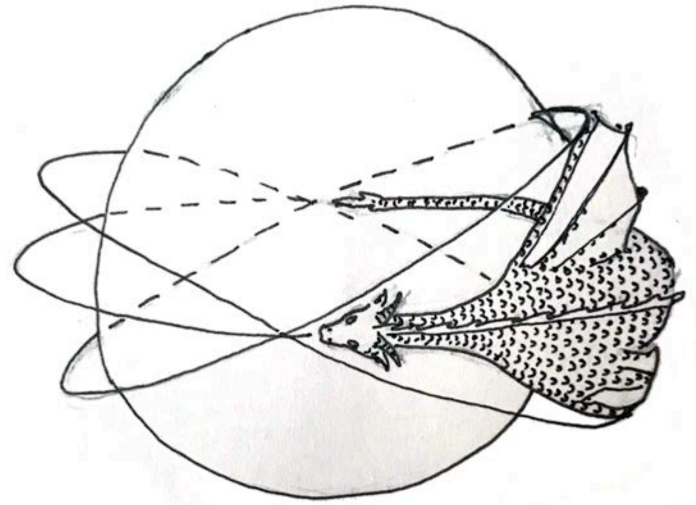
QUADRIVIUM

ASSIGNMENT 13A:
ASTRO-4

FOR

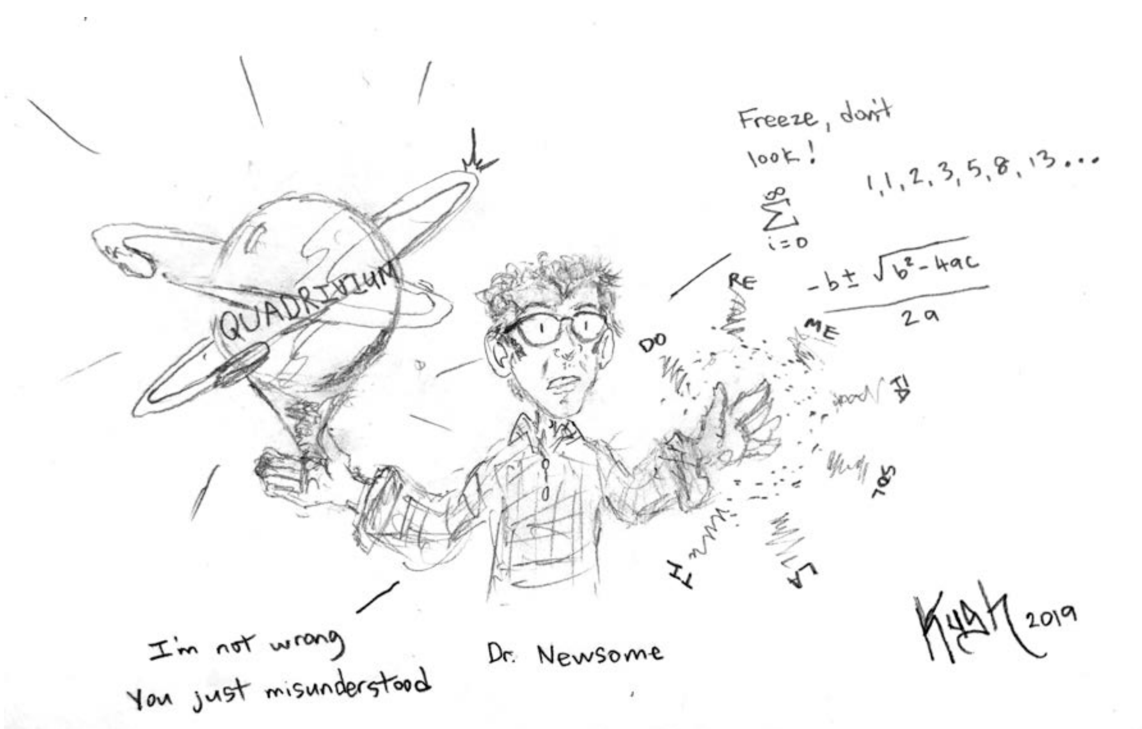
-ANNANDALE- TUESDAY, APRIL 30TH
OR
-FISHKILL- WEDNESDAY, MAY 8TH



"...when the moon at full is in the head or tail of the dragon beneath the nadir of the sun, then the earth is interposed between sun and moon, and the cone of the earth's shadow falls on the body of the moon."

-Sacrobosco on the lunar eclipse.
Izzy's interpretation.

From Grant's Sourcebook (in the Reader, Volume II). -Read Ch. 66, Oresme's "Attack on Astrology" (pp. 488-494). -Read Ch. 67, "On the Possible Diurnal Rotation of the Earth" and Ptolemy's "The Immobility of the Earth in the Center of the World" (pp. 494-495). -Read Ch. 67, Oresme's "The Compatibility of the Earth's Diurnal Rotation..." (pp. 503-510).
-Read Chapters 1 and 2 from Yoko Ogawa's *The Housekeeper and the Professor*. [You bought this at the bookstore (I presume).]
-Do the attached homework.



HW-13a

Canones de motibus & Tabulae Mediorum Motuum...

- Canon of Motions & Tables of Mean Motions...

by Prosdocimo de Beldemandis (ca. 1370-1428)

folio15r from MS-2284-Bologna- Bib. Universitaria.

Esiduum tabule mediorum motuum planetarum annis christi expansis ab unitate asque ad 28

Likewise, the table of mean motions of the planets for the years of christ expanding from unity [1] to 28.

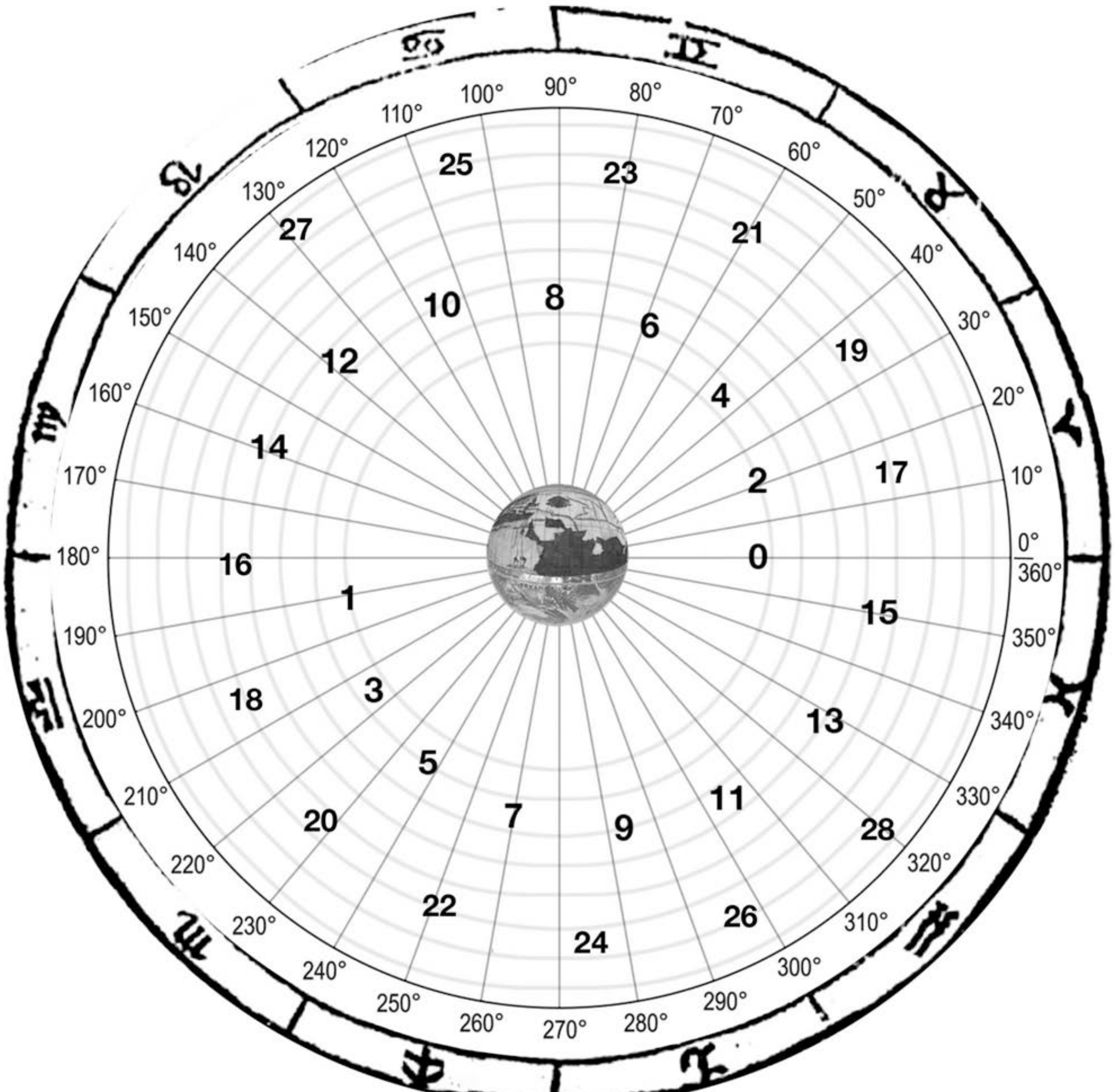
Mediꝰ motꝰ Martis Mean Motion of Mars				Modern Analysis			
sign= 60º	1º	1/60º	1/3600º				
sig.	Grad.	min.	sec.	Year	Conversion to degrees in decimal notation	Year-to-Year Difference	
o	o	o	o	0	0.0000		
3	11	17	5	1	191.2847	$Year_1 - Year_0 =$	191.2847
o	22	34	10	2	22.5694	$Year_2 - Year_1 =$	191.2847
3	33	51	16	3	213.8544	$Year_3 - Year_2 =$	191.2850
o	45	39	48	4	45.6633	$Year_4 - Year_3 =$	191.8089
3	56	56	53	5	236.9481	$Year_n - Year_{n-1} =$	191.2848
1	8	13	58	6	68.2328	$Year_n - Year_{n-1} =$	191.2847
4	19	31	3	7	259.5175	$Year_n - Year_{n-1} =$	191.2847
1	31	19	35	8	91.3264	$Year_n - Year_{n-1} =$	191.8089
4	42	36	40	9	282.6111	$Year_n - Year_{n-1} =$	191.2847
1	53	53	46	10	113.8961	$Year_n - Year_{n-1} =$	191.2850
5	5	10	51	11	305.1808	$Year_n - Year_{n-1} =$	191.2847
2	16	59	23	12	136.9897	$Year_n - Year_{n-1} =$	191.8089
5	28	16	27	13	328.2742	$Year_n - Year_{n-1} =$	191.2844
2	39	33	33	14	159.5592	$Year_n - Year_{n-1} =$	191.2850
5	50	50	38	15	350.8439	$Year_n - Year_{n-1} =$	191.2847
3	2	39	10	16	182.6528	$Year_n - Year_{n-1} =$	191.8089
o	13	56	15	17	13.9375	$Year_n - Year_{n-1} =$	191.2847
3	25	13	21	18	205.2225	$Year_n - Year_{n-1} =$	191.2850
o	36	30	26	19	36.5072	$Year_n - Year_{n-1} =$	191.2847
3	48	18	58	20	228.3161	$Year_n - Year_{n-1} =$	191.8089
o	59	36	3	21	59.6008	$Year_n - Year_{n-1} =$	191.2847
4	10	53	8	22	250.8856	$Year_n - Year_{n-1} =$	191.2847
1	22	10	14	23	82.1706	$Year_n - Year_{n-1} =$	191.2850
4	33	58	45	24	273.9792	$Year_n - Year_{n-1} =$	191.8086
1	45	15	51	25	105.2642	$Year_n - Year_{n-1} =$	191.2850
4	56	32	56	26	296.5489	$Year_n - Year_{n-1} =$	191.2847
2	7	50	1	27	127.8336	$Year_n - Year_{n-1} =$	191.2847
5	19	38	33	28	319.6425	$Year_n - Year_{n-1} =$	191.8089
						Average:	**191.4207**

Here we see the median motion of Mars over 28 years. This is the general motion of Mars on its deferent. Recall that the deferent is the circle that carries the epicycles of Mars. It "ferries" all the Martian geometrical apparatus. The modern analysis converts all the sexagesimal numbers to modern decimal degrees, finds the angular motion per year, and then averages this angular motion.

Mars' average orbital velocity on the deferent is ca. 191.42º per year. Using the Rule of 3 you can figure out how many years for a full orbit, its orbital period.

$$\frac{191.42°}{1\,year} = \frac{360°}{x} \quad \rightarrow \quad x \cong 1.881\,years \quad \rightarrow \quad 1.881(365.25) \cong\ 687\,days.$$

The modern measurement for the period for Mars' orbit around the sun is... you guessed it... 687 days.
Medieval astronomy was pretty accurate.



In this chart the earth is in the center and the location of Mars is indicated by year: 1st year, 2nd year, 3rd year, etc.
This is where Mars will be within the zodiac on a yearly basis over a span of 28 years.
The radial distance of Mars is not accurately indicated in this chart.
The numbers spiral out so that their angular pattern can be seen and
so that the numbers don't have to be written on top of each other.

13a: Homework Assignment

Figure out the orbital period of Venus in years and then in days from the following data.

DATA FROM ALFONSINE TABLE						
Sexagesimal						
A	B	C	D	E	F	G
60^2 3600º	60^1 60º sig.	60^0 1º Grad.	Year	Angular rotation in Degrees (in decimal)	Difference in Degrees (decimal) $degrees_{year\ n} - degrees_{n-1}$	Location on Diagram
0	3	45	I	225º	n.a.	225º
0	13	30	II			
0	23	15	III			
0	33	0	IV	1980º		
0	42	45	V	2565º	585º	45º
0	52	30	VI			
1	02	15	VII			
1	12	1	VIII		586º	
1	21	46	IX			
1	31	31	X	5491º		91º
1	41	16	XI			
1	51	2	XII			
					Average:	

Instructions

1) Finish Column E: Convert the Sexagesimal angles into decimal angles.
E.g. In year 5→ 42:45 = 42(60º) + 45(1º) = 2565º. Put your results in column E.
Note: I converted the original manuscript data in Columns A, B, and C into rotation angles.
For example a resultant decimal angle measuring 2565º is 7 complete rotations plus 45º, $7\times 360° + 45°$.

2) Finish Column F: Figure out the angular difference from one year to the next by subtracting each year's angular rotation from the previous year.
E.g. Year 5 differs from year 4 → 2565º – 1980º = 585º. Put these results in column F.

3) Finish Column G and plot points: Locate Venus on the diagram below. Here's how....For year 5, the angle of rotation [column E] is 2565º. To figure out where that is on a 360º diagram, just divide 2565º by 360. The result is 7.125. Venus completed 7 rotations and 0.125 more. The location on the diagram is just the 0.125 part. 0.125 times 360º is the location.

$$0.125(360°) = \mathbf{45}°.$$

Then plot these points with the year-number on the diagram below. I plotted a few to show you how.

Another way to find the location is to take the angle of rotation from column D and subtract 360º over and over again until you get a number below 360º.

$$\text{E.g. } 2565° - 360 - 360 - 360 - 360 - 360 - 360 - 360 = 45°.$$

or

$$2565° - 7(360°) = 45°$$

4) Determine the length of time it takes Venus to complete one orbit. First find the average of all the differences of column F. This is the average angular rotation of Venus per year. Use the Rule of 3 to figure out how long it takes Venus to complete one (360º) rotation.

$$\frac{Column\ F\ Average}{1\ year} = \frac{360°}{x} \quad \rightarrow \quad x \cong \qquad\qquad years \quad \rightarrow \quad x(365.25) \cong \qquad\qquad days.$$

Compare this orbital period with the modern value for the orbital period of Venus. Look it up.

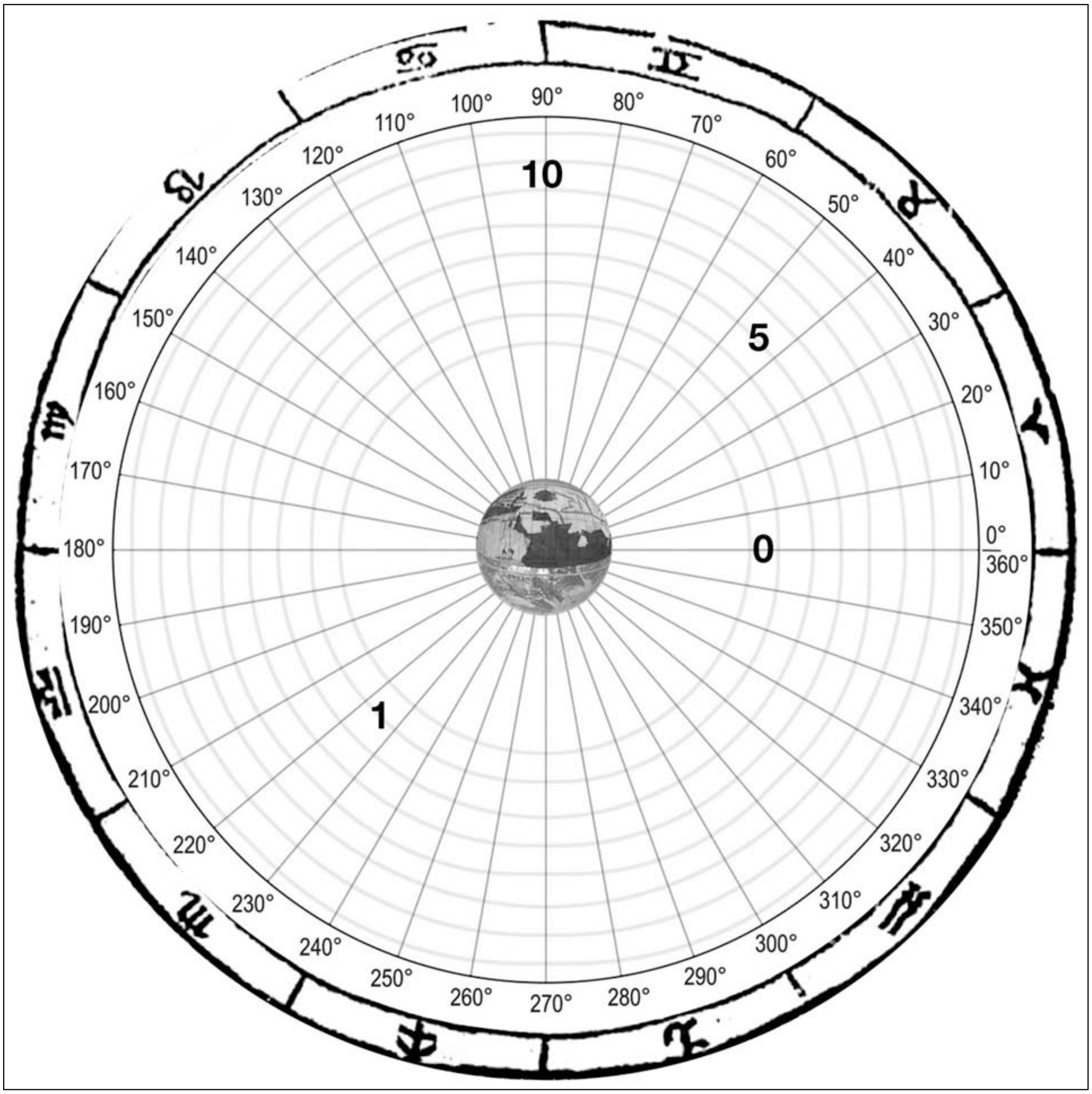


Diagram of where Venus will be seen within the zodiac every year over a span of 12 years.