Module 10

Modern Navigation Systems

Solving for Time

Module 10B
The 1804 Nautical Almanac

Summary of Module 10

- Students will learn how to determine time from celestial measurements, and about the relationship between index and time offset errors for sextant and GPS observations, respectively. (10A)
- **Students will learn how to read and use Nevil Maskelyne's 1804 Nautical Almanac, the predecessor to today's modern Nautical and Air Almanacs. (10B)**
- Students will use Newton's method to determine latitude, learn how to relate the lunar distance to GHAϒ in order to determine GMT/UTC time and longitude, and learn how to compute the corrections for parallax using Richharia's equations. (10C)
- Students will use these new skills to analyze actual celestial observation data from the Lewis and Clark expedition. (10D)

The Nautical Almanac

- Nevil Maskelyne created the world's first nautical almanac.
- It has been updated and published ever since, leading to the 2015 Nautical Almanac that is required for this course.

Who was Neville Maskelyne?

- Nevil Maskelyne was the Royal Astronomer in England in the late 18th and early 19th centuries
- He provided considerable guidance and assistance to the Mason-Dixon survey
  - In Danson's book, Maskelyne is portrayed as a hero
- At the same time, Maskelyne was actively involved in the controversy over John Harrison's attempt to win the Longitude Prize by building a precision chronometer that could keep time aboard ship to an accuracy of better than 2 minutes over a span of three months
  - In Sovel's book, Maskelyne is portrayed as a villain.

The 1804 Almanac

- At Thomas Jefferson's instruction, Lewis and Clark took a sextant and a copy of the 1804 Almanac on their expedition.
- The Almanac has been copied and republished, and can be purchased on Amazon.
- The entries from the Almanac for June 1804 are provided in the slides that follow.
- Note the ubiquitous use of the middle case "s", which in turn looks like a script "f" and an integral sign. For example, "right afcenfion" means "right a$\int$cen$\int$ion" = "right a$\int$cen$\int$ion" until about 1804, when it was replaced by "right ascension".

Title page, the 1804 Nautical Almanac

THE

NAUTICAL ALMANAC

AND

ASTRONOMICAL EPHEMERIS

FOR THE YEAR

1804.

PUBLISHED BY ORDER OF THE

COMMISSIONERS OF LONGITUDE.

LONDON:

PRINTED BY C BUCKTON, GREAT PULTENEY STREET;

AND

SOLD BY P ELMSLY, STRAND, BOOKSELLER TO THE SAID

COMMISSIONERS.

M DCC XCVI.

[Price *Three Shillings and Sixpence.*]

I. JUNE 1804. 61

Days of the Week.	Days of the Month.	Sundays, Holidays, Terms, &c.
F.	1	Nicomede. Trin. T. beg.
Sa.	2	
Sun.	3	1st Su. af T. [of H.T. 2 r
M.	4	K. G III. b 1738. In 8 d.
Tu.	5	Boniface. Pr. Ktn. Aug. b.
W.	6	
Th.	7	
F	8	
Sa.	9	
Sun.	10	2d Sunday after Trinity.
M.	11	St. Barnabas. In 15 days
Tu.	12	[of H.T. 3 ret.
W.	13	
Th.	14	
F.	15	
Sa.	16	
Sun.	17	3d. Su. aft. Trin. St Alban.
M.	18	In 3 w. of H. Trin. 4 ret
Tu.	19	
W.	20	Trin. Term ends Tr. of
Th.	21	[Edw. K. of W. S
F.	22	
Sa.	23	
Sun.	24	4th Su. aft. Tr. Nativity of
M.	25	[St. John Bap.
Tu.	26	
W.	27	
Th.	28	
F	29	St. Peter.
Sa.	30	

Phases of the MOON.

	D. H. M.
● New Moon	7. 11. 7
☽ First Quarter	14. 12. 58
○ Full Moon	22. 18. 22
☾ Last Quarter	30. 3. 34

Other *Phenomena*.

D. H. M.	
3. 22. 49	☽ ☌ ♓
10. 20. 43	☽ ☌ ♋
20 - -	☿ Stationary.
20. 2. 24	☽ ☍ ♏
20. 12. 9	☽ ☌ ♏
20. 16. 4	☽ ☌ ♏
21. - -	♅ Stationary.
21. 4. 50	○ enters ♋
21. 15. 55	☽ 43 Ophiuchi.
22. - -	♃ Stationary.
22. 20. 38	☽ ☌ ♐
23. 8. 27	☽ ☌ ♐
27. 8. 19	☽ ☌ ♒

62 JUNE 1804. II.

Days of the Week.	Days of the Month.	THE SUN'S Longitude.	R^t. Ascen in Time.	Declin. North.	Equation of Time Sub.	Diff.
		S. D. M. S.	H. M. S.	D. M. S.	M. S.	S.
F.	1	2. 10. 41. 57	4 36. 24, 9	22. 4 28	2 37, 3	9, 1
Sa.	2	2. 11. 39. 24	4. 40 30, 6	22 12 26	2. 28, 2	9, 5
Sun.	3	2. 12. 36. 50	4. 44. 36, 7	22 20. 1	2. 18, 7	9, 8
M.	4	2. 13. 34. 15	4. 48. 43, 2	22. 27. 13	2. 8, 9	10, 3
Tu.	5	2 14. 31. 40	4. 52. 50, 0	22 34. 1	1. 58, 6	10, 6
W.	6	2. 15. 29. 4	4. 56. 57, 2	22. 40. 25	1. 48, 0	10, 9
Th.	7	2. 10. 26. 27	5. 1. 4, 7	22. 46 26	1. 37, 1	11, 3
F.	8	2. 17. 23. 50	5. 5. 12, 5	22. 52 2	1. 25, 8	11, 5
Sa.	9	2. 18. 21. 12	5. 9. 20, 6	22. 57. 15	1. 14, 3	11, 7
Sun	10	2. 19. 18. 34	5. 13 29, 0	23. 2. 3	1. 2, 6	12, 0
M.	11	2. 20. 15. 54	5. 17. 37, 5	23. 6. 27	0. 50, 6	12, 2
Tu.	12	2. 21. 13. 13	5. 21. 46, 3	23. 10. 27	0. 38, 4	12, 3
W.	13	2. 22. 10. 32	5 25. 55, 2	23. 14. 2	0 26, 1	12, 5
Th.	14	2. 23. 7. 49	5. 30. 4, 3	23. 17. 12	0. 13, 6	12, 6
F.	15	2. 24. 5. 6	5. 34. 13, 5	23. 19. 58	0. 1, 0	12, 6
Sa.	16	2. 25. 2 22	5. 38. 22, 7	23. 22. 19	*Add* 11, 6	12, 8
Sun.	17	2. 25. 59. 37	5 42. 32, 1	23. 24. 16	0. 24, 4	12, 8
M.	18	2. 26. 56. 51	5. 46. 41, 5	23. 25. 48	0. 37, 2	12, 9
Tu.	19	2. 27. 54. 5	5. 50. 51, 0	23. 26. 55	0. 50, 1	12, 9
W.	20	2 28. 51. 18	5. 55. 0, 4	23. 27. 37	1. 3, 0	12, 8
Th	21	2. 29 48. 30	5. 59. 9, 8	23. 27. 54	1. 15, 8	12, 8
F.	22	3. 0 45 42	6. 3. 19, 3	23. 27. 47	1 28, 6	12, 8
Sa.	23	3. 1. 42. 53	6. 7. 28. 6	23. 27. 15	1 41, 4	12, 7
Sun	24	3. 2. 40 5	6. 11 37, 9	23. 26. 18	1. 54, 1	12, 7
M	25	3. 3. 37. 16	6. 15 47, 2	23. 24. 56	2. 6, 8	12, 5
Tu.	26	3. 4. 34. 27	6 19 56, 3	23 23. 10	2. 19, 3	12, 4
W.	27	3. 5. 31. 38	6. 24 5, 3	23 20. 59	2 31, 7	12, 3
Th.	28	3. 6. 28. 50	6. 28. 14, 2	23. 18. 23	2. 44, 0	12, 1
F.	29	3. 7. 26. 1	6 32 22, 9	23. 15. 23	2. 56, 1	11, 9
Sa.	30	3. 8. 23. 13	6. 36. 31, 4	23. 11. 58	3. 8, 0	

III. JUNE 1804. 63

Days	Time of ☉'s Semidiam passs Merid.	THE SUN's Semi-diameter	Hourly Motion.	Logar. Distance.	Place of the ☽'s Node
	M. S.	M. S.	M. S.		S D. M.
1	1 8, 3	15. 48, 9	2. 23, 6	0. 006307	10. 7. 51
7	1. 8, 6	15. 48, 2	2. 23, 4	0. 006648	10. 7. 32
13	1. 8, 7	15 47, 6	2 23, 2	0. 006896	10. 7. 13
19	1. 8, 8	15 47, 2	2 23, 1	0. 007066	10. 6 54
25	1. 8, 8	15. 47, 0	2. 23, 0	0. 007180	10. 6. 35

ECLIPSES of the SATELLITES of JUPITER.

I. Satellite. Emersions.		II Satellite. Emersions.		III. Satellite.		
Days	H M S.	Days.	H. M. S.	Days.	H. M. S.	
2	0. 53. 55	* 1	13. 8 41	5	21. 2. 9	Im.
3	19. 22. 20	5	2. 25. 52	5	22. 57. 53	E.
5	13. 50. 48	8	15 43. 0	13	0. 59. 48	Im.
7	8. 19 6	12	5 0. 7	13	2. 55. 21	E.
9	2. 47. 30	15	18. 17. 16	20	4. 57. 23	Im.
10	21. 15. 47	19	7. 34. 29	20	6. 52. 26	E.
12	15 44. 10	22	20. 51. 43	27	8. 54. 53	Im.
*14	10. 12. 26	*26	10. 9. 12	*27	10. 49. 44	E.
16	4. 40. 45	29	23. 26. 37			
17	23. 9. 5					
19	17 37. 24					
21	12 5 40					
23	6. 32. 3					
25	1. 2. 23					
26	19. 30. 40					
28	13. 58. 58					
30	8. 27 21					

IV. Satellite. Conj.		
5	17. 1	Int.
14	0. 44	Sup.
22	9. 6	Int.
30	17. 12	Sup.

64 JUNE 1804. IV

THE PLANETS

Days	Heliocentric Long.	Heliocentric Lat.	Geocentric Long.	Geocentric Lat.	Declin.	Passage Merid
	S D. M.	D. M.	S. D. M	D. M.	D. M.	H. M
	☿ MERCURY.				Inf. ☌ 8ᵈ.10ʰ	
1	7. 27. 19	1. 23 S	2. 21. 23	1. 6 S	22. 5 N	0. 46
4	8. 5 39	2. 22	2. 20. 10	1. 58	21. 8	0. 29
7	8. 13. 54	3. 17	2. 18. 36	2. 47	20. 12	0. 10
10	8. 22. 9	4. 8	2. 16. 56	3. 29	19. 21	23. 45
13	9. 0. 30	4. 55	2. 15. 24	4. 1	18. 40	23 27
16	9. 9. 3	5. 36	2. 14. 15	4 20	18 13	23. 11
19	9. 17. 54	6. 11	2. 13. 38	4. 28	18. 2	22. 57
22	9. 27. 9	6. 38	2. 13. 42	4. 23	18. 7	22. 45
25	10. 6. 55	6. 55	2. 14. 27	4. 9	18. 26	22. 37
28	10. 17. 22	7. 0	2. 15 56	3. 46	18. 59	22. 31
30	10. 24 47	6. 55	2. 17. 19	3 27	19 25	22. 30
	♀ VENUS.					
1	7. 0. 16	2. 23 N	3. 25. 52	2 36 N	23. 33 N	3. 17
7	7. 9. 54	1. 57	4. 1. 9	2 18	22. 10	3. 15
13	7. 19. 29	1. 27	4. 6. 2	1. 52	20. 36	3 10
19	7. 29. 4	0. 56	4. 10. 24	1. 18	18 54	3. 2
25	8 8. 36	0. 22	4 14. 8	0 34	17. 9	2 51
	♂ MARS.					
1	0. 3. 3	1. 19 S	1. 0 38	0. 55 S	10 55 N	21. 18
7	0. 6. 45	1. 14	1. 5. 15	0. 52	12. 28	21. 11
13	0. 10. 26	1. 8	1. 9 39	0. 48	13. 57	21. 3
19	0. 14. 6	1 2	1 14 2	0 45	15. 21	20. 55
25	0. 17 44	0. 56	1. 18. 22	0. 41	16. 39	20. 47
	♃ JUPITER.					
1	7. 4. 7	1. 12 N	6 26. 40	1. 24 N	9. 0 S	9. 3
7	7. 4. 35	1. 12	6. 26 20	1. 22	8. 54	8. 37
13	7. 5. 2	1. 11	6 26. 6	1. 21	8. 50	8. 11
19	7. 5. 30	1. 11	6. 25. 59	1 19	8. 49	7 46
25	7. 5. 57	1. 11	6. 25. 58	1. 17	8. 51	7. 21
	♄ SATURN.				☐ 18ᵈ. 4ʰ.	
1	6. 2. 39	2. 22 N	5. 26. 46	2 27 N	3. 32 N	7. 14
7	6. 2. 51	2. 22	5. 26. 50	2. 26	3. 29	6 59
13	6. 3. 3	2. 22	5 26. 57	2. 24	3 25	6. 36
19	6. 3 15	2. 22	5. 27. 8	2. 23	3. 20	6. 1
25	6. 3. 28	2. 23	5. 27 22	2 22	3. 17	[illegible]
	♅ GEORGIAN.					
1	6 15. 26	0. 39 N	6. 12. 44	0. 40 N	4. 25 S	8 [illegible]
11	6 15 34	0. 39	6 12. 27	0. 40	4. 23	7. 29
21	6. 15. 42	0 39	6. 12. 35	0. 39	4. 22	6. 47

Days of the Week.	Days of the Month.	THE MOON's Longitude. Noon.	Longitude. Midnight.	Latitude. Noon.	Latitude. Midnight.
		S. D. M. S.	S. D. M. S.	D. M. S.	D. M. S.
F.	1	11. 12. 18 42	11. 19. 8. 40	3. 0. 15 N	3. 28. 30 N
Sa.	2	11 26 4. 44	0. 3. 6. 57	3. 54. 8	4. 16. 39
Sun	3	0. 10. 15. 14	0. 17. 29. 22	4. 35. 31	4. 50. 14
M.	4	0. 24. 48. 57	1. 2. 13. 22	5. 0 25	5. 5. 43
Tu.	5	1. 9. 41. 48	1. 17 13. 17	5. 5. 54	5. 0. 49
W.	6	1 24. 46. 39	2. 2 20 44	4. 50 27	4. 35. 1
Th.	7	2. 9. 54. 19	2. 17 26. 0	4. 14. 47	3. 50. 9
F.	8	2. 24. 54. 35	3. 2. 19. 2	3. 21. 41	2. 50. 3
Sa.	9	3. 9. 38. 20	3. 16. 51. 47	2. 15. 54	1. 39. 58
Sun.	10	3. 23. 58. 48	4. 0. 59. 3	1. 2. 56 N	0. 25. 30 N
M.	11	4. 7. 52. 21	4. 14. 38. 45	0. 11. 45 S	0. 48. 14 S
Tu	12	4. 21. 18. 25	4. 27. 51. 37	1. 23. 28	1. 57. 3
W.	13	5. 4. 18. 46	5. 10. 40. 21	2. 28. 37	2. 57. 52
Th.	14	5 16. 56. 50	5. 23. 8. 51	3. 24. 35	3. 48. 33
F.	15	5. 29. 16. 58	6 5. 21. 42	4. 9. 37	4. 27. 40
Sa	16	6. 11. 23. 42	6. 17. 23. 28	4. 42. 35	4. 54. 19
Sun.	17	6 23. 21. 35	6. 29. 18 32	5. 2. 47	5. 7. 58
M.	18	7. 5. 14. 47	7 11. 10. 49	5. 9. 49	5. 8. 21
Tu.	19	7. 17. 7. 0	7 23. 3. 42	5. 3. 34	4. 55. 29
W.	20	7. 29. 1. 17	8. 5. 0. 1	4. 44. 11	4. 29. 45
Th	21	8. 11. 0. 12	8. 17. 1 58	4. 12. 14	3. 51. 51
F.	22	8. 22. 5. 37	8. 29 11 16	3 28 43	3. 3. 4
Sa.	23	9. 5. 19. 5	9. 11. 29. 15	2. 35. 5	2. 5. 7
Sun.	24	9. 17 41. 52	9. 23. 57. 7	1. 33. 24	1. 0. 19 S
M.	25	10. 0 15. 9	10 6. 36. 6	0. 26. 13 S	0. 8. 31 N
Tu.	26	10. 13. 0. 12	10. 19. 27 35	0. 43. 26 N	1. 18. 9
W.	27	10 25. 58. 28	11. 2. 33 2	1. 52. 10	2. 25. 2
Th.	28	11. 9. 11. 30	11. 15. 54. 1	2. 56. 17	3. 25. 26
F.	29	11 22 40 45	11. 29. 31. 48	3. 52. 2	4. 15. 36
Sa.	30	0. 6. 27. 14	0. 13. 27. 0	4. 35. 41	4. 51. 56

Days of the Week.	Days of the Month.	Age.	Passage Merid.	Right Ascension. Noon.	Right Ascension. Midnight.	Declination. Noon.	Declination. Midnight.
		D.	H. M.	D. M.	D. M.	D. M.	D. M.
F.	1	24	18 49	342 33	348. 40	4. 10 S	1. 6 S
Sa	2	25	19. 37	354. 51	1. 9	2. 1 N	5. 10 N
Sun	3	26	20 29	7 36	14. 14	8 17	11. 20
M	4	27	21. 24	21. 5	28. 11	14 16	17 2
Tu	5	28	22. 24	35. 34	43. 14	19. 34	21. 48
W.	6	29	23. 28	51. 8	59. 16	23. 41	25. 9
Th.	7	1	0	67. 34	75. 56	26. 9	26. 41
F.	8	2	0. 33	84. 18	92. 35	26 44	26. 17
Sa.	9	3	1. 37	100. 40	108. 31	25. 22	24. 3
Sun.	10	4	2 36	116 4	123. 19	22. 22	20. 23
M.	11	5	3 30	130. 14	136 52	18. 8	15. 41
Tu.	12	6	4. 19	143. 14	149. 22	13. 6	10. 24
W.	13	7	5. 4	155. 17	161. 2	7 38	4. 50 N
Th.	14	8	5. 46	166. 40	172. 12	2. 1 N	0 47 S
F.	15	9	6. 27	177. 41	183. 9	3. 32 S	6. 14
Sa.	16	10	7. 8	188. 37	194. 7	8. 51	11. 22
Sun.	17	11	7. 50	199. 41	205. 21	13 46	16. 2
M.	18	12	8 34	211. 8	217. 3	18. 9	20. 5
Tu.	19	13	9. 20	223. 6	229. 18	21. 49	23. 19
W.	20	14	10. 8	235. 40	242. 9	24. 35	25. 34
Th.	21	15	10. 59	248. 46	255. 29	26. 17	26. 41
F.	22	16	11 51	262 17	269. 6	26. 46	26. 31
Sa	23	17	12. 42	275. 55	282. 41	25. 57	25. 3
Sun.	24	18	13. 33	289. 24	296. 2	23. 50	22. 20
M.	25	19	14 22	302. 33	308. 58	20. 33	18. 30
Tu.	26	20	15. 10	315. 16	321. 28	16. 14	13. 46
W.	27	21	15. 56	327. 35	333. 39	11. 7	8. 19
Th.	28	22	16. 41	339. 40	345. 42	5. 24 S	2. 25 S
F.	29	23	17. 28	351. 45	357. 52	0. 39 N	3. 43 N
Sa.	30	24	18 .6	4. 6	10. 27	6. 47	9. 48

VII. JUNE 1804. 67

Days of the Week.	Days of the Month.	THE MOON's Semidiameter. Noon. M. S.	Semidiameter. Midnight. M. S.	Hor. Parallax. Noon. M. S.	Hor. Parallax. Midnight. M. S.	Proportional Logarithm. Noon.	Midn.
F.	1	15. 52	15 59	58. 14	58. 38	4901	4871
Sa.	2	16. 5	16. 11	59. 2	59. 25	4842	4813
Sun.	3	16. 17	16. 23	59 47	60. 8	4787	4761
M.	4	16. 28	16. 32	60. 26	60. 42	4740	4721
Tu	5	16. 36	16. 38	60. 55	61. 4	4705	4694
W.	6	16. 40	16 40	61. 9	61. 10	4689	4687
Th.	7	16. 39	16. 37	61. 6	60. 57	4692	4703
F.	8	16. 33	16. 29	60 44	60. 28	4718	4737
Sa.	9	16. 23	16 17	60. 8	59. 45	4761	4789
Sun	10	16. 10	16. 3	59. 19	58. 53	4821	4853
M.	11	15. 55	15. 48	58. 26	57. 58	4886	4921
Tu.	12	15. 40	15 33	57. 30	57. 2	4956	4991
W.	13	15. 25	15. 19	56. 36	56. 12	5025	5055
Th.	14	15. 13	15. 7	55 50	55. 29	5084	5111
F.	15	15. 2	14. 58	55. 11	54. 55	5134	5155
Sa.	16	14. 55	14. 52	54. 43	54. 32	5171	5186
Sun.	17	14. 49	14 48	54. 24	54. 18	5197	5205
M.	18	14. 47	14. 46	54. 14	54 12	5210	5213
Tu.	19	14. 46	14. 47	54. 12	54. 15	5213	5209
W.	20	14. 48	14. 49	54. 19	54. 24	5203	5197
Th	21	14. 51	14. 54	54. 31	54. 40	5187	5175
F.	22	14. 56	14. 59	54. 49	54. 59	5163	5150
Sa.	23	15. 2	15. 6	55. 11	55. 23	5134	5119
Sun.	24	15. 9	15. 13	55 36	55. 50	5102	5084
M.	25	15. 17	15. 21	56 5	56. 20	5064	5045
Tu.	26	15. 25	15. 30	56. 36	56. 52	5025	5004
W.	27	15. 34	15. 39	57 8	57. 25	4984	4962
Th.	28	15. 43	15 48	57. 42	58 0	4941	4918
F.	29	15. 53	15. 58	58 17	58. 35	4897	4875
Sa.	30	16. 2	16. 7	58. 52	59. 9	4853	4833

I 2

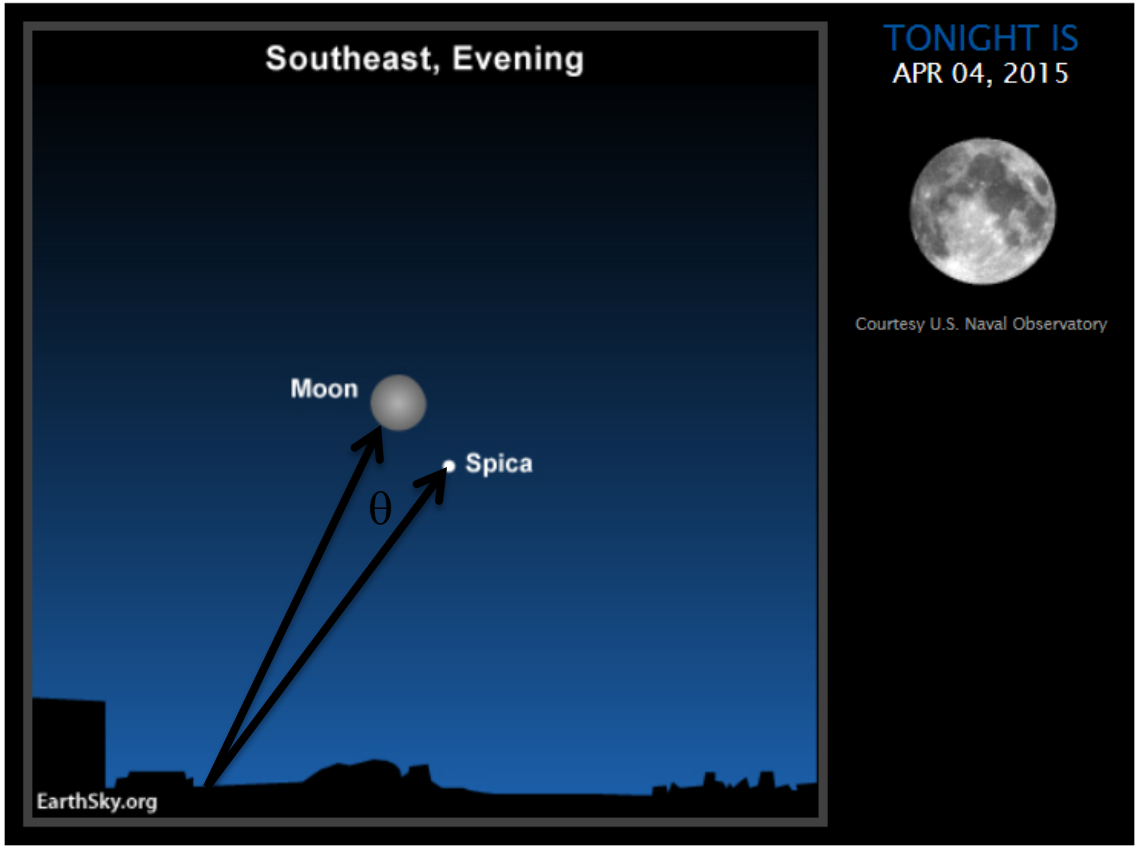
68 JUNE 1804. VIII.

DISTANCES of MOON's *Center* from SUN, and from STARS *EAST* of her.

Stars Names.	Days	Noon. D M. S.	III^h. D. M. S	VI^h. D M S	IX^h. D M. S.	Midnight. D M S	XV^h. D. M. S.	XVIII^h. D. M. S	XXI^h. D M S.
The Sun.	1	88. 23 23	86. 48. 17	85. 13. 50	83 38 42	82. 2. 53	80. 26. 53	78 52 31	77. 13 48
	2	75 30. 43	73 59 16	72 21. 24	70. 43 20	69. 4. 50	67. 25. 59	65 46 48	64 7 16
	3	62 27 23	60 47 10	59. 6. 37	57 25. 45	55. 44. 33	54. 3. 2	52 21. 15	50. 39. 9
	4	48. 56 47	47 14 8	45 31. 15	43. 48 7	42 4. 45	40. 21 11	38 37 25	
Regulus.	9	47. 29. 41	45. 40. 38	43. 51. 57	42. 3. 39	40 15. 45	38. 28 15	36 41 10	34 54 30
	10	33. 8. 16	31. 22. 28	29 37. 7	27. 52. 15	26. 7. 50	24. 23 55	22. 40. 30	20 57. 30
	11	19. 15. 14							
Spica ♍	11	73. 15. 6	71. 32 35	69. 50. 41	68. 8. 53	66 27. 41	64. 46 55	63 6. 36	61. 26 41
	12	59. 47. 13	58. 8 10	56. 29 33	54. 51. 19	53. 13. 31	51 36. 7	49. 59 6	48 22. 29
	13	46. 46. 15	45. 10 24	43. 34 55	41 59 49	40. 25. 4	38. 50. 41	37 16 39	35. 42 57
	14	34. 9. 30	32. 36. 34	31. 3. 52	29. 31. 29	27. 59. 26	26. 27. 42	24. 56. 17	23. 25. 12
	15	21 54. 25							
Antares	15	07. 32. 18	66. 0. 57	64. 29 49	62. 58 53	61. 28 9	59. 57. 37	58 27. 15	56. 57. 3
	16	55. 27. 1	53. 57. 9	52. 27. 24	50. 57 48	49. 28. 19	47. 58 57	46. 29. 41	45. 0 31
	17	43. 31. 27	42. 2. 28	40. 33. 32	39. 4. 41	37. 35. 53	36. 7. 8	34. 38. 25	33. 9. 44
	18	31. 41. 4							
α Aquilæ.	18	87. 7. 18	85. 50. 24	84. 33. 32	83. 16. 44	81 59. 59	80. 43. 18	79. 26. 42	78. 10. 11
	19	76. 53. 46	75. 37. 26	74 21. 14	73. 5. 10	71. 49. 13	70. 33. 24	69 17. 46	68. 2. 20
	20	66 47. 4	65. 32. 2	64. 17. 15	63. 2. 43	61. 48. 27			

Lunar distance θ between the moon and the star Spica

First full moon of spring (or fall) on April 4



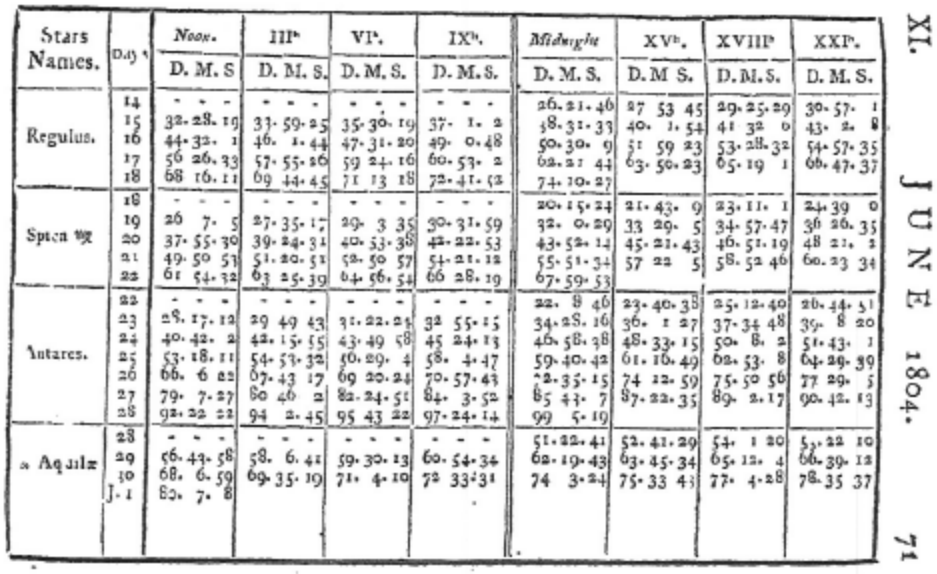
IX. JUNE 1804.

Stars Names.	Days	Noon.	IIIh.	VIh.	IXh.	Midnight.	XVh.	XVIIIh.	XXIh.
		D. M. S	D. M. S	D. M. S	D. M. S.	D. M. S.	D. M. S.	D M S.	D. M. S.
Fomalhaut.	20	- - -	- - -	- - -	- - -	84. 45. 39	83. 23 19	82. 0. 56	80. 38. 30
	21	79 16. 1	77. 53. 30	76. 30. 57	75. 8. 24	73. 45 49	72. 23. 13	71. 0. 38	69. 38. 4
	22	68 15 32	66. 53. 2	65 30. 36	64. 8. 16	62. 46. 0	61 23. 50	60. 1. 50	58. 40. 0
	23	57 18. 19	55. 56. 49	54 35. 35	53. 14. 39	51. 54. 0	50. 33. 44	49. 13. 52	47. 54. 26
	24	46 35. 28							
α Pegasi.	24	65. 27. 32	63. 47. 57	62 18 18	60 48. 36	59. 18. 51	57. 49. 5	56. 19. 19	54. 49 35
	25	53 19 51	51. 50. 8	50 20 32	48 51. 1	47. 21. 37	45. 52. 23	44. 23. 19	42. 54 28
	26	41 25. 51							
α Arietis.	26	81. 55. 18	80. 18. 44	78. 41 58	77. 4 59	75 27 49	73 50 26	72. 12. 52	70. 35. 4
	27	68. 57 5	67. 18. 53	65. 40. 29	64. 1 52	62 23. 3	60. 44 1	59. 4. 46	57. 25. 19
	28	55. 45. 39	54 5. 46	52 25 41	50 45 24	49 4 54	47. 24 11	45 43. 10	44. 2 10
	29	42. 20. 51	40. 39 20	38 57. 38	37 15. 46	35. 33. 43	33. 51. 31	32. 9. 11	30. 26 43
	30	28. 44 7							
The Sun.	27	- - -	- - -	- - -	- - -	- - -	- - -	120. 20. 34	118 47. 54
	28	117. 15. 0	115. 41. 52	114. 8. 30	112. 34. 53	111. 1. 2	109 26. 56	107. 52. 36	106. 18. 1
	29	104. 43. 12	103. 8. 8	101. 32. 48	99 57. 14	98. 21. 23	96 45. 21	95. 9. 1	93. 32. 27
	30	91. 55. 37	90. 18. 32	88. 41. 13	87. 3. 38	85. 25. 49	83. 47. 45	82. 9. 25	80. 30. 51
	J. 1	78. 52 2							

X. JUNE 1804.

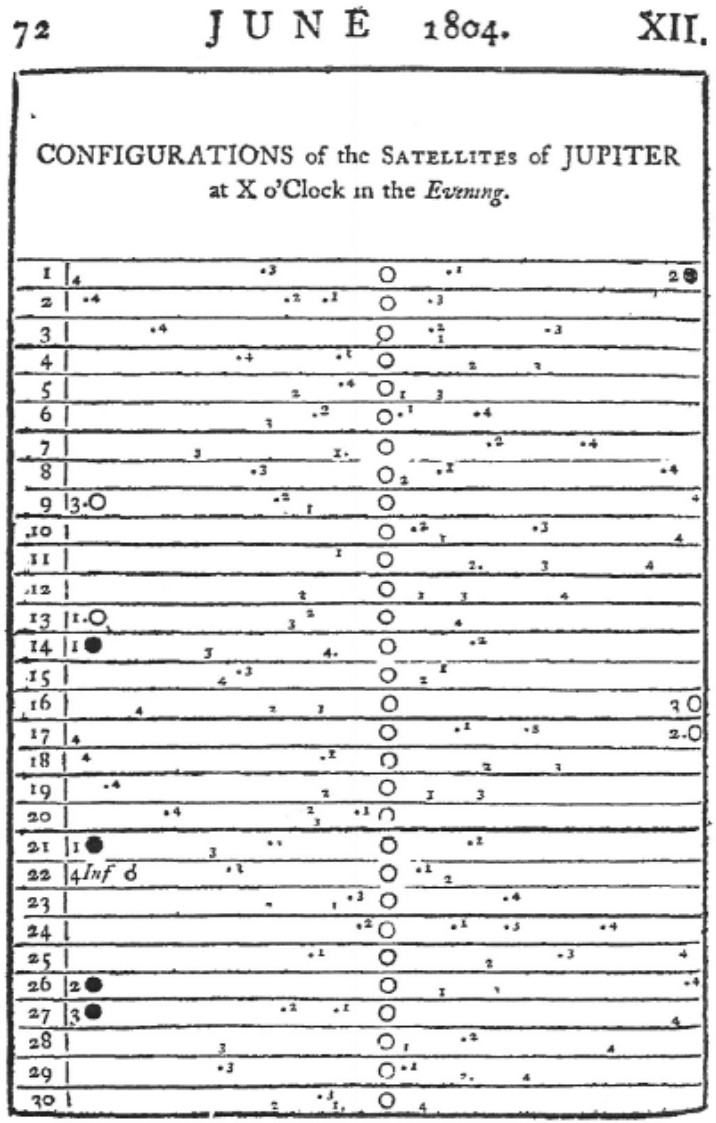
DISTANCES of MOON's *Center* from SUN, and from STARS *WEST* of her.

Stars Names.	Days	Noon.	IIIh.	VIh.	IXh.	Midnight.	XVh.	XVIIIh.	XXIh.
		D M S	D. M. S.	D M S	D. M. S.	D M. S.	D M. S.	D M S	D. M. S.
Antares	1	95 29. 0	97 11 9	98. 53 32	100 36. 17	102 19. 23			
α Aquilæ.	1	- - -	- - -	- - -	- - -	54 0. 30	55. 22 38	56 45 42	58. 9 49
	2	50. 34. 52	61. 0. 52	62. 27 41	63. 55. 21	65 23. 51	66 52 4	68. 22. 30	69. 53 33
	3	71. 24. 49	72. 56 41	74 29 5	76. 2. 2	77. 35. 31	79 9 28	80. 43. 51	82. 18 39
	4	83. 53. 50							
α Pegasi.	4	36. 9. 4	37. 47. 28	39. 20 57	41. 7. 26	42 48. 51	44 31. 10	46 14. 12	47. 57. 58
	5	49. 42. 27	51. 27 27	53. 12. 57	54 58. 55	56. 45. 22	58 32 11	60 19. 19	62. 6. 45
	6	63. 54. 25							
The Sun.	10	- - -	- - -	- - -	39 34. 47	41. 11. 55	42. 48. 39	44. 25. 0	46. 0 56
	11	47 36. 28	49. 11 35	50. 46 17	52. 20. 34	53. 54. 26	55. 27. 53	57. 0. 36	58. 33. 34
	12	60 5. 47	61. 37 35	63. 9. 0	64 40. 0	66. 10. 37	67 40. 50	69. 10. 41	70 40 10
	13	72 9. 16	73 38. 1	75. 6. 24	76. 34. 27	78 2. 9	79 29 30	80. 56. 33	82. 23. 16
	14	83 49. 41	85 15. 48	86. 41. 38	88. 7. 11	89. 32. 27	90. 57 28	92. 22 14	93 46. 46
	15	95. 11. 3	96. 35. 6	97. 58. 56	99. 22. 34	100. 45. 59	102. 9. 14	103. 32. 18	104. 55. 12
	16	106. 17. 56	107. 40. 31	109. 2. 57	110. 25. 16	111. 47 26	113. 9. 29	114 31. 2,	115. 53. 18
	17	117. 15. 4	118. 36. 45	119. 58. 22	121. 19. 55	122. 41. 25			



XI. JUNE 1804. 71

Stars Names.	Day	Noon.	IIIh	VIh.	IXh.	Midnight	XVh.	XVIIIh	XXIh.
		D. M. S	D. M. S.	D. M. S.	D. M. S.	D. M. S.	D. M S.	D. M. S.	D. M. S.
Regulus.	14	- - -	- - -	- - -	- - -	26. 21. 46	27 53 45	29. 25. 29	30. 57. 1
	15	32. 28. 19	33. 59. 25	35. 30. 19	37. 1. 2	38. 31. 33	40. 1. 54	41 32 0	43. 2. 8
	16	44. 32. 1	46. 1. 44	47. 31. 20	49. 0. 48	50. 30. 9	51 59 23	53. 28. 32	54. 57. 35
	17	56 26. 33	57. 55. 26	59 24. 16	60. 53. 2	62. 21 44	63. 50. 23	65. 19 1	66. 47. 37
	18	68 16. 11	69 44. 45	71 13 18	72. 41. 52	74. 10. 27			
Spica Vgi	18	- - -	- - -	- - -	- - -	20. 15. 24	21. 43. 9	23. 11. 1	24 39 0
	19	26 7. 5	27. 35. 17	29. 3 35	30. 31. 59	32. 0. 29	33 29. 5	34. 57. 47	36 26. 35
	20	37. 55. 30	39. 24. 31	40. 53. 38	42. 22. 53	43. 52. 14	45. 21. 43	46. 51. 19	48 21. 2
	21	49. 50 53	51. 20. 51	52. 50 57	54. 21. 12	55. 51. 34	57 22 5	58. 52 46	60. 23 34
	22	61 54. 32	63 25. 39	64. 56. 54	66 28. 19	67. 59. 53			
Antares.	22	- - -	- - -	- - -	- - -	22. 8 46	23. 40. 38	25. 12. 40	26. 44. 51
	23	28. 17. 12	29 49 43	31. 22. 25	32 55. 15	34. 28. 16	36. 1 27	37. 34 48	39. 8 20
	24	40. 42. 2	42. 15. 55	43. 49 58	45 24. 13	46. 58. 38	48. 33. 15	50. 8. 2	51. 43. 1
	25	53. 18. 11	54. 53. 32	56. 29. 4	58. 4. 47	59. 40. 42	61. 16. 49	62. 53. 8	64. 29. 39
	26	66. 6 22	67. 43 17	69 20. 24	70. 57. 43	72. 35. 15	74 12. 59	75. 50 56	77 29. 5
	27	79. 7. 27	80 46 2	82. 24. 51	84. 3. 52	85 43. 7	87. 22. 35	89. 2. 17	90. 42. 13
	28	92. 22 22	94 2. 45	95 43 22	97. 24. 14	99 5. 19			
α Aquilæ	28	- - -	- - -	- - -	- - -	51. 22. 41	52. 41. 29	54. 1 20	55. 22 10
	29	56. 49. 58	58. 6. 41	59. 30. 13	60. 54. 34	62. 19. 43	63. 45. 34	65. 12. 4	66. 39. 12
	30	68. 6. 59	69. 35. 19	71. 4. 10	72 33. 31	74 3. 24	75. 33 43	77. 4. 28	78. 35 37
	J. 1	80. 7. 8							



72 JUNE 1804. XII.

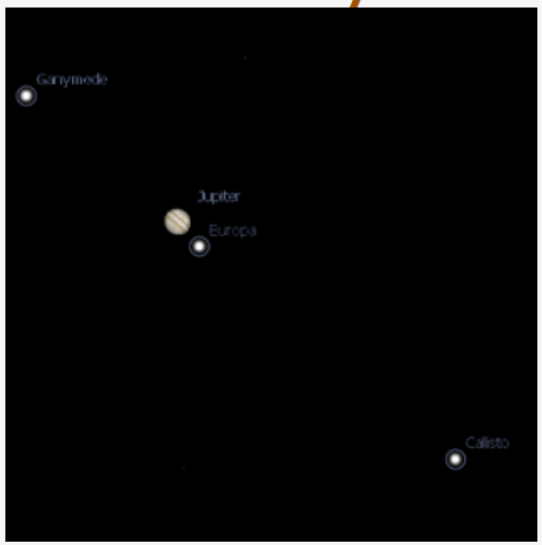
CONFIGURATIONS of the SATELLITES of JUPITER at X o'Clock in the *Evening*.

This page shows the relative positions of the four largest moons of Jupiter . Since the orbital radius of each moon is different, so are their orbital periods. Since Jupiter is so far away from earth, parallax isn't an issue. Hence, the view of the moons is the same from different points on earth, and the relative positions of the different moons are like the hands on a clock.

Viewing Jupiter's largest moons

Sunday, September 26, 2010

Seeing Jupiter's Moons with the Unaided Eye.



Left image, Jupiter at 11:00 pm on Monday 27 September; Right image, Orientation of the Moons, Callisto will be to the right and below Jupiter, Ganymede will ne up and to the left.

It is not commonly known, but Jupiter's moons are bright enough to be seen with the unaided eye. However, they are so close to bright Jupiter that the intensity of it's light (and the optical imperfections of our eyes), makes it impossible to see them except under special circumstances).

At opposition bright Ganymede (mag 4.6) and Callisto (mag 5.7) can be far enough away from Jupiter to see when they are at their maximum distance from Jupiter in their orbits. Jupiter's light will still probably obscure them for all but those with the most sensitive vision. However, if you use a wall or post to just block out Jupiter's light, you should see them pop into view.

http://astroblogger.blogspot.com/2010/09/seeing-jupiters-moons-with-unaided-eye.html

Assignment 10.2

1. Compare your result for the equation of time correction from assignment 10.1 with the corresponding entry in the 1804 Almanac.
2. Compare your result for the lunar distance computation from assignment 10.1 with the corresponding entry in the 1804 almanac.
3. Plot the lunar distance as a function of time for June 1804 on the same graph as a plot of GHA♈ for the same period of time.
4. Comment on your results with respect to the use of the lunar distance for determining GHA♈.

End of Mod 10B