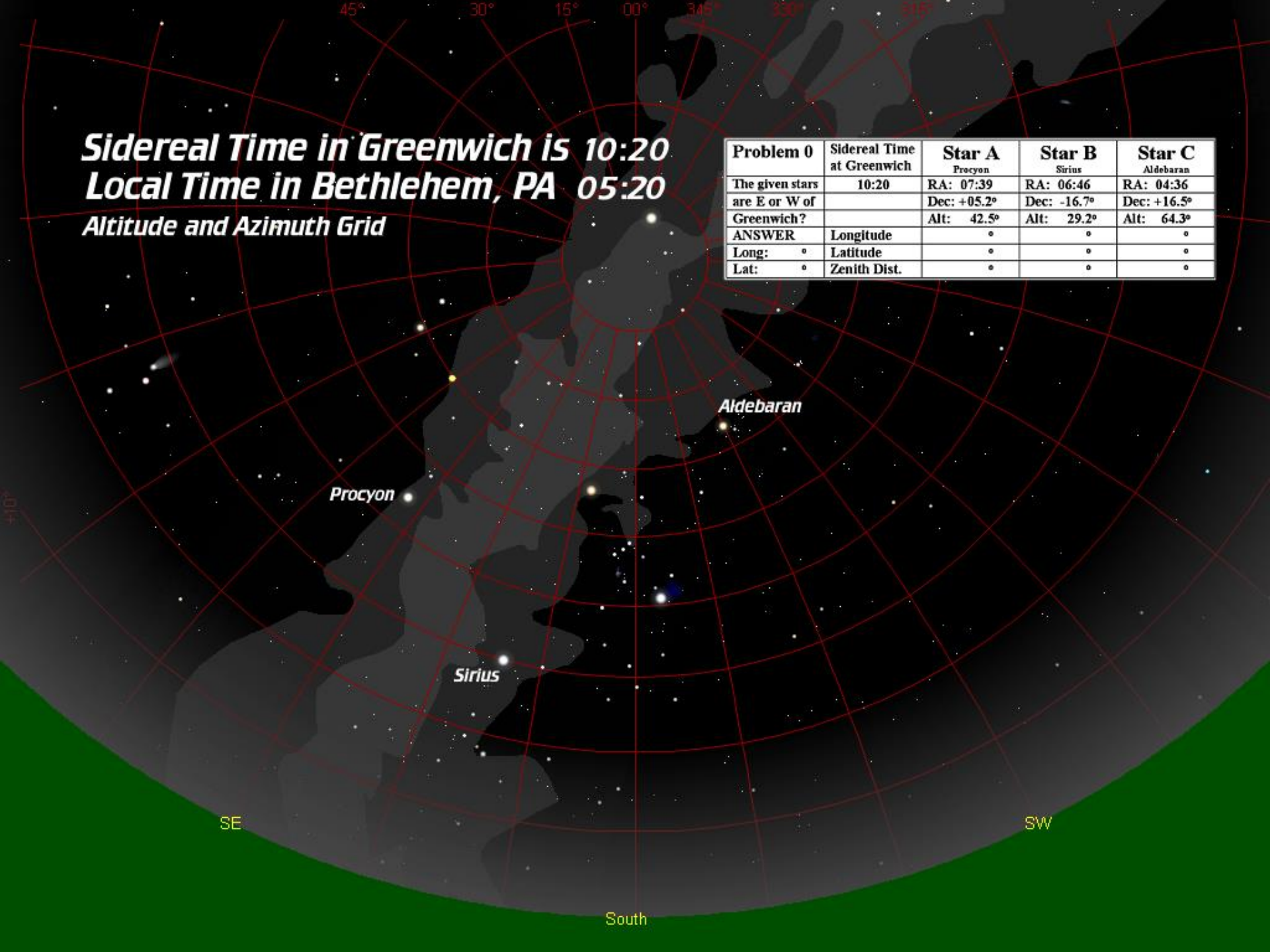
Sidereal Time in Greenwich is 10:20
Local Time in Bethlehem, PA 05:20
Right Ascension and Declination

Problem 0	Sidereal Time at Greenwich	Star A Procyon	Star B Sirius	Star C Aldebaran
The given stars	10:20	RA: 07:39	RA: 06:46	RA: 04:36
are E or W of Greenwich?		Dec: +05.2°	Dec: -16.7°	Dec: +16.5°
ANSWER		Alt: 42.5°	Alt: 29.2°	Alt: 64.3°
Long: °	Longitude	°	°	°
Lat: °	Latitude	°	°	°
	Zenith Dist.	°	°	°



Sidereal Time in Greenwich is 10:20
Local Time in Bethlehem, PA 05:20
Altitude and Azimuth Grid

Problem 0	Sidereal Time at Greenwich	Star A Procyon	Star B Sirius	Star C Aldebaran
The given stars	10:20	RA: 07:39	RA: 06:46	RA: 04:36
are E or W of Greenwich?		Dec: +05.2°	Dec: -16.7°	Dec: +16.5°
ANSWER	Longitude	Alt: 42.5°	Alt: 29.2°	Alt: 64.3°
Long: °	Latitude			
Lat: °	Zenith Dist.			



Procyon

Sirius

Aldebaran

SE

SW

South

Procedure for Solving the Problem

- 1. Find the sub-stellar positions for the three observed stars:**
 - a. Convert the declinations of the stars directly into latitude.** The declination at an observer's zenith always equals the latitude position of where that star would be found overhead. The declinations of the stars directly yield their sub-stellar latitude positions on the Earth.
 - b. Find the sub-stellar longitude position of the star** by noting the difference in the sidereal time between Greenwich, England and the three observed stars. Convert these times into angles. Each hour angle of right ascension equal 15° . Every four minutes of time is equal to one degree of longitude since the Earth rotates at the rate of one degree every four minutes.
 - c. Plot the sub-stellar positions of the stars on an appropriately labeled grid system of latitude and longitude.**
- 2. Convert the altitudes of the stars measured by the sextant into zenith distances** by subtracting them from 90° .
- 3. Utilize your graph paper to its fullest potential** by establishing a scale which places the sub-stellar positions of the stars at their greatest distances from each other.
- 4. With your compass, sweep arcs equal to the zenith distances of the plotted sub-stellar positions** on the grid system. Each arc has its origin at the sub-stellar positions of the stars that were used (graphed) in the exercise.
- 5. The intersection positions of the three arcs will be the unique location of the observer** on the Earth who made the measurements with the sextant.
- 6. Identify this position** as a longitude and latitude location.

THE MORAVIAN PLOT THICKENS
(Practice Problem)

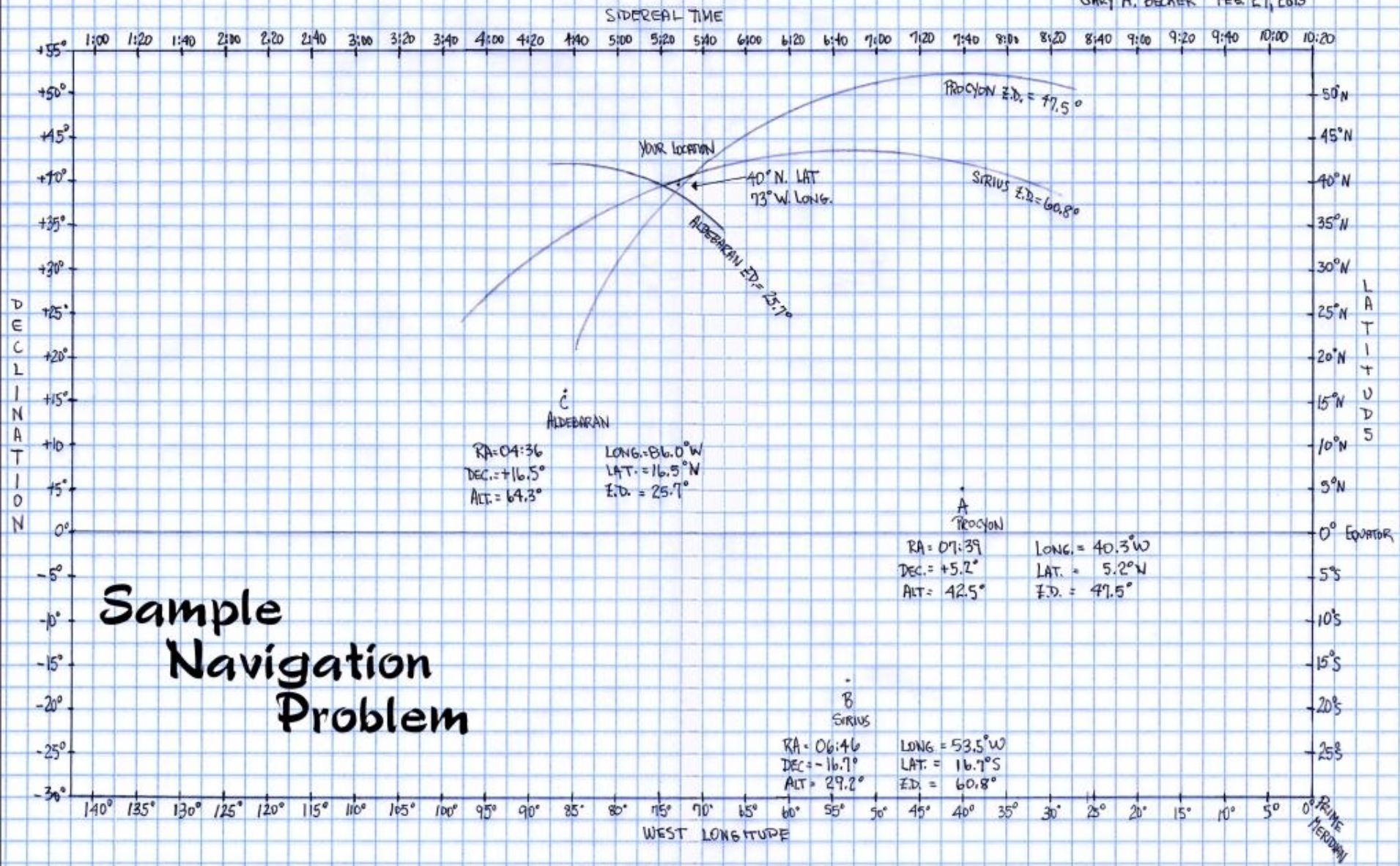
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The given stars	10:20	RA: 07:39	RA: 06:46	RA: 04:36
are E or W of		Dec: +05.2°	Dec: -16.7°	Dec: +16.5°
Greenwich?		Alt: 42.5°	Alt: 29.2°	Alt: 64.3°
ANSWER	Longitude	40.3° W	53.5° W	86.0° W
Long: 73° W	Latitude	5.2° N	16.7° S	16.5° N
Lat: 40° N	Zenith Dist.	47.5°	60.8°	25.7°

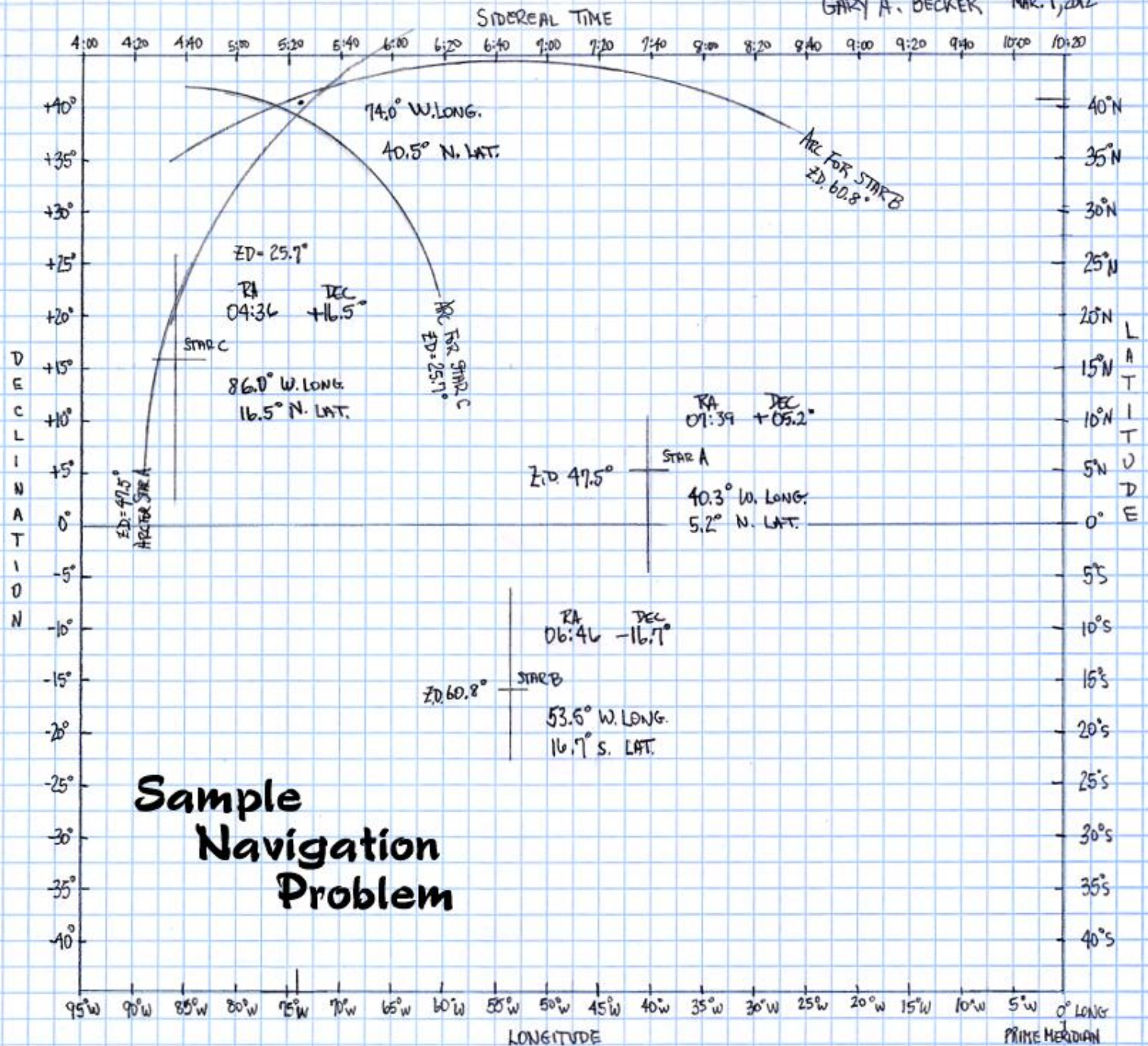
Show all work below. Do not forget to submit your labeled, scaled, and titled graph.

Star A: Procyon	Star B: Sirius	Star C: Aldebaran
<u>Zenith Distance: 90° – Alt.</u> 90.0° – 42.5° = 47.5° -----	<u>Zenith Distance: 90° – Alt.</u> 90.0° – 29.2° = 60.8° -----	<u>Zenith Distance: 90° – Alt.</u> 90.0° – 64.3° = 25.7° -----
<u>Latitude of Sub-stellar Point = Declination at Zenith:</u> +05.2° Dec. = 05.2° N. Lat. -----	<u>Latitude of Sub-stellar Point = Declination at Zenith:</u> -16.7° Dec. = 16.7° S. Lat. -----	<u>Latitude of Sub-stellar Point = Declination at Zenith:</u> +16.5° Dec. = 16.5° N. Lat. -----
<u>Long. of Sub-stellar Point:</u> Greenwich 10 hr 20 min - RA Proc. 07 hr 39 min 02 hr 41 min 2 hr x $\frac{15^\circ}{\text{hr}}$ + 41 min x $\frac{1^\circ}{4 \text{ min}}$ 30.0° + 10.25° 40.3° W. Long.	<u>Long. of Sub-stellar Point:</u> Greenwich 10 hr 20 min - RA Proc. 06 hr 46 min 03 hr 34 min 3 hr x $\frac{15^\circ}{\text{hr}}$ + 34 min x $\frac{1^\circ}{4 \text{ min}}$ 45.0° + 8.5° 53.5° W. Long.	<u>Long. of Sub-stellar Point:</u> Greenwich 10 hr 20 min - RA Proc. 04 hr 36 min 05 hr 44 min 5 hr x $\frac{15^\circ}{\text{hr}}$ + 44 min x $\frac{1^\circ}{4 \text{ min}}$ 75.0° + 11.0° 86.0° W. Long.

GARY A. BECKER FEB. 27, 2013



Sample Navigation Problem



Sample Navigation Problem

NAVIGATION PROBLEM 1

GARY A. BECKY

N LATITUDE

16°
10°N
0°
10S
20°
30°
40°S

Z.D. FOR STARA = 36°

Z.D. FOR STARC = 56°

69.5°E LONG. 0.5°S LAT.
LOCATION OF OBSERVER

• STARB
SUB-STELLAR POSITION
98°E LONG.
14°N LAT.

SOUTH LATITUDE

Navigation Problem 1

SUB-STELLAR POSITION
38°E. LONG.
18°S LAT.

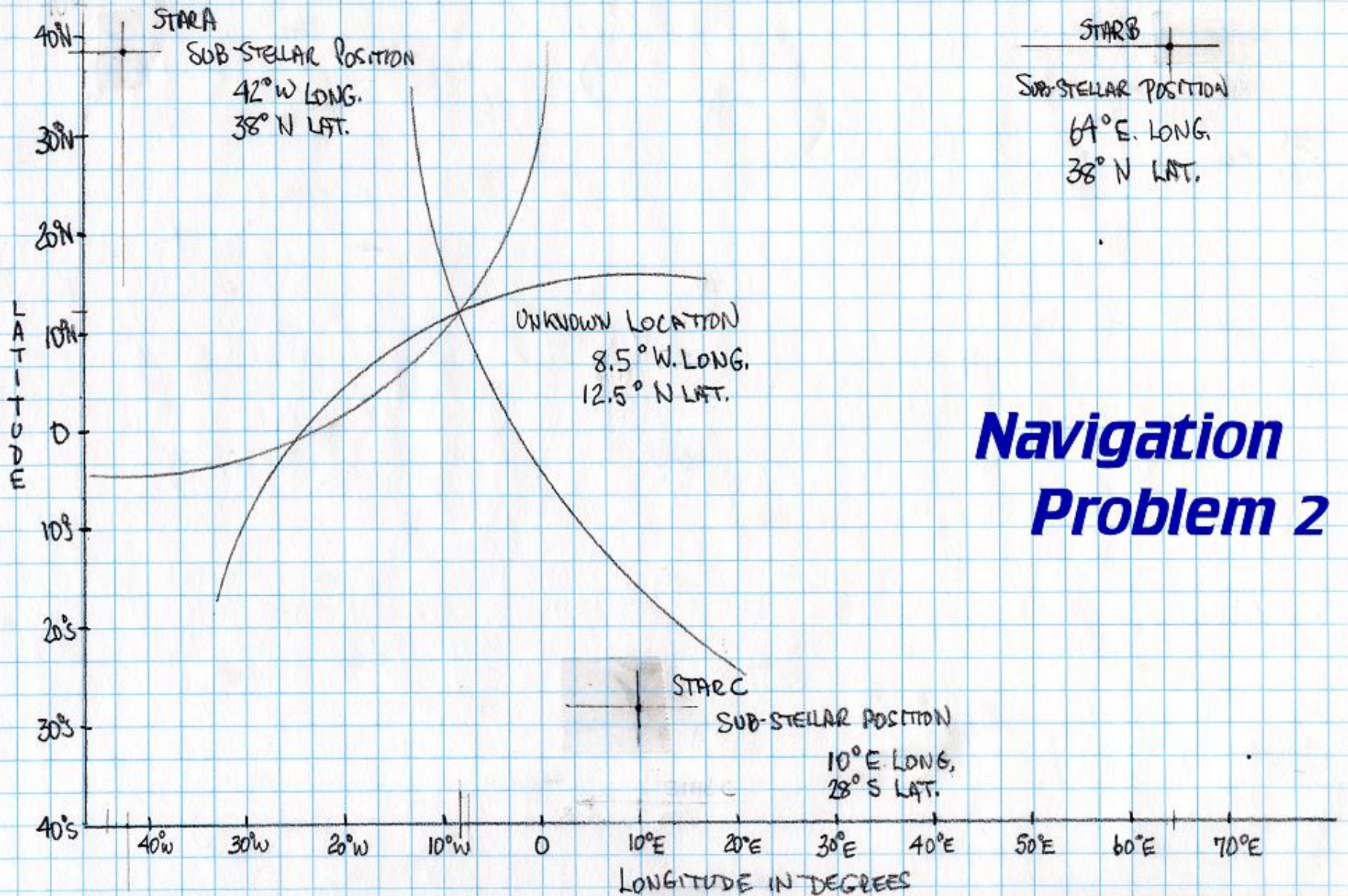
• STARA

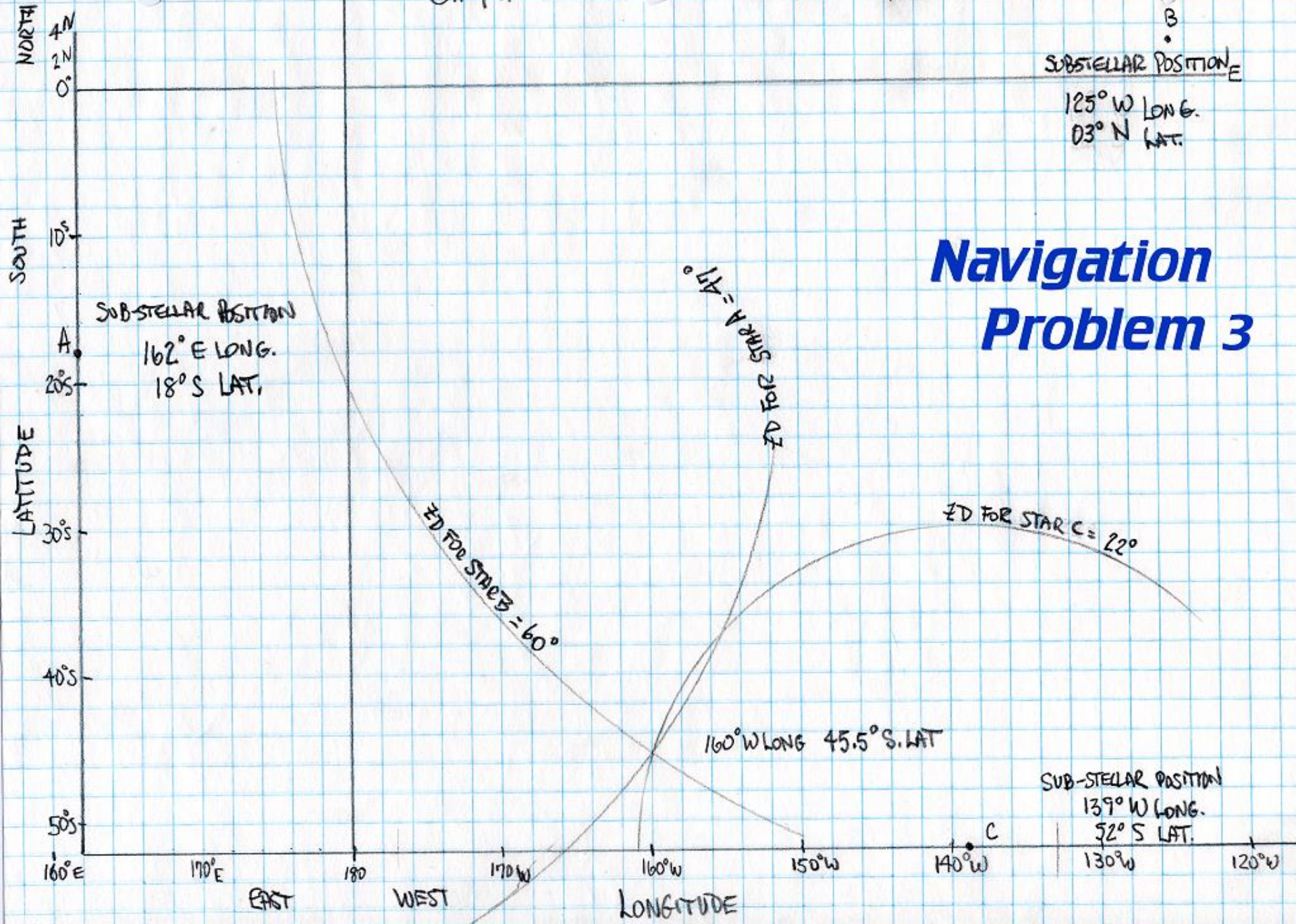
Z.D. FOR STARB = 32°

SUB-STELLAR POSITION
114°E LONG.
34°S LAT. • STARC

36°E 40°E 50°E 60°E 70°E 80°E 90°E 100°E 110°E 116°E
EAST LONGITUDE

NAVIGATION PROBLEM 2





Navigation Problem 3

The Analemma

