CVG 2171

ASSIGNMENT #7

PROBLEM # 1:

a) Find the exact time of observing Polaris at Upper Culmination on November 2 at point P, latitude 47° N and longitude 73.5° W.
b) Find the bearing and the time of observing Polaris at the next West Elongation on the same date and at the same point.

PROBLEM # 2:

i) A radio tower situated on level ground casts a shadow of 80 m when the sun's altitude is 40°22'. What is the height of the radio tower?

ii) The time of upper culmination of Polaris at point A, longitude 93^0 45'W is 20^h23^m, what is the time of upper culmination at point B, longitude 87°55'W on the same date?

iii) What is the date and standard time in Paris, longitude 02°15' 15" E of Greenwich, when it is in Ottawa, longitude 73°53'30" W of Greenwich, 23^h45^m of April 30, 2006?

iv) What is the approximate date of the vernal equinox? What is the declination of the sun on that day? Vernal Equinox signifies the beginning of what season in the Northern hemisphere?

SOLUTION

Problem II 1

Time of observing Polaris on NOV 2, at P.
Latitude 47°N & longitude 73° 30'W

a) Time of U. Culmination.

1) From table 8: OCT. 27 → $23^h\ 50.6^m$
NOV. 6 → $23^h\ 11.3^m$
difference $0^h\ 39.3^m$

∴ For NOV 2: $23^h\ 50.6^m - \frac{6}{10} \times 39.3 = \underline{\underline{23^h\ 27.02^m}}$

2) $3.93 \text{ min} \times \frac{73.5^\circ}{360^\circ} = -0.80 \text{ min.}$

3) $(75^\circ - 73.5^\circ) \times 4 \text{ min/degree} = -6.0 \text{ min.}$

∴ Polaris Culminates at:

$23^h\ 27.02^m - 0.8 - 6.0 = \underline{\underline{23^h\ 20.22^m}}$ ANS.

b) Time of W. Elongation (following day)

1) From table 8: OCT. 27 → $5^h\ 46.8^m$
NOV. 6 → $5^h\ 07.5^m$
39.3^m

∴ For NOV. 2; $5^h\ 46.8 - \frac{6}{10} \times 39.3 = \underline{\underline{5^h\ 23.22^m}}$
(For NOV. 3).

2) $3.93 \times \frac{73.5}{360} = -0.80 \text{ min.}$

3) $1.5 \times 4 \text{ min} = -6.0 \text{ min.}$

4) Correction for latitude other than 40°N.

From table 9: $45^\circ = -0.5^m$; $50^\circ = -1.2^m$

∴ For 47°N: $-0.5 - \left(\frac{1.2 - 0.5}{5}\right) \times 2^\circ = -0.78^m$

∴ Time of w. Elongation:

$5^h\ 23.22 - 0.8 - 6.0 - 0.78 = \underline{\underline{5^h\ 15.64^m}}$.

Bearing of Polaris:

Polar distance, from table 3

Oct. 28 → 49.75'
Nov. 7 → 49.69'

∴ For Nov. 3, $49.75 - \frac{6}{10}(49.75 - 49.69) = 49.71'$

From Table 7:

Bearing of Polaris: for 49.70 → 1° 12.9'
49.90 → 1° 13.2'

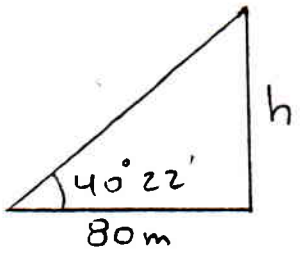
∴ For 49.71: $1°\,12.9 + \left(\frac{1°\,13.2 - 1°\,12.9}{0.2}\right) \times 0.01 =$

$\underline{\underline{1°\,12.92'}}$

Problem # 2

i) $\tan 40^\circ 22' = \frac{h}{80}$

$\therefore h = 80 \tan 40^\circ 22' = \underline{68 \text{ m.}}$ ANS.



ii) Points A and B lie in the same time zone (Central).

Difference in longitude : $93^\circ 45' - 87^\circ 55' = 5^\circ 50'$

$\therefore$ Difference in time of upper Culmination:

$\left(5^\circ + \frac{50}{60}\right) \times 4 \text{ min.} = 23^m\ 20^s$

$\therefore$ Upper Culmination at point B occurs on:

$20^h\ 23^m - 23^m\ 20^s = \underline{19^h\ 59^m\ 40^s}$ ANS.

iii) Standard time in Paris = Time at Greenwich.

Standard time in Ottawa = Eastern standard Time

$= 5^h$ West of Greenwich.

$\therefore$ Standard time in Paris $= 23^h 45^m + 5^h$

$= 28^h\ 45^m$

$= \underline{4^h\ 45^m,\ \text{the following day}}$

$\underline{\text{or May 1ST.}}$ ANS.

iv) Approximate date of Vernal Equinox is:

$\underline{21 \text{ March}}$ ANS.

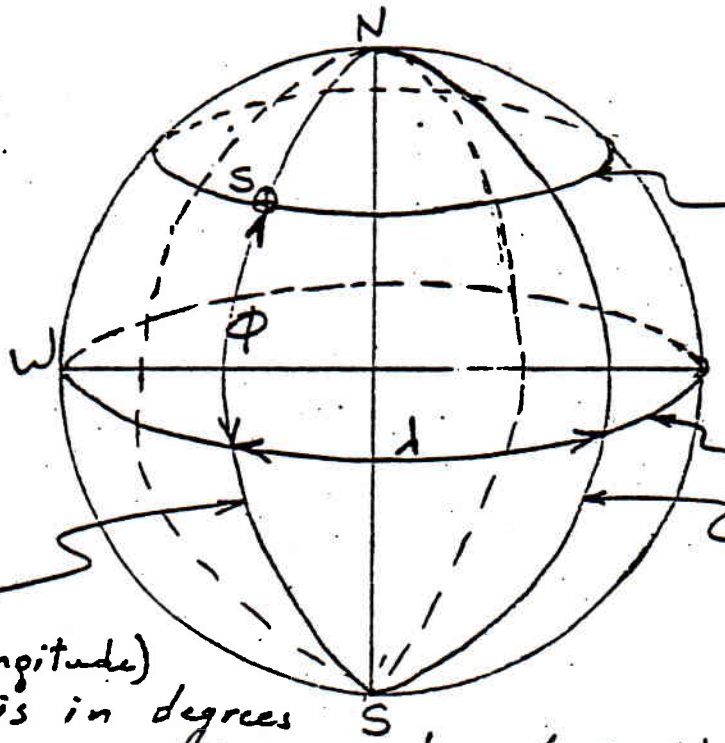
Sun's declination on that day $= \underline{0^\circ}$ ANS.

Vernal Equinox signifies the beginning of:

$\underline{\text{SPRING Season}}$ ANS.

Earth

S = station.



Latitude (Φ) or Parallel (0–90° N or S of Equator)

Equator

Greenwitch Meridian

Meridian Circle (longitude)

= λ ; it is in degrees of arcs or in hours of time (15° = 1 hr.) Measured East or West of Greenwitch.

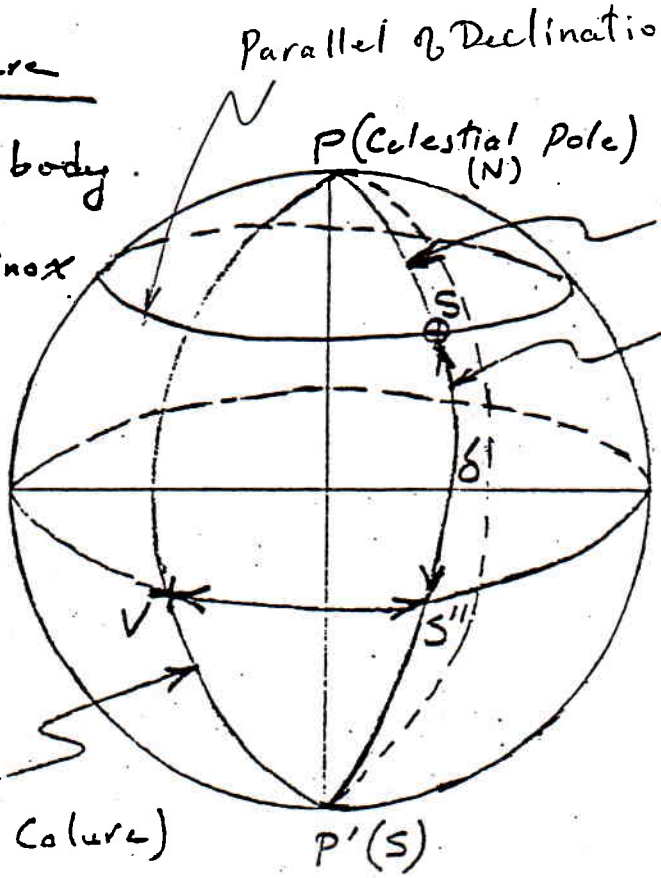
Celestial Sphere

S = heavenly body.

V = Vernal Equinox

VS' = Right Ascension

SS' = Declination = δ (0–90°)



Polar distance = 90 − δ (Co-declination)

Hour Circle

Right Ascension is measured Eastward from V & varies 0°–360° 0–24 hr.

Hour Circle (Equinoctial Colure)

TABLE 7

BEARING OF POLARIS AT ELONGATION

Polar Dist.	0° 49.50	0° 49.70	0° 49.90	0° 50.10	Polar Dist.	0° 49.50	0° 49.70	0° 49.90	0° 50.10
Lat.	Bearing at Elongation				Lat.	Bearing at Elongation			
°	° ′	° ′	° ′	° ′	°	° ′	° ′	° ′	° ′
10	0 50.3	0 50.5	0 50.7	0 50.9	40	1 04.6	1 04.9	1 05.1	1 05.4
11	0 50.4	0 50.6	0 50.8	0 51.0	41	1 05.6	1 05.9	1 06.1	1 06.4
12	0 50.6	0 50.8	0 51.0	0 51.2	42	1 06.6	1 06.9	1 07.1	1 07.4
13	0 50.8	0 51.0	0 51.2	0 51.4	43	1 07.7	1 08.0	1 08.2	1 08.5
14	0 51.0	0 51.2	0 51.4	0 51.6	44	1 08.8	1 09.1	1 09.4	1 09.6
15	0 51.2	0 51.5	0 51.7	0 51.9	45	1 10.0	1 10.3	1 10.6	1 10.9
16	0 51.5	0 51.7	0 51.9	0 52.1	46	1 11.3	1 11.5	1 11.8	1 12.1
17	0 51.8	0 52.0	0 52.2	0 52.4	47	1 12.6	1 12.9	1 13.2	1 13.5
18	0 52.0	0 52.3	0 52.5	0 52.7	48	1 14.0	1 14.3	1 14.6	1 14.9
19	0 52.4	0 52.6	0 52.8	0 53.0	49	1 15.5	1 15.8	1 16.1	1 16.4
20	0 52.7	0 52.9	0 53.1	0 53.3	50	1 17.0	1 17.3	1 17.6	1 17.9
21	0 53.0	0 53.2	0 53.5	0 53.7	51	1 18.7	1 19.0	1 19.3	1 19.6
22	0 53.4	0 53.6	0 53.8	0 54.0	52	1 20.4	1 20.7	1 21.1	1 21.4
23	0 53.8	0 54.0	0 54.2	0 54.4	53	1 22.3	1 22.6	1 22.9	1 23.3
24	0 54.2	0 54.4	0 54.6	0 54.8	54	1 24.2	1 24.6	1 24.9	1 25.2
25	0 54.6	0 54.8	0 55.1	0 55.3	55	1 26.3	1 26.7	1 27.0	1 27.4
26	0 55.1	0 55.3	0 55.5	0 55.7	56	1 28.5	1 28.9	1 29.2	1 29.6
27	0 55.6	0 55.8	0 56.0	0 56.2	57	1 30.9	1 31.3	1 31.6	1 32.0
28	0 56.1	0 56.3	0 56.5	0 56.7	58	1 33.4	1 33.8	1 34.2	1 34.6
29	0 56.6	0 56.8	0 57.1	0 57.3	59	1 36.1	1 36.5	1 36.9	1 37.3
30	0 57.2	0 57.4	0 57.6	0 57.9	60	1 39.0	1 39.4	1 39.8	1 40.2
31	0 57.7	0 58.0	0 58.2	0 58.4	61	1 42.1	1 42.5	1 42.9	1 43.4
32	0 58.4	0 58.6	0 58.8	0 59.1	62	1 45.5	1 45.9	1 46.3	1 46.7
33	0 59.0	0 59.3	0 59.5	0 59.7	63	1 49.0	1 49.5	1 49.9	1 50.4
34	0 59.7	0 59.9	1 00.2	1 00.4	64	1 52.9	1 53.4	1 53.8	1 54.3
35	1 00.4	1 00.7	1 00.9	1 01.2	65	1 57.1	1 57.6	1 58.1	1 58.6
36	1 01.2	1 01.4	1 01.7	1 01.9	66	2 01.7	2 02.2	2 02.7	2 03.2
37	1 02.0	1 02.2	1 02.5	1 02.7	67	2 06.7	2 07.2	2 07.7	2 08.2
38	1 02.8	1 03.1	1 03.3	1 03.6	68	2 12.2	2 12.7	2 13.2	2 13.8
39	1 03.7	1 04.0	1 04.2	1 04.5	69	2 18.2	2 18.7	2 19.3	2 19.8
40	1 04.6	1 04.9	1 05.1	1 05.4	70	2 24.8	2 25.4	2 25.9	2 26.5

To obtain the Bearing at any other declination compute:

$$\text{Bear. Polaris (in minutes)} = \frac{\text{Polar Dist. (in minutes)}}{\cos \text{Lat.}}$$

TABLE 8

POLARIS FOR THE MERIDIAN OF GREENWICH
LATITUDE 40° N

Universal Time or Greenwich Civil Time

Date		Upper Culmination	Previous East Elongation	Next West Elongation	Next Lower Culmination	Var. Per Day
		h m	h m	h m	h m	m
Jan.	1	19 28.7	13 32.5	1 25.0	7 26.7	3.96
	11	18 49.2	12 52.9	0 45.4	6 47.2	3.96
	21	18 09.6	12 13.3	0 05.8	6 07.6	3.96
	31	17 30.0	11 33.8	23 26.3	5 28.1	3.96
Feb.	10	16 50.5	10 54.2	22 46.7	4 48.5	3.96
	20	16 10.9	10 14.7	22 07.2	4 08.9	3.95
Mar.	2	15 31.4	9 35.1	21 27.6	3 29.4	3.95
	12	14 51.9	8 55.6	20 48.1	2 49.9	3.95
	22	14 12.4	8 16.2	20 08.7	2 10.4	3.94
Apr.	1	13 33.0	7 36.7	19 29.2	1 31.0	3.94
	11	12 53.6	6 57.4	18 49.9	0 51.6	3.93
	21	12 14.3	6 18.0	18 10.5	0 12.3	2.93
May	1	11 35.0	5 38.7	17 31.2	23 33.0	3.93
	11	10 55.7	4 59.5	16 52.0	22 53.8	3.92
	21	10 16.5	4 20.3	16 12.8	22 14.6	3.92
	31	9 37.4	3 41.1	15 33.6	21 35.4	3.91
June	10	8 58.3	3 02.0	14 54.5	20 56.3	3.91
	20	8 19.1	2 22.9	14 15.4	20 17.2	3.91
	30	7 40.1	1 43.8	13 36.3	19 38.1	3.91
July	10	7 01.0	1 04.7	12 57.2	18 59.0	3.91
	20	6 21.9	0 25.7	12 18.2	18 20.0	3.91
	30	5 42.8	23 46.6	11 39.1	17 40.9	3.91
Aug.	9	5 03.8	23 07.5	11 00.0	17 01.8	3.91
	19	4 24.7	22 28.5	10 21.0	16 22.8	3.91
	29	3 45.6	21 49.4	9 41.9	15 43.7	3.91
Sep.	8	3 06.5	21 10.3	9 02.8	15 04.5	3.91
	18	2 27.4	20 31.1	8 23.6	14 25.4	3.92
	28	1 48.2	19 52.0	7 44.5	13 46.3	3.92
Oct.	8	1 09.0	19 12.8	7 05.3	13 07.1	3.92
	18	0 29.8	18 33.6	6 26.1	12 27.8	3.93
	27	23 50.6	17 54.3	5 46.8	11 48.6	3.93
Nov.	6	23 11.3	17 15.0	5 07.5	11 09.3	3.94
	16	22 31.9	16 35.6	4 28.1	10 29.9	3.94
	26	21 52.5	15 56.3	3 48.8	9 50.6	3.94
Dec.	6	21 13.1	15 16.8	3 09.3	9 11.1	3.95
	16	20 33.6	14 37.4	2 29.9	8 31.7	3.95
	26	19 54.1	13 57.9	1 50.4	7 52.1	
Jan.	5	19 14.6	13 18.3	1 10.8	7 12.6	3.95

From July 27 to Oct. 25 the East Elongation is for the previous day. From Jan. 1 to Jan 22 and from Oct. 26 to Jan. 5 the West Elongation is for the next day.
From Jan. 1 to Apr. 23 and from Oct. 25 to Jan. 5 the lower culmination is for the next day.

TABLE 8

CORRECTIONS TO TIMES OF ELONGATION FOR DIFFERENT LATITUDES

Latitude	10°	15°	20°	25°	30°	35°	40°	45°	50°
	m	m	m	m	m	m	m	m	m
West Elongation	+2.2	+1.9	+1.6	+1.2	+0.9	+0.5	0.0	−0.5	−1.2
East Elongation	−2.2	−1.9	−1.6	−1.2	−0.9	−0.5	0.0	+0.5	+1.2

TABLE 3

POLAR DISTANCE OF POLARIS,
For 0h Universal Time or Greenwich Civil Time

	Polar Distance			Polar Distance		
		Angle	Cotan		Angle	Cotan
		° ′			° ′	
Jan.	1	0 49.66	69.22	July 10	0 50.16	68.53
	11	0 49.64	69.25	20	0 50.16	68.53
	21	0 49.62	69.28	30	0 50.15	68.54
	31	0 49.62	69.28			
Feb.	10	0 49.62	69.28	Aug. 9	0 50.13	68.57
	20	0 49.64	69.25	19	0 50.10	68.61
				29	0 50.07	68.65
Mar.	2	0 49.67	69.21	Sep. 8	0 50.03	68.71
	12	0 49.70	69.17	18	0 49.98	68.78
	22	0 49.75	69.10	28	0 49.93	68.85
Apr.	1	0 49.80	69.03	Oct. 8	0 49.87	68.93
	11	0 49.85	68.96	18	0 49.81	69.01
	21	0 49.90	68.89	28	0 49.75	69.10
May	1	0 49.95	68.82	Nov. 7	0 49.69	69.18
	11	0 50.00	68.75	17	0 49.62	69.28
	21	0 50.04	68.70	27	0 49.56	69.36
	31	0 50.08	68.64			
June	10	0 50.12	68.59	Dec. 7	0 49.51	69.43
	20	0 50.14	68.56	17	0 49.46	69.50
	30	0 50.15	68.54	27	0 49.42	69.56

Declination = 90° − Polar Distance

TABLE 18-2 LONGITUDES OF STANDARD MERIDIANS IN THE UNITED STATES AND TIME DIFFERENCES FROM GREENWICH

Standard Time Zone (and Abbreviation)	Longitude of Standard Meridian	Corrections in Hours, to Add to Obtain UT	
		Standard Time	Daylight Time
Atlantic (AST)	60°	4	3
Eastern (EST)	75°	5	4
Central (CST)	90°	6	5
Mountain (MST)	105°	7	6
Pacific (PST)	120°	8	7
Yukon (YST)	135°	9	8
Alaska/Hawaii (AHST)	150°	10	9
Bering Sea (BST)	165°	11	10