

Mathematics HL Internal Assessment

Predicting the amount of daylight hours based on latitude

Candidate Number

Exam Session: May 2020

Rationale

This mathematical exploration will investigate the number of daylight hours for any latitude on the earth using the application of trigonometric functions and vector equations. I decided to focus on the topic of daylight hours when I went to visit my older sister studying in Rotterdam, Netherlands. I quickly realised and was surprised by the difference in the number of daylight hours that Rotterdam receives during the summer compared to where I live, in Turin, Italy.

My initial thought was to model the amount of daylight hours that Rotterdam and Turin receive on the first day of every month for the year of 2018. I did this using a digital application called *GeoGebra* in order to visualise the model. Even though, the difference of daylight hours received by the two cities wasn't radical, I was intrigued by the idea that daylight hours vary based on any and each specific location on this Earth. After consulting my teacher a question came to mind: Would it be possible to predict the amount of daylight hours any location receives based on its latitude? In order to answer my question, I not only need my knowledge and skills on trigonometry and vectors, but also analytic geometry, which is not part of the syllabus. Furthermore, this exploration will challenge me to improve my skills on writing mathematical proofs, performing operations with trigonometric functions, vectors and planes, and graphing and modeling data. Finally I will be applying my findings to a specific and real location, using the latitude of Turin and comparing it to the data from "*timeanddate.com*".

Introduction

Sunlight is a phenomenon that everyone experiences on a regular basis. It is the solar radiation that is visible at the Earth's surface and depends on the extent of the daytime cloud cover (britannica). Some places on Earth, such as the Sahara, receive more than 4,000 hours of sunlight per year, meanwhile, other places, such as Iceland, only receive 2,000 hours. But why do these two places receive such different amounts of daylight? Sunrise and sunset times are dependent on several factors such as: latitude, longitude, solar declination and the Earth's orbit. The Earth's complete rotation takes exactly 23 hours, 56 minutes and 4 seconds. During this rotation, the

part of the Earth's surface that faces the sun will receive sunlight, meaning that the rest of the Earth's surface, which is not exposed to sunlight will be experiencing what we call "nighttime". A specific location will be receiving sunlight, from sunrise, when the sun appears and rises above the horizon, to sunset, when the sun goes below the horizon, this time defines the day length for that specific location. One of the factors that impact the amount of daylight received by a certain location is the location itself, more specifically its latitude and longitude, in respect to the Earth's surface as a whole. As I stated previously in the aim of this mathematical exploration, I am going to focus specifically on latitude as a factor of daylight. Latitude is part of the coordinate system of the Earth, which is used to locate each and any place on the Earth's surface. A latitude can be measured North or South of the Equator (that has a latitude of 0°), which is the only latitude known as a "great circle" and has a constant day length of approximately 12 hours. Depending on the time of the year, when the latitude is 90° North or South of the equator, the day length increases to 24 hours or decreases to 0, these are the day length of the polar circles. In total there are 180 imaginary lines, parallel to the equator, that form circles around the Earth (*National Geographic*).

In order to predict the sunrise and sunset of a specific location on a day of the year, this mathematical exploration will use a published research called "Predicting Sunrise and Sunset Times" by Donald A. Teets. Moreover I will explain and show the mathematical proof of the formulas that have been used, as well as test and model the results, predicting the day length of a specific location's latitude throughout a whole year.

Predicting Sunrise and Sunset of a given day of the year

As previously mentioned, to predict sunrise and sunset times a set skills in trigonometry and analytic geometry are required. In mathematics analytic geometry, also known as coordinate geometry, connects algebraic equations with geometric curves (Bix et al.). Figure 1, below, is a simple representation of the *geocentric equatorial coordinate system* and its correlation in respect to the sun is shown in Figure 2 on the xy-plane.

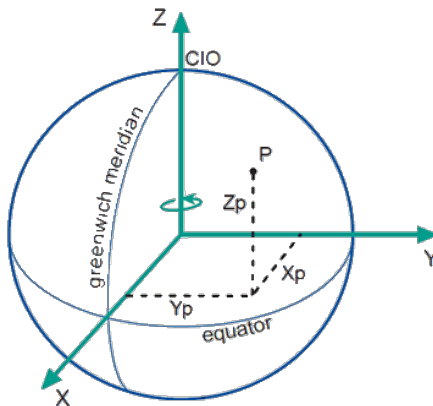


Figure 1

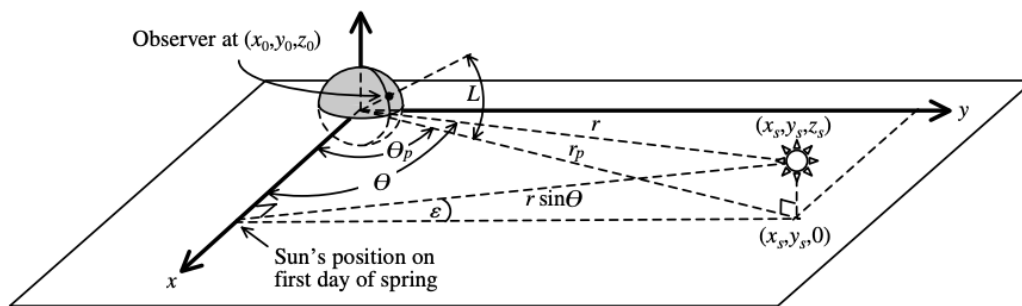


Figure 2

The geocentric equatorial coordinate system is the projection of latitude and longitude coordinate system onto the celestial sphere (*Astronomyswin*). Firstly it is important to understand clearly what the notations represent:

ε = is the inclination between the xy-plane and the *ecliptic plane*. The “ecliptic” is the path of the sun’s motion on the celestial sphere as seen from the Earth (*Hyperphysics*). The Earth’s spin axis is tilted approximately 23.5° with respect to its orbit around the sun, thus: $\varepsilon = 23.5^\circ$

Θ_p = is the angle between the projection vector $(x_s, y_s, 0)$ and the positive x-axis

r = the length of the earth-sun vector (x_s, y_s, z_s)

Θ = is the angle between the positive x-axis and r

r_p = the length of the projection vector $(x_s, y_s, 0)$

L = is the latitude. On this coordinate system the lines of declination (in degrees), indicate how far the observer's latitude is from the equator (*Astronomyswin*).

R = radius of the earth, which is 6378 km

At noon the sun (x_s, y_s, z_s) is directly above the observer's meridian (x_0, y_0, z_0) . Even though, in most cases, it does not occur at 12 o'clock, this phenomenon is known as the "solar noon", and it is the moment when the sun reaches its highest position in the sky and passes a location's meridian. The meridian is an imaginary line on the Earth's surface, that connects all locations that have the same longitude from the North to the South Pole. The line that passes through our observer's location is it's local meridian (*Timeanddate*).

This point can be calculated using the "*standard spherical coordinate conversion*" in the following way:

$$x_0 = R \cos(L) \cos(\Theta_p)$$

$$y_0 = R \cos(L) \sin(\Theta_p)$$

$$z_0 = R \sin(L)$$

If we take into account that the earth rotates 360° or 2π in 24 hours, or 1440 minutes, the coordinates of the observer on the meridian, t -minutes before or after noon, will equal to:

$$x_0 = R \cos(L) \cos(\Theta_p + \frac{2\pi}{1440}t)$$

$$y_0 = R \cos(L) \sin(\Theta_p + \frac{2\pi}{1440}t)$$

$$z_0 = R \sin(L)$$

where, $t < 0$ before noon and $t > 0$ after noon.

Another important factor that needs to be considered is the time zone that corresponds to the observer's location. To simplify this discussion we will assume that the observer is found on standard time meridian otherwise known as Greenwich Mean time. In this case, when the sun is at its highest point above the Prime Meridian, it is noon at Greenwich.

The vector (x_0, y_0, z_0) is the normal vector for the plane tangent to the earth's surface at the observer's location.

Tangent of the plane: $x_0(x - x_0) + y_0(y - y_0) + z_0(z - z_0)$

Thus, from the observer's perspective, the sun is below the plane before sunrise and above the plane after the sunrise, and vice versa for the sunset. This interpretation is helpful because it means that the beginning of a sunrise or the end of a sunset will occur when the center of the sun aligns with the tangent plane. Thus:

$$x_0(x_s - x_0) + y_0(y_s - y_0) + z_0(z_s - z_0)$$

If we recall from the unit circle, the equation of a circle corresponds to $x^2 + y^2 = r^2$, similarly on with three dimensions, the equation of a sphere is:

$$x_0^2 + y_0^2 + z_0^2 = R^2$$

$$= x_0x_s + y_0y_s + z_0z_s = R^2$$

Substitute (x_0, y_0, z_0) :

$$= x_s R \cos L \cos(\theta_p + \frac{2\pi}{1440}t) + y_s R \cos L \sin(\theta_p + \frac{2\pi}{1440}t) + z_s R \sin L = R^2$$

In order to find the amount of minutes after the solar noon when the sunset takes place, solve for t:

$$= x_s R \cos L \cos(\theta_p + \frac{2\pi}{1440}t) + y_s R \cos L \sin(\theta_p + \frac{2\pi}{1440}t) = R^2 - z_s R \sin L$$

$$= R \cos L (x_s \cos(\theta_p + \frac{2\pi}{1440}t) + y_s \sin(\theta_p + \frac{2\pi}{1440}t)) = R^2 - z_s R \sin L$$

$$= x_s \cos(\theta_p + \frac{2\pi}{1440}t) + y_s \sin(\theta_p + \frac{2\pi}{1440}t) = \frac{R^2 - z_s R \sin L}{R \cos L} = \frac{R - z_s \sin L}{\cos L}$$

Using compound angle identities:

$$x_s (\cos(\theta_p) \cos(\frac{2\pi}{1440}t) - \sin(\theta_p) \sin(\frac{2\pi}{1440}t)) + y_s (\sin(\theta_p) \cos(\frac{2\pi}{1440}t) + \cos(\theta_p) \sin(\frac{2\pi}{1440}t)) = \frac{R - z_s \sin L}{\cos L}$$

Pythagoras and sine and cosine identities:

- $\cos(\theta_p) = \frac{x_s}{r_p}$
- $\sin(\theta_p) = \frac{y_s}{r_p}$
- $r_p = \sqrt{r^2 - z_s^2}$
- $r_p^2 = x_s^2 + y_s^2$

After substituting these into the equation:

$$x_s ((\frac{x_s}{r_p}) \cos(\frac{2\pi}{1440}t) - (\frac{y_s}{r_p}) \sin(\frac{2\pi}{1440}t)) + y_s ((\frac{y_s}{r_p}) \cos(\frac{2\pi}{1440}t) + (\frac{x_s}{r_p}) \sin(\frac{2\pi}{1440}t)) = \frac{R - z_s \sin L}{\cos L}$$

$$= \frac{x_s^2}{r_p} \cos(\frac{2\pi}{1440}t) - \frac{x_s y_s}{r_p} \sin(\frac{2\pi}{1440}t) + \frac{y_s^2}{r_p} \cos(\frac{2\pi}{1440}t) + \frac{x_s y_s}{r_p} \sin(\frac{2\pi}{1440}t) = \frac{R - z_s \sin L}{\cos L}$$

$$= \frac{x_s^2}{r_p} \cos(\frac{2\pi}{1440}t) + \frac{y_s^2}{r_p} \cos(\frac{2\pi}{1440}t) = \frac{R - z_s \sin L}{\cos L}$$

$$= \cos(\frac{2\pi}{1440}t) (\frac{x_s^2}{r_p} + \frac{y_s^2}{r_p}) = \frac{R - z_s \sin L}{\cos L}$$

$$= \cos(\frac{2\pi}{1440}t) = \frac{R - z_s \sin L}{\cos L} \times \frac{r_p}{x_s^2 + y_s^2}$$

$$= \cos(\frac{2\pi}{1440}t) = \frac{R - z_s \sin L}{\cos L} \times \frac{r_p}{r_p^2}$$

$$= \cos(\frac{2\pi}{1440}t) = \frac{R - z_s \sin L}{r_p \cos L}$$

$$= \frac{2\pi}{1440} t = \cos^{-1} \left(\frac{R - z_s \sin L}{r_p \cos L} \right)$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1} \left(\frac{R - z_s \sin L}{r_p \cos L} \right)$$

t_0 represents the amount of minutes after the solar noon when the sunset takes place, thus $-t_0$ represents the amount of minutes before the solar noon when the sunrise takes place. In order to calculate the total daylight received by the location of the observer: $t_0 + (-t_0)$.

Predicting the Day length of Torino, Italy

In order to apply this concept to a real and specific location, I will be calculating an approximation of the day length for Torino that has a latitude of 45° North, during a random day of the year, which in this case will be the 8th of May.

Assuming that the Earth's orbit around the sun is circular instead of elliptical r will be approximately 149598000 and $\theta = \frac{2\pi}{365.25}(d - 80)$, d is the day of the year.

L = latitude of Turin, Italy which is 45° North (0.785 radians)

d = 8th of May which is the 128th day of the year

$$\theta = \frac{2\pi}{365.25}(128 - 80) =$$

$$\theta = \frac{2\pi}{365.25}(48) = \frac{301.593}{365.25} = 0.8257$$

$$Z_s = r \times \sin \theta \times \sin \epsilon$$

$$Z_s = 149598000 \times \sin(0.8257) \times \sin(0.409)$$

$$Z_s = 149598000 \times 0.7558 \times 0.3977 = 4.3729 \times 10^7$$

$$r_p = \sqrt{r^2 - Z_s} = \sqrt{(149598000)^2 - (43728916.59)^2} = 1.4306 \times 10^8$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1}\left(\frac{R - z_s \sin L}{r_p \cos L}\right) = \frac{1440}{2\pi} \cos^{-1}\left(\frac{6378 - z_s \sin(0.785)}{r_p \cos(0.785)}\right)$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1}\left(\frac{6378 - (43728916.59)\sin(0.785)}{(143064123.6)\cos(0.785)}\right)$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1}(-0.3053532259)$$

$$t_0 = \frac{1440}{2\pi} \times 1.881105676$$

$$t_0 \approx 431 \text{ minutes}$$

Correction of 5 minutes = 436 minutes

436 minutes \approx 7 hours and 15 minutes

Thus, from the results achieved, on the 8th of May, sunrise in Torino should occur at 4:45 am and sunset at 7:15 pm, resulting in a day length of 14 hours and 30 minutes. However, according to “timeanddate.com” these results are proven partially incorrect, as the sunrise in Torino, on the 8th of May, would actually occur at 6:09 am and sunset at 8:43 pm, resulting in a day length of 14 hours and 33 minutes. I noticed that even though the sunrise and sunset times between my results and the ones from the source are significantly different, the overall day lengths only differ by 3 minutes.

Still assuming that the Earth’s orbit around the sun is circular, when $d = 80$ the sun will be directly on the x axis. Meaning that on March 21, when the March equinox occurs, the distance between the Earth and the Sun is about 149.6 km, which is closer to our approximation of $r = 149598000$ km, and the prediction of sunrise and sunset should be more accurate.

$d = 21$ st of March which is the 80th day of the year and the 1st day of spring

$$\theta = \frac{2\pi}{365.25}(80 - 80) =$$

$$\theta = \frac{2\pi}{365.25}(0) = 0$$

$$Z_s = r \times \sin \theta \times \sin \varepsilon = 0$$

$$r_p = \sqrt{r^2 - Z_s} = \sqrt{(149598000)^2 - (0)^2} = r = 149598000$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1}\left(\frac{R - z_s \sin L}{r_p \cos L}\right) = \frac{1440}{2\pi} \cos^{-1}\left(\frac{6378}{(149598000) \cos(0.785)}\right)$$

$$t_0 = \frac{1440}{2\pi} \cos^{-1}\left(\frac{6378}{105823870.3}\right)$$

$$t_0 = \frac{1440}{2\pi} \times 1.570736057$$

$$t_0 \approx 360 \text{ minutes}$$

Correction of 5 minutes = 365 minutes

365 minutes \approx 6 hours and 5 minutes

In this case, sunrise should occur at 5:55 am and sunset at 6:05 pm, resulting in a day length of 12 hours and 10 minutes. Similarly to the results obtained in the previous example, according to the same source previously used, our results are still partially incorrect. The sunrise in Torino, on the 21st of March, actually occurs at 6:31 am and sunset at 6:42 pm, resulting in a day length of 12 hours and 11 minutes. In this case, however, the result of the day length I obtained only differs by 1 minute with the actual day length for that day.

The table below shows prediction of the day length and the actual day length for the first and last 20 days of the year in Torino. *APPENDIX B* shows the full table for the day length for each day of the year.

Day of the year	Prediction	Actual Day Length	Difference
1	8.50	8.29	-0.21
2	8.51	8.5	-0.01
3	8.52	8.51	-0.01
4	8.54	8.52	-0.02
5	8.55	8.53	-0.02
6	8.56	8.55	-0.01
7	8.57	8.56	-0.01
8	8.59	8.57	-0.02
9	9.00	8.59	-0.01
10	9.02	9.0	-0.02
11	9.03	9.02	-0.01
12	9.05	9.03	-0.02
13	9.06	9.05	-0.01
14	9.08	9.07	-0.01
15	9.10	9.08	-0.02
16	9.12	9.1	-0.02
17	9.14	9.12	-0.02
18	9.16	9.14	-0.02
19	9.18	9.16	-0.02
20	9.20	9.18	-0.02

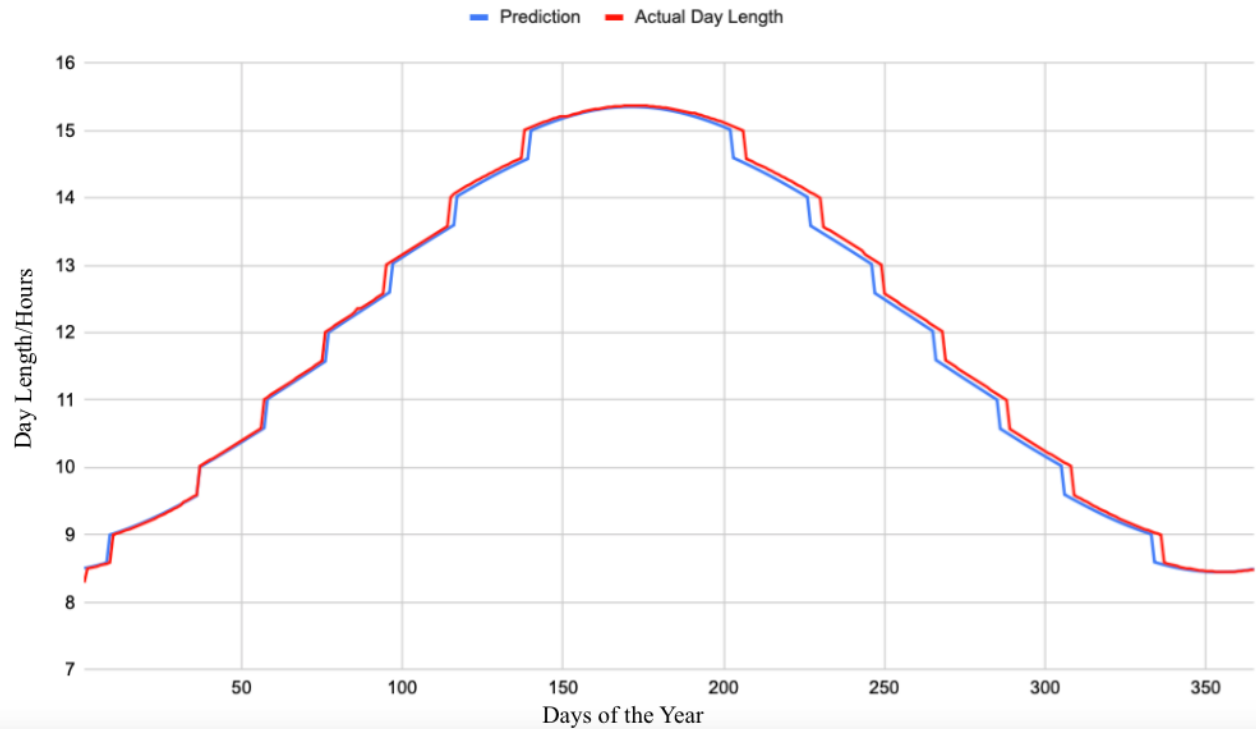
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345	8.48	8.5	0.02
346	8.47	8.49	0.02

347	8.47	8.48	0.01
348	8.46	8.47	0.01
349	8.46	8.47	0.01
350	8.45	8.46	0.01
351	8.45	8.46	0.01
352	8.45	8.46	0.01
353	8.45	8.45	0.00
354	8.45	8.45	0.00
355	8.45	8.45	0.00
356	8.45	8.45	0.00
357	8.45	8.45	0.00
358	8.45	8.45	0.00
359	8.46	8.45	-0.01
360	8.46	8.46	0.00
361	8.47	8.46	-0.01
362	8.47	8.47	0.00
363	8.48	8.47	-0.01
364	8.49	8.48	-0.01
365	8.49	8.48	-0.01

Graph

Day Length for Latitude 45°North

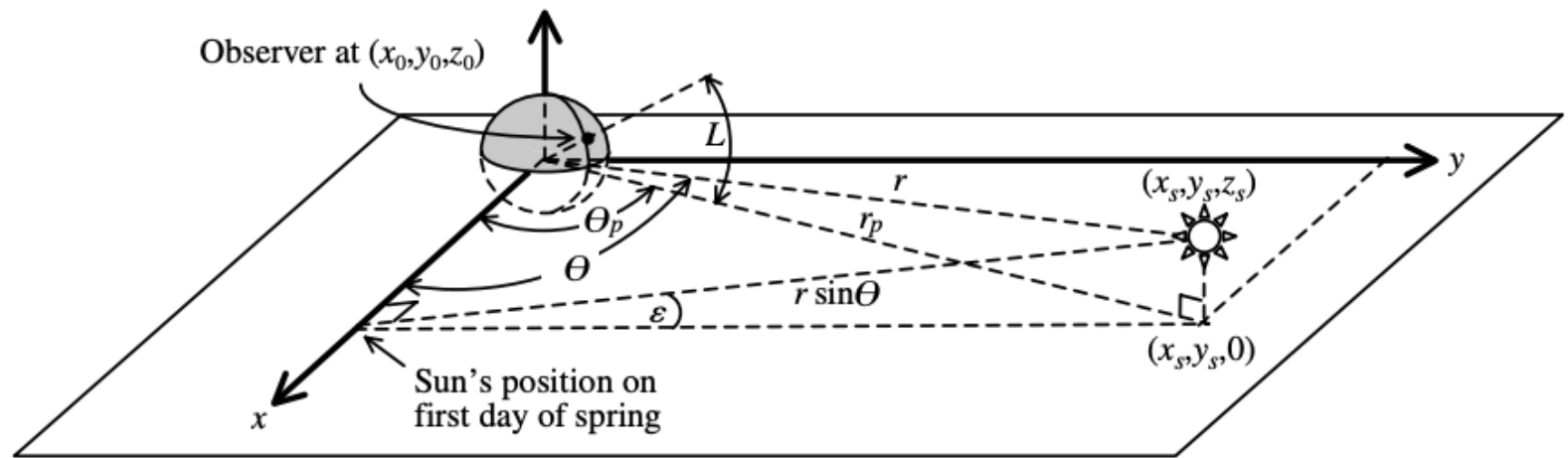


As it can be observed from the table and the graph above, the results obtained using the formula, for Torino's day length over a year span, are similar to the data obtained from the internet source. In both cases, there is a positive relationship between the x-axis and the y-axis, meaning that, as the day of the year increased, the day length also increased. This relationship continues from about day 1 to day 150. The graph then shows that for about 50 days the day length stabilizes before decreasing again towards the initial length for the first day of the year. In order to have a clearer understanding of the difference between my results and the actual day length, I decided to make the decimal values equal to minutes, which explains why the data points from the graph increase to the following hour after ".59" as a decimal, or 59 minutes.

Initially, the graph shows that the data achieved using the formula, is greater than the actual day length for the location, meanwhile towards the end of the year, the actual day length is more significantly, greater than the prediction. I believe this occurred because, by calculating the value of "+t" I was able to find the amount of time, in minutes, after noon when the sunset occurred which was the same as "-t" or the amount of minutes before noon when the sunrise occurred. This can also be seen with the symmetry in my results on the graph between the first and the second half. If we consider the calculation for predicting the day length for Torino on the 8th of May, I only subtracted and added, in this case 6 hours and 5 minutes, from noon. Meanwhile from the data found on the internet, we can clearly see that sunrise occurs 5 hours and 51 minutes before noon and sunset occurs 8 hours and 43 minutes after noon.

Moreover, to a certain extent, in order to enhance the calculation of the day length for a specific location, along with the latitude other factors need to be fully considered, these are: the longitude, solar declination, the Earth's orbit, and the specific time zone of the observer. In this mathematical exploration, due to the complexity of the problem and time constraints, I focused mainly on the latitude. Furthermore, we assumed that the Earth's orbit around the sun was not elliptical but circular, which led to approximating the distance between the Earth and the Sun to $r = 149598000$ km. This meant having more accurate results when the distance between the sun and the Earth was closer to our approximation, for example during the March equinox, and less accurate results, for example during the summer solstice, when the Sun is farther away from the Earth (152.1 million km).

APPENDIX A



APPENDIX B

Day	Theta	Zs	Z_s^2	Rp	R - zsSi nL	rpCo sL	Divis ion	t0 + 5	- t 0 +5	Daylengt h/hours	Prediction
1	-1.35899148 3	-581 6442 3.21	3.38 31E +15	1378 2765 1.4	4111 8456 .97	9749 7663 .73	0.42 1737 8693	265. 2	-255. 2	8.84	8.50
2	-1.34178905 9	-579 4067 5.55	3.35 712 E+1 5	1379 2186 0.9	4096 0306 .49	9756 4306 .48	0.41 9828 808	265. 7	-255. 7	8.86	8.51
3	-1.32458663 6	-576 9978 2.31	3.32 926 E+1 5	1380 2281 2.3	4079 0037 .08	9763 5718 .32	0.41 7777 8152	266. 2	-256. 2	8.87	8.52
4	-1.30738421 2	-574 4181 4.79	3.29 956 E+1 5	1381 3037 1.5	4060 7699 .14	9771 1804 .38	0.41 5586 4217	266. 8	-256. 8	8.89	8.54
5	-1.29018178 8	-571 6684 9.3	3.26 805 E+1 5	1382 4439 5.7	4041 3346 .61	9779 2463 .8	0.41 3256 2473	267. 4	-257. 4	8.91	8.55

6	-1.27297936 4	-568 7496 7.22	3.23 476 E+1 5	1383 6473 4.3	4020 7037 .01	9787 7589 .94	0.41 0788 9971	268. 0	-258. 0	8.93	8.56
7	-1.25577694	-565 6625 4.93	3.19 974 E+1 5	1384 9122 8.6	3998 8831 .38	9796 7070 .52	0.40 8186 4567	268. 6	-258. 6	8.95	8.57
8	-1.23857451 6	-562 4080 3.77	3.16 303 E+1 5	1386 2371 2.2	3975 8794 .31	9806 0787 .87	0.40 5450 4881	269. 3	-259. 3	8.98	8.59
9	-1.22137209 3	-558 9871 0.05	3.12 467 E+1 5	1387 6201 1.4	3951 6993 .85	9815 8619 .1	0.40 2583 0255	270. 0	-260. 0	9.00	9.00
10	-1.20416966 9	-555 4007 5	3.08 47E +15	1389 0594 5.4	3926 3501 .57	9826 0436 .31	0.39 9586 0699	270. 8	-260. 8	9.03	9.02
11	-1.18696724 5	-551 6500 4.75	3.04 318 E+1 5	1390 5532 6.6	3899 8392 .48	9836 6106 .8	0.39 6461 6853	271. 6	-261. 6	9.05	9.03
12	-1.16976482 1	-547 7361 0.29	3.00 015 E+1 5	1392 0996 0.9	3872 1745 .02	9847 5493 .31	0.39 3211 9933	272. 4	-262. 4	9.08	9.05
13	-1.15256239 7	-543 6600 7.44	2.95 566 E+1 5	1393 6964 8.2	3843 3641 .05	9858 8454 .21	0.38 9839 1689	273. 2	-263. 2	9.11	9.06
14	-1.13535997 3	-539 4231 6.81	2.90 977 E+1 5	1395 3418 2.4	3813 4165 .85	9870 4843 .79	0.38 6345 4354	274. 1	-264. 1	9.14	9.08
15	-1.11815755	-535 0266 3.78	2.86 254 E+1 5	1397 0335 2	3782 3408 .02	9882 4512 .4	0.38 2733 0598	275. 0	-265. 0	9.17	9.10
16	-1.10095512 6	-530 4717 8.45	2.81 4E+ 15	1398 7694 0.4	3750 1459 .52	9894 7306 .78	0.37 9004 3483	275. 9	-265. 9	9.20	9.12

17	-1.08375270 2	-525 7599 5.61	2.76 424 E+1 5	1400 5472 6.1	3716 8415 .62	9907 3070 .25	0.37 5161 6411	276. 9	-266. 9	9.23	9.14
18	-1.06655027 8	-520 8925 4.69	2.71 329 E+1 5	1402 3648 2.9	3682 4374 .88	9920 1642 .95	0.37 1207 3085	277. 8	-267. 8	9.26	9.16
19	-1.04934785 4	-515 8709 9.72	2.66 123 E+1 5	1404 2198 1	3646 9439 .1	9933 2862 .09	0.36 7143 7461	278. 8	-268. 8	9.29	9.18
20	-1.03214543	-510 6967 9.29	2.60 811E +15	1406 1098 6.3	3610 3713 .31	9946 6562 .21	0.36 2973 3703	279. 9	-269. 9	9.33	9.20
21	-1.01494300 6	-505 3714 6.53	2.55 4E+ 15	1408 0326 1.4	3572 7305 .75	9960 2575 .39	0.35 8698 614	280. 9	-270. 9	9.36	9.22
22	-0.99774058 26	-499 8965 9.01	2.49 897 E+1 5	1409 9856 5.9	3534 0327 .78	9974 0731 .51	0.35 4321 9229	282. 0	-272. 0	9.40	9.24
23	-0.98053815 88	-494 2737 8.74	2.44 307 E+1 5	1411 9665 6.6	3494 2893 .93	9988 0858 .52	0.34 9845 7507	283. 1	-273. 1	9.44	9.26
24	-0.96333573 5	-488 5047 2.12	2.38 637 E+1 5	1413 9728 7.7	3453 5121 .8	1000 2278 2.6	0.34 5272 5559	284. 2	-274. 2	9.47	9.28
25	-0.946133311 1	-482 5910 9.86	2.32 894 E+1 5	1416 0021 1.6	3411 7132 .07	1001 6632 8.6	0.34 0604 7975	285. 3	-275. 3	9.51	9.31
26	-0.92893088 73	-476 5346 6.95	2.27 085 E+1 5	1418 0517 8.6	3368 9048 .41	1003 1131 9.9	0.33 5844 932	286. 5	-276. 5	9.55	9.33
27	-0.911728463 4	-470 3372 2.62	2.21 217 E+1 5	1420 1193 8	3325 0997 .51	1004 5757 9	0.33 0995 4094	287. 7	-277. 7	9.59	9.35

28	-0.89452603 96	-464 0006 0.25	2.15 297 E+1 5	1422 2023 7.7	3280 3108 .99	1006 0492 7.8	0.32 6058 6703	288. 9	-278. 9	9.63	9.38
29	-0.87732361 58	-457 5266 7.35	2.09 331 E+1 5	1424 2982 4.9	3234 5515 .39	1007 5318 7.3	0.32 1037 1427	290. 1	-280. 1	9.67	9.40
30	-0.860121191 9	-450 9173 5.5	2.03 326 E+1 5	1426 4044 6.6	3187 8352 .11	1009 0217 8.6	0.31 5933 2391	291. 3	-281. 3	9.71	9.43
31	-0.84291876 81	-444 1746 0.29	1.97 291 E+1 5	1428 5184 9.2	3140 1757 .41	1010 5172 2.4	0.31 0749 3537	292. 6	-282. 6	9.75	9.45
32	-0.82571634 42	-437 3004 1.23	1.91 232 E+1 5	1430 6377 9.8	3091 5872 .31	1012 0163 9.6	0.30 5487 8601	293. 8	-283. 8	9.79	9.48
33	-0.80851392 04	-430 2968 1.75	1.85 155 E+1 5	1432 7598 5.7	3042 0840 .6	1013 5175 1.6	0.30 0151 1086	295. 1	-285. 1	9.84	9.50
34	-0.791311496 6	-423 1658 9.1	1.79 069 E+1 5	1434 8821 5.2	2991 6808 .75	1015 0188 0.2	0.29 4741 4245	296. 4	-286. 4	9.88	9.53
35	-0.77410907 27	-415 9097 4.28	1.72 981 E+1 5	1437 0021 7.3	2940 3925 .93	1016 5184 8	0.28 9261 1055	297. 7	-287. 7	9.92	9.55
36	-0.75690664 89	-408 5305 2.03	1.66 897 E+1 5	1439 1174 2.9	2888 2343 .9	1018 0147 8.7	0.28 3712 4201	299. 1	-289. 1	9.97	9.58
37	-0.73970422 51	-401 0304 0.7	1.60 825 E+1 5	1441 2254 4.1	2835 2217 .01	1019 5059 7	0.27 8097 6064	300. 4	-290. 4	10.01	10.01
38	-0.72250180 12	-393 4116 2.24	1.54 773 E+1 5	1443 3237 5.3	2781 3702 .12	1020 9902 9.1	0.27 2418 8698	301. 8	-291. 8	10.06	10.04

39	-0.70529937 74	-385 6764 2.09	1.48 746 E+1 5	1445 4099 2.8	2726 6958 .61	1022 4660 2.7	0.26 6678 3824	303. 1	-293. 1	10.10	10.06
40	-0.68809695 35	-377 8270 9.16	1.42 753 E+1 5	1447 4815 5.4	2671 2148 .25	1023 9314 7.1	0.26 0878 2814	304. 5	-294. 5	10.15	10.09
41	-0.67089452 97	-369 8659 5.72	1.36 801 E+1 5	1449 5362 4.8	2614 9435 .22	1025 3849 3.8	0.25 5020 6684	305. 9	-295. 9	10.20	10.12
42	-0.65369210 59	-361 7953 7.35	1.30 896 E+1 5	1451 5716 5.4	2557 8986 .04	1026 8247 6	0.24 9107 6085	307. 3	-297. 3	10.24	10.15
43	-0.63648968 2	-353 6177 2.87	1.25 045 E+1 5	1453 5854 5.1	2500 0969 .51	1028 2492 9.6	0.24 3141 1294	308. 7	-298. 7	10.29	10.17
44	-0.61928725 82	-345 3354 4.27	1.19 257 E+1 5	1455 5753 4.8	2441 5556 .68	1029 6569 2.6	0.23 7123 2211	310. 1	-300. 1	10.34	10.20
45	-0.60208483 43	-336 9509 6.64	1.13 536 E+1 5	1457 5390 9.3	2382 2920 .79	1031 0460 5.6	0.23 1055 8355	311. 6	-301. 6	10.39	10.23
46	-0.58488241 05	-328 4667 8.09	1.07 89E +15	1459 4744 7.2	2322 3237 .19	1032 4151 2.1	0.22 4940 886	313. 0	-303. 0	10.43	10.26
47	-0.56767998 67	-319 8853 9.68	1.02 327 E+1 5	1461 3793 1.2	2261 6683 .36	1033 7625 8.2	0.21 8780 2475	314. 5	-304. 5	10.48	10.29
48	-0.55047756 28	-311 2093 5.35	9685 1261 7084 715	1463 2514 8.2	2200 3438 .77	1035 0869 3.3	0.21 2575 7563	315. 9	-305. 9	10.53	10.32
49	-0.53327513 9	-302 4412 1.83	9147 0690 5377 452	1465 0888 9.5	2138 3684 .89	1036 3866 9.8	0.20 6329 2103	317. 4	-307. 4	10.58	10.35

50	-0.51607271 52	-293 5835 8.59	8619 1321 9156 399	1466 8895 1.1	2075 7605 .13	1037 6604 3.2	0.20 0042 3691	318. 8	-308. 8	10.63	10.38
51	-0.49887029 13	-284 6390 7.74	8101 9404 3803 089	1468 6513 3.9	2012 5384 .74	1038 9067 2.9	0.19 3716 9544	320. 3	-310. 3	10.68	10.41
52	-0.48166786 75	-275 6103 3.96	7596 1059 2932 934	1470 3724 3.6	1948 7210 .82	1040 1242 1.3	0.18 7354 6504	321. 8	-311. 8	10.73	10.44
53	-0.46446544 36	-266 5000 4.43	7102 2273 5944 213	1472 0509 1.2	1884 3272 .21	1041 3115 4.7	0.18 0957 1042	323. 3	-313. 3	10.78	10.47
54	-0.44726301 98	-257 3108 8.73	6620 8892 7158 036	1473 6849 2.8	1819 3759 .45	1042 4674 3.1	0.17 4525 9268	324. 8	-314. 8	10.83	10.50
55	-0.43006059 6	-248 0455 8.79	6152 6613 6633 172	1475 2727 0.2	1753 8864 .76	1043 5906 0.4	0.16 8062 6933	326. 3	-316. 3	10.88	10.53
56	-0.41285817 21	-238 7068 8.78	5698 0978 2737 609	1476 8125 0.7	1687 8781 .92	1044 6798 4.4	0.16 1568 944	327. 8	-317. 8	10.93	10.56
57	-0.39565574 83	-229 2975 5.05	5257 7366 6556 658	1478 3026 7.3	1621 3706 .26	1045 7339 6.9	0.15 5046 1852	329. 3	-319. 3	10.98	10.59
58	-0.37845332 44	-219 8203 6.03	4832 0990 8215 239	1479 7415 8.9	1554 3834 .6	1046 7518 4.1	0.14 8495 8897	330. 8	-320. 8	11.03	11.02
59	-0.36125090 06	-210 2781 2.18	4421 6888 5189 709	1481 1277 0.3	1486 9365 .15	1047 7323 6.2	0.14 1919 4986	332. 4	-322. 4	11.08	11.05
60	-0.34404847 68	-200 6736 5.86	4026 9917 2682 254	1482 4595 2.5	1419 0497 .51	1048 6744 7.7	0.13 5318 4216	333. 9	-323. 9	11.13	11.08

61	-0.32684605 29	-191 0098 1.29	3648 4748 6128 402	1483 7356 2.7	1350 7432 .56	1049 5771 7.7	0.12 8694 0384	335. 4	-325. 4	11.18	11.11
62	-0.30964362 91	-181 2894 4.42	3286 5862 5905 724	1484 9546 4.5	1282 0372 .43	1050 4394 9.6	0.12 2047 6998	337. 0	-327. 0	11.23	11.14
63	-0.29244120 53	-171 5154 2.91	2941 7542 4309 141	1486 1152 7.7	1212 9520 .43	1051 2605 1.4	0.11 5380 7288	338. 5	-328. 5	11.28	11.17
64	-0.27523878 14	-161 6906 5.99	2614 3869 4855 620	1487 2162 8.9	1143 5080 .99	1052 0393 5.7	0.10 8694 4221	340. 0	-330. 0	11.33	11.20
65	-0.25803635 76	-151 8180 4.37	2304 8718 3978 237	1488 2565 1.1	1073 7259 .62	1052 7751 9.7	0.10 1990 0512	341. 6	-331. 6	11.39	11.23
66	-0.24083393 37	-141 9005 0.22	2013 5752 5166 802	1489 2348 4	1003 6262 .81	1053 4672 5.6	0.09 5268 8634 7	343. 1	-333. 1	11.44	11.26
67	-0.22363150 99	-131 9409 7	1740 8419 5609 310	1490 1502 4.1	9332 298. 001	1054 1148 0	0.08 8532 084	344. 7	-334. 7	11.49	11.29
68	-0.20642908 61	-121 9423 9.43	1486 9947 5385 541	1491 0017 4.8	8625 573. 497	1054 7171 4.6	0.08 1780 9166 2	346. 2	-336. 2	11.54	11.32
69	-0.18922666 22	-111 9077 3.4	1252 3340 9261 105	1491 7884 6.3	7916 298. 434	1055 2736 5.9	0.07 5016 5453 9	347. 8	-337. 8	11.59	11.36
70	-0.17202423 84	-101 8399 5.83	1037 1377 1127 160	1492 5095 5.9	7204 682. 699	1055 7837 5.4	0.06 8240 1360 6	349. 3	-339. 3	11.64	11.39
71	-0.15482181 45	-917 4204 .659	8416 6031 1278 75	1493 1642 7.7	6490 936. 87	1056 2468 9.3	0.06 1452 8375	350. 9	-340. 9	11.70	11.42

72	-0.13761939 07	-816 1698 .691	6661 3325 5145 59	1493 7519 3	5775 272. 155	1056 6625 9.2	0.05 4655 7832	352. 5	-342. 5	11.75	11.45
73	-0.12041696 69	-714 6777 .544	5107 6429 2621 33	1494 2719 0.2	5057 900. 332	1057 0304 1.5	0.04 7850 0927	354. 0	-344. 0	11.80	11.48
74	-0.10321454 3	-612 9741 .551	3757 3731 4803 49	1494 7236 4.9	4339 033. 682	1057 3499 7.5	0.04 1036 8731 7	355. 6	-345. 6	11.85	11.51
75	-0.086012119 19	-511 0891 .669	2612 1213 6488 70	1495 1066 9.8	3618 884. 929	1057 6209 3.9	0.03 4217 2208 8	357. 2	-347. 2	11.91	11.54
76	-0.06880969 535	-409 0529 .391	1673 2430 7019 57	1495 4206 4.9	2897 667. 178	1057 8430 2.5	0.02 7392 2227 7	358. 7	-348. 7	11.96	11.57
77	-0.05160727 152	-306 8956 .661	9418 4949 8516 9	1495 6651 7.3	2175 593. 847	1058 0159 9.8	0.02 0562 9579 4	360. 3	-350. 3	12.01	12.01
78	-0.03440484 768	-204 6475 .776	4188 0631 0304 6	1495 8400 1.6	1452 878. 611	1058 1396 8	0.01 3730 4992 8	361. 9	-351. 9	12.06	12.04
79	-0.01720242 384	-102 3389 .307	1047 3256 7335 0	1495 9449 9.5	7297 35.3 321	1058 2139 4.1	0.00 6895 9149 38	363. 4	-353. 4	12.11	12.07
80	0	0	0	1495 9800 0	6378	1058 2387 0.3	0.00 0060 2699 5594	365. 0	-355. 0	12.17	12.10
81	0.017202423 84	1023 389. 307	1047 3256 7335 0	1495 9449 9.5	-716 979. 3321	1058 2139 4.1	-0.00 6775 3722 05	366. 6	-356. 6	12.22	12.13
82	0.034404847 68	2046 475. 776	4188 0631 0304 6	1495 8400 1.6	-144 0122 .611	1058 1396 8	-0.01 3609 9480 9	368. 1	-358. 1	12.27	12.16

83	0.051607271 52	3068 956. 661	9418 4949 8516 9	1495 6651 7.3	-216 2837 .847	1058 0159 9.8	-0.02 0442 3926 6	369. 7	-359. 7	12.32	12.19
84	0.068809695 35	4090 529. 391	1673 2430 7019 57	1495 4206 4.9	-288 4911 .178	1057 8430 2.5	-0.02 7271 6377 7	371. 3	-361. 3	12.38	12.23
85	0.086012119 19	5110 891. 669	2612 1213 6488 70	1495 1066 9.8	-360 6128 .929	1057 6209 3.9	-0.03 4096 6105 6	372. 8	-362. 8	12.43	12.26
86	0.103214543	6129 741. 551	3757 3731 4803 49	1494 7236 4.9	-432 6277 .682	1057 3499 7.5	-0.04 0916 2319 4	374. 4	-364. 4	12.48	12.29
87	0.120416966 9	7146 777. 544	5107 6429 2621 33	1494 2719 0.2	-504 5144 .332	1057 0304 1.5	-0.04 7729 415	375. 9	-365. 9	12.53	12.32
88	0.137619390 7	8161 698. 691	6661 3325 5145 59	1493 7519 3	-576 2516 .155	1056 6625 9.2	-0.05 4535 0634 9	377. 5	-367. 5	12.58	12.35
89	0.154821814 5	9174 204. 659	8416 6031 1278 75	1493 1642 7.7	-647 8180 .87	1056 2468 9.3	-0.06 1332 0702 8	379. 1	-369. 1	12.64	12.38
90	0.172024238 4	1018 3995 .83	1037 1377 1127 160	1492 5095 5.9	-719 1926 .699	1055 7837 5.4	-0.06 8119 3158 6	380. 6	-370. 6	12.69	12.41
91	0.189226662 2	1119 0773 .4	1252 3340 9261 105	1491 7884 6.3	-790 3542 .434	1055 2736 5.9	-0.07 4895 6667 9	382. 2	-372. 2	12.74	12.44
92	0.206429086 1	1219 4239 .43	1486 9947 5385 541	1491 0017 4.8	-861 2817 .497	1054 7171 4.6	-0.08 1659 9742 4	383. 7	-373. 7	12.79	12.47
93	0.223631509 9	1319 4097	1740 8419 5609 310	1490 1502 4.1	-931 9542 .001	1054 1148 0	-0.08 8411 0725 2	385. 3	-375. 3	12.84	12.51

94	0.240833933 7	1419 0050 .22	2013 5752 5166 802	1489 2348 4	-100 2350 6.81	1053 4672 5.6	-0.09 5147 7776	386. 8	-376. 8	12.89	12.54
95	0.258036357 6	1518 1804 .37	2304 8718 3978 237	1488 2565 1.1	-107 2450 3.62	1052 7751 9.7	-0.10 1868 8857	388. 4	-378. 4	12.95	12.57
96	0.275238781 4	1616 9065 .99	2614 3869 4855 620	1487 2162 8.9	-114 2232 4.99	1052 0393 5.7	-0.10 8573 1719	389. 9	-379. 9	13.00	12.60
97	0.292441205 3	1715 1542 .91	2941 7542 4309 141	1486 1152 7.7	-121 1676 4.43	1051 2605 1.4	-0.11 5259 3888	391. 5	-381. 5	13.05	13.03
98	0.309643629 1	1812 8944 .42	3286 5862 5905 724	1484 9546 4.5	-128 0761 6.43	1050 4394 9.6	-0.12 1926 2649	393. 0	-383. 0	13.10	13.06
99	0.326846052 9	1910 0981 .29	3648 4748 6128 402	1483 7356 2.7	-134 9467 6.56	1049 5771 7.7	-0.12 8572 5038	394. 5	-384. 5	13.15	13.09
100	0.344048476 8	2006 7365 .86	4026 9917 2682 254	1482 4595 2.5	-141 7774 1.51	1048 6744 7.7	-0.13 5196 7824	396. 1	-386. 1	13.20	13.12
101	0.361250900 6	2102 7812 .18	4421 6888 5189 709	1481 1277 0.3	-148 5660 9.15	1047 7323 6.2	-0.14 1797 75	397. 6	-387. 6	13.25	13.15
102	0.378453324 4	2198 2036 .03	4832 0990 8215 239	1479 7415 8.9	-155 3107 8.6	1046 7518 4.1	-0.14 8374 027	399. 1	-389. 1	13.30	13.18
103	0.395655748 3	2292 9755 .05	5257 7366 6556 658	1478 3026 7.3	-162 0095 0.26	1045 7339 6.9	-0.15 4924 2039	400. 6	-390. 6	13.35	13.21
104	0.412858172 1	2387 0688 .78	5698 0978 2737 609	1476 8125 0.7	-168 6602 5.92	1044 6798 4.4	-0.16 1446 8397	402. 2	-392. 2	13.41	13.24

105	0.430060596	2480 4558 .79	6152 6613 6633 172	1475 2727 0.2	-175 2610 8.76	1043 5906 0.4	-0.16 7940 4615	403. 7	-393. 7	13.46	13.27
106	0.447263019 8	2573 1088 .73	6620 8892 7158 036	1473 6849 2.8	-181 8100 3.45	1042 4674 3.1	-0.17 4403 5633	405. 2	-395. 2	13.51	13.30
107	0.464465443 6	2665 0004 .43	7102 2273 5944 213	1472 0509 1.2	-188 3051 6.21	1041 3115 4.7	-0.18 0834 6048	406. 7	-396. 7	13.56	13.33
108	0.481667867 5	2756 1033 .96	7596 1059 2932 934	1470 3724 3.6	-194 7445 4.82	1040 1242 1.3	-0.18 7232 0112	408. 2	-398. 2	13.61	13.36
109	0.498870291 3	2846 3907 .74	8101 9404 3803 089	1468 6513 3.9	-201 1262 8.74	1038 9067 2.9	-0.19 3594 1715	409. 7	-399. 7	13.66	13.39
110	0.516072715 2	2935 8358 .59	8619 1321 9156 399	1466 8895 1.1	-207 4484 9.13	1037 6604 3.2	-0.19 9919 4388	411. 1	-401. 1	13.70	13.42
111	0.533275139	3024 4121 .83	9147 0690 5377 452	1465 0888 9.5	-213 7092 8.89	1036 3866 9.8	-0.20 6206 1289	412. 6	-402. 6	13.75	13.45
112	0.550477562 8	3112 0935 .35	9685 1261 7084 715	1463 2514 8.2	-219 9068 2.77	1035 0869 3.3	-0.21 2452 5203	414. 1	-404. 1	13.80	13.48
113	0.567679986 7	3198 8539 .68	1.02 327 E+1 5	1461 3793 1.2	-226 0392 7.36	1033 7625 8.2	-0.21 8656 8536	415. 5	-405. 5	13.85	13.51
114	0.584882410 5	3284 6678 .09	1.07 89E +15	1459 4744 7.2	-232 1048 1.19	1032 4151 2.1	-0.22 4817 331	417. 0	-407. 0	13.90	13.54
115	0.602084834 3	3369 5096 .64	1.13 536 E+1 5	1457 5390 9.3	-238 1016 4.79	1031 0460 5.6	-0.23 0932 1164	418. 4	-408. 4	13.95	13.57

116	0.619287258 2	3453 3544 .27	1.19 257 E+1 5	1455 5753 4.8	-244 0280 0.68	1029 6569 2.6	-0.23 6999 3351	419. 8	-409. 8	13.99	13.60
117	0.636489682	3536 1772 .87	1.25 045 E+1 5	1453 5854 5.1	-249 8821 3.51	1028 2492 9.6	-0.24 3017 0738	421. 3	-411. 3	14.04	14.03
118	0.653692105 9	3617 9537 .35	1.30 896 E+1 5	1451 5716 5.4	-255 6623 0.04	1026 8247 6	-0.24 8983 3809	422. 7	-412. 7	14.09	14.05
119	0.670894529 7	3698 6595 .72	1.36 801 E+1 5	1449 5362 4.8	-261 3667 9.22	1025 3849 3.8	-0.25 4896 2664	424. 1	-414. 1	14.14	14.08
120	0.688096953 5	3778 2709 .16	1.42 753 E+1 5	1447 4815 5.4	-266 9939 2.25	1023 9314 7.1	-0.26 0753 7027	425. 5	-415. 5	14.18	14.11
121	0.705299377 4	3856 7642 .09	1.48 746 E+1 5	1445 4099 2.8	-272 5420 2.61	1022 4660 2.7	-0.26 6553 6252	426. 8	-416. 8	14.23	14.14
122	0.722501801 2	3934 1162 .24	1.54 773 E+1 5	1443 3237 5.3	-278 0094 6.12	1020 9902 9.1	-0.27 2293 9322	428. 2	-418. 2	14.27	14.16
123	0.739704225 1	4010 3040 .7	1.60 825 E+1 5	1441 2254 4.1	-283 3946 1.01	1019 5059 7	-0.27 7972 4869	429. 6	-419. 6	14.32	14.19
124	0.756906648 9	4085 3052 .03	1.66 897 E+1 5	1439 1174 2.9	-288 6958 7.9	1018 0147 8.7	-0.28 3587 1174	430. 9	-420. 9	14.36	14.22
125	0.774109072 7	4159 0974 .28	1.72 981 E+1 5	1437 0021 7.3	-293 9116 9.93	1016 5184 8	-0.28 9135 6183	432. 2	-422. 2	14.41	14.24
126	0.791311496 6	4231 6589 .1	1.79 069 E+1 5	1434 8821 5.2	-299 0405 2.75	1015 0188 0.2	-0.29 4615 752	433. 5	-423. 5	14.45	14.27

127	0.808513920 4	4302 9681 .75	1.85 155 E+1 5	1432 7598 5.7	-304 0808 4.6	1013 5175 1.6	-0.30 0025 2499	434. 8	-424. 8	14.49	14.30
128	0.825716344 2	4373 0041 .23	1.91 232 E+1 5	1430 6377 9.8	-309 0311 6.31	1012 0163 9.6	-0.30 5361 8147	436. 1	-426. 1	14.54	14.32
129	0.842918768 1	4441 7460 .29	1.97 291 E+1 5	1428 5184 9.2	-313 8900 1.41	1010 5172 2.4	-0.31 0623 1213	437. 4	-427. 4	14.58	14.35
130	0.860121191 9	4509 1735 .5	2.03 326 E+1 5	1426 4044 6.6	-318 6559 6.11	1009 0217 8.6	-0.31 5806 8196	438. 6	-428. 6	14.62	14.37
131	0.877323615 8	4575 2667 .35	2.09 331 E+1 5	1424 2982 4.9	-323 3275 9.39	1007 5318 7.3	-0.32 0910 5363	439. 9	-429. 9	14.66	14.40
132	0.894526039 6	4640 0060 .25	2.15 297 E+1 5	1422 2023 7.7	-327 9035 2.99	1006 0492 7.8	-0.32 5931 8774	441. 1	-431. 1	14.70	14.42
133	0.911728463 4	4703 3722 .62	2.21 217 E+1 5	1420 1193 8	-332 3824 1.51	1004 5757 9	-0.33 0868 4305	442. 3	-432. 3	14.74	14.45
134	0.928930887 3	4765 3466 .95	2.27 085 E+1 5	1418 0517 8.6	-336 7629 2.41	1003 1131 9.9	-0.33 5717 7679	443. 5	-433. 5	14.78	14.47
135	0.946133311 1	4825 9109 .86	2.32 894 E+1 5	1416 0021 1.6	-341 0437 6.07	1001 6632 8.6	-0.34 0477 4494	444. 6	-434. 6	14.82	14.49
136	0.963335735	4885 0472 .12	2.38 637 E+1 5	1413 9728 7.7	-345 2236 5.8	1000 2278 2.6	-0.34 5145 0249	445. 8	-435. 8	14.86	14.52
137	0.980538158 8	4942 7378 .74	2.44 307 E+1 5	1411 9665 6.6	-349 3013 7.93	9988 0858 .52	-0.34 9718 0385	446. 9	-436. 9	14.90	14.54

138	0.997740582 6	4998 9659 .01	2.49 897 E+1 5	1409 9856 5.9	-353 2757 1.78	9974 0731 .51	-0.35 4194 0313	448. 0	-438. 0	14.93	14.56
139	1.014943006	5053 7146 .53	2.55 4E+ 15	1408 0326 1.4	-357 1454 9.75	9960 2575 .39	-0.35 8570 5451	449. 0	-439. 0	14.97	14.58
140	1.03214543	5106 9679 .29	2.60 811E +15	1406 1098 6.3	-360 9095 7.31	9946 6562 .21	-0.36 2845 1262	450. 1	-440. 1	15.00	15.00
141	1.049347854	5158 7099 .72	2.66 123 E+1 5	1404 2198 1	-364 5668 3.1	9933 2862 .09	-0.36 7015 3294	451. 1	-441. 1	15.04	15.02
142	1.066550278	5208 9254 .69	2.71 329 E+1 5	1402 3648 2.9	-368 1161 8.88	9920 1642 .95	-0.37 1078 7219	452. 1	-442. 1	15.07	15.04
143	1.083752702	5257 5995 .61	2.76 424 E+1 5	1400 5472 6.1	-371 5565 9.62	9907 3070 .25	-0.37 5032 8876	453. 1	-443. 1	15.10	15.06
144	1.100955126	5304 7178 .45	2.81 4E+ 15	1398 7694 0.4	-374 8870 3.52	9894 7306 .78	-0.37 8875 4312	454. 1	-444. 1	15.14	15.08
145	1.11815755	5350 2663 .78	2.86 254 E+1 5	1397 0335 2	-378 1065 2.02	9882 4512 .4	-0.38 2603 9826	455. 0	-445. 0	15.17	15.10
146	1.135359973	5394 2316 .81	2.90 977 E+1 5	1395 3418 2.4	-381 2140 9.85	9870 4843 .79	-0.38 6216 2016	455. 9	-445. 9	15.20	15.12
147	1.152562397	5436 6007 .44	2.95 566 E+1 5	1393 6964 8.2	-384 2088 5.05	9858 8454 .21	-0.38 9709 7826	456. 7	-446. 7	15.22	15.13
148	1.169764821	5477 3610 .29	3.00 015 E+1 5	1392 0996 0.9	-387 0898 9.02	9847 5493 .31	-0.39 3082 4585	457. 6	-447. 6	15.25	15.15

149	1.186967245	5516 5004 .75	3.04 318 E+1 5	1390 5532 6.6	-389 8563 6.48	9836 6106 .8	-0.39 6332 0065	458. 4	-448. 4	15.28	15.17
150	1.204169669	5554 0075	3.08 47E +15	1389 0594 5.4	-392 5074 5.57	9826 0436 .31	-0.39 9456 2516	459. 2	-449. 2	15.31	15.18
151	1.221372093	5589 8710 .05	3.12 467 E+1 5	1387 6201 1.4	-395 0423 7.85	9815 8619 .1	-0.40 2453 0725	459. 9	-449. 9	15.33	15.20
152	1.238574516	5624 0803 .77	3.16 303 E+1 5	1386 2371 2.2	-397 4603 8.31	9806 0787 .87	-0.40 5320 4056	460. 6	-450. 6	15.35	15.21
153	1.25577694	5656 6254 .93	3.19 974 E+1 5	1384 9122 8.6	-399 7607 5.38	9796 7070 .52	-0.40 8056 2496	461. 3	-451. 3	15.38	15.23
154	1.272979364	5687 4967 .22	3.23 476 E+1 5	1383 6473 4.3	-401 9428 1.01	9787 7589 .94	-0.41 0658 671	462. 0	-452. 0	15.40	15.24
155	1.290181788	5716 6849 .3	3.26 805 E+1 5	1382 4439 5.7	-404 0059 0.61	9779 2463 .8	-0.41 3125 8078	462. 6	-452. 6	15.42	15.25
156	1.307384212	5744 1814 .79	3.29 956 E+1 5	1381 3037 1.5	-405 9494 3.14	9771 1804 .38	-0.41 5455 8745	463. 2	-453. 2	15.44	15.26
157	1.324586636	5769 9782 .31	3.32 926 E+1 5	1380 2281 2.3	-407 7728 1.08	9763 5718 .32	-0.41 7647 1663	463. 7	-453. 7	15.46	15.27
158	1.341789059	5794 0675 .55	3.35 712 E+1 5	1379 2186 0.9	-409 4755 0.49	9756 4306 .48	-0.41 9698 0634	464. 3	-454. 3	15.48	15.29
159	1.358991483	5816 4423 .21	3.38 31E +15	1378 2765 1.4	-411 0570 0.97	9749 7663 .73	-0.42 1607 0354	464. 7	-454. 7	15.49	15.29

160	1.376193907	5837 0959 .08	3.40 717 E+1 5	1377 4030 9.1	-412 5168 5.72	9743 5878 .82	-0.42 3372 6449	465. 2	-455. 2	15.51	15.30
161	1.393396331	5856 0222 .04	3.42 93E +15	1376 5995 0.6	-413 8546 1.55	9737 9034 .19	-0.42 4993 5512	465. 6	-455. 6	15.52	15.31
162	1.410598755	5873 2156 .09	3.44 947 E+1 5	1375 8668 3.4	-415 0698 8.87	9732 7205 .82	-0.42 6468 5143	466. 0	-456. 0	15.53	15.32
163	1.427801179	5888 6710 .35	3.46 764 E+1 5	1375 2060 5.5	-416 1623 1.71	9728 0463 .13	-0.42 7796 3979	466. 3	-456. 3	15.54	15.33
164	1.445003602	5902 3839 .09	3.48 381 E+1 5	1374 6180 5.7	-417 1315 7.75	9723 8868 .8	-0.42 8976 1725	466. 6	-456. 6	15.55	15.33
165	1.462206026	5914 3501 .72	3.49 795 E+1 5	1374 1036 2.8	-417 9773 8.32	9720 2478 .71	-0.43 0006 9182	466. 9	-456. 9	15.56	15.34
166	1.47940845	5924 5662 .84	3.51 005 E+1 5	1373 6634 6.1	-418 6994 8.37	9717 1341 .8	-0.43 0887 8275	467. 1	-457. 1	15.57	15.34
167	1.496610874	5933 0292 .22	3.52 008 E+1 5	1373 2981 4.8	-419 2976 6.54	9714 5499 .99	-0.43 1618 2072	467. 3	-457. 3	15.58	15.35
168	1.513813298	5939 7364 .8	3.52 805 E+1 5	1373 0081 8.1	-419 7717 5.13	9712 4988 .09	-0.43 2197 4804	467. 4	-457. 4	15.58	15.35
169	1.531015722	5944 6860 .75	3.53 393 E+1 5	1372 7939 5.2	-420 1216 0.12	9710 9833 .77	-0.43 2625 1883	467. 5	-457. 5	15.58	15.35
170	1.548218145	5947 8765 .42	3.53 772 E+1 5	1372 6557 5	-420 3471 1.14	9710 0057 .48	-0.43 2900 9913	467. 6	-457. 6	15.59	15.35

171	1.565420569	5949 3069 .37	3.53 943 E+1 5	1372 5937 6	-420 4482 1.53	9709 5672 .42	-0.43 3024 6702	467. 6	-457. 6	15.59	15.35
172	1.582622993	5948 9768 .35	3.53 903 E+1 5	1372 6080 6.7	-420 4248 8.29	9709 6684 .5	-0.43 2996 1266	467. 6	-457. 6	15.59	15.35
173	1.599825417	5946 8863 .36	3.53 655 E+1 5	1372 6986 5.2	-420 2771 2.12	9710 3092 .36	-0.43 2815 3831	467. 6	-457. 6	15.59	15.35
174	1.617027841	5943 0360 .58	3.53 197 E+1 5	1372 8653 9.2	-420 0049 7.38	9711 4887 .35	-0.43 2482 5835	467. 5	-457. 5	15.58	15.35
175	1.634230265	5937 4271 .39	3.52 53E +15	1373 1080 6.2	-419 6085 2.13	9713 2053 .54	-0.43 1997 9924	467. 4	-457. 4	15.58	15.35
176	1.651432688	5930 0612 .41	3.51 656 E+1 5	1373 4263 3.5	-419 0878 8.1	9715 4567 .78	-0.43 1361 9942	467. 2	-457. 2	15.57	15.34
177	1.668635112	5920 9405 .41	3.50 575 E+1 5	1373 8197 8.1	-418 4432 0.7	9718 2399 .72	-0.43 0575 092	467. 0	-457. 0	15.57	15.34
178	1.685837536	5910 0677 .41	3.49 289 E+1 5	1374 2878 7.1	-417 6746 9.01	9721 5511 .87	-0.42 9637 9066	466. 8	-456. 8	15.56	15.34
179	1.70303996	5897 4460 .56	3.47 799 E+1 5	1374 8299 7.5	-416 7825 5.76	9725 3859 .65	-0.42 8551 1743	466. 5	-456. 5	15.55	15.33
180	1.720242384	5883 0792 .22	3.46 106 E+1 5	1375 4453 6.4	-415 7670 7.36	9729 7391 .53	-0.42 7315 7451	466. 2	-456. 2	15.54	15.32
181	1.737444808	5866 9714 .9	3.44 214 E+1 5	1376 1332 1.1	-414 6285 3.86	9734 6049 .06	-0.42 5932 5803	465. 8	-455. 8	15.53	15.32

182	1.754647232	5849 1276 .27	3.42 123 E+1 5	1376 8925 9.6	-413 3672 8.94	9739 9767 .02	-0.42 4402 7497	465. 5	-455. 5	15.52	15.31
183	1.771849655	5829 5529 .12	3.39 837 E+1 5	1377 7225 0.1	-411 9836 9.93	9745 8473 .51	-0.42 2727 4289	465. 0	-455. 0	15.50	15.30
184	1.789052079	5808 2531 .4	3.37 358 E+1 5	1378 6218 1.7	-410 4781 7.78	9752 2090 .11	-0.42 0907 8961	464. 6	-454. 6	15.49	15.29
185	1.806254503	5785 2346 .12	3.34 689 E+1 5	1379 5893 4.7	-408 8511 7.02	9759 0532 .01	-0.41 8945 5286	464. 1	-454. 1	15.47	15.28
186	1.823456927	5760 5041 .4	3.31 834 E+1 5	1380 6238 0.1	-407 1031 5.82	9766 3708 .12	-0.41 6841 7993	463. 5	-453. 5	15.45	15.27
187	1.840659351	5734 0690 .42	3.28 795 E+1 5	1381 7238 0.8	-405 2346 5.89	9774 1521 .33	-0.41 4598 2724	463. 0	-453. 0	15.43	15.26
188	1.857861775	5705 9371 .4	3.25 577 E+1 5	1382 8879 1.1	-403 2462 2.53	9782 3868 .57	-0.41 2216 6003	462. 4	-452. 4	15.41	15.25
189	1.875064198	5676 1167 .6	3.22 183 E+1 5	1384 1145 7.1	-401 1384 4.57	9791 0641 .07	-0.40 9698 5183	461. 7	-451. 7	15.39	15.23
190	1.892266622	5644 6167 .26	3.18 617 E+1 5	1385 4021 7.3	-398 9119 4.4	9800 1724 .51	-0.40 7045 8412	461. 1	-451. 1	15.37	15.22
191	1.909469046	5611 4463 .59	3.14 883 E+1 5	1386 7490 2.5	-396 5673 7.89	9809 6999 .25	-0.40 4260 4585	460. 4	-450. 4	15.35	15.21
192	1.92667147	5576 6154 .75	3.10 986 E+1 5	1388 1533 6.3	-394 1054 4.43	9819 6340 .47	-0.40 1344 3296	459. 6	-449. 6	15.32	15.19

193	1.943873894	5540 1343 .8	3.06 931 E+1 5	1389 6133 5.3	-391 5268 6.87	9829 9618 .46	-0.39 8299 4795	458. 9	-448. 9	15.30	15.18
194	1.961076318	5502 0138 .71	3.02 722 E+1 5	1391 1270 9.5	-388 8324 1.51	9840 6698 .78	-0.39 5127 9942	458. 1	-448. 1	15.27	15.16
195	1.978278741	5462 2652 .27	2.98 363 E+1 5	1392 6926 2.4	-386 0228 8.08	9851 7442 .51	-0.39 1832 0157	457. 3	-447. 3	15.24	15.15
196	1.995481165	5420 9002 .11	2.93 862 E+1 5	1394 3079 1.8	-383 0990 9.74	9863 1706 .46	-0.38 8413 7374	456. 4	-446. 4	15.21	15.13
197	2.012683589	5377 9310 .64	2.89 221 E+1 5	1395 9708 9.3	-380 0619 2.98	9874 9343 .41	-0.38 4875 3994	455. 5	-445. 5	15.18	15.11
198	2.029886013	5333 3705	2.84 448 E+1 5	1397 6794 1.7	-376 9122 7.69	9887 0202 .33	-0.38 1219 2835	454. 6	-444. 6	15.15	15.09
199	2.047088437	5287 2317 .06	2.79 548 E+1 5	1399 4313 0.2	-373 6510 7.08	9899 4128 .66	-0.37 7447 7091	453. 7	-443. 7	15.12	15.07
200	2.064290861	5239 5283 .35	2.74 527 E+1 5	1401 2243 1.8	-370 2792 7.64	9912 0964 .49	-0.37 3563 0281	452. 7	-442. 7	15.09	15.05
201	2.081493284	5190 2745 .03	2.69 389 E+1 5	1403 0561 8.8	-366 7978 9.16	9925 0548 .83	-0.36 9567 6204	451. 8	-441. 8	15.06	15.04
202	2.098695708	5139 4847 .85	2.64 143 E+1 5	1404 9245 9.6	-363 2079 4.64	9938 2717 .86	-0.36 5463 8897	450. 7	-440. 7	15.02	15.01
203	2.115898132	5087 1742 .12	2.58 793 E+1 5	1406 8271 9.1	-359 5105 0.34	9951 7305 .18	-0.36 1254 259	449. 7	-439. 7	14.99	14.59

204	2.133100556	5033 3582 .61	2.53 347 E+1 5	1408 7615 8.6	-355 7066 5.65	9965 4142 .01	-0.35 6941 166	448. 6	-438. 6	14.95	14.57
205	2.15030298	4978 0528 .59	2.47 81E +15	1410 7253 6.6	-351 7975 3.14	9979 3057 .48	-0.35 2527 0598	447. 6	-437. 6	14.92	14.55
206	2.167505404	4921 2743 .71	2.42 189 E+1 5	1412 7160 8.8	-347 7842 8.49	9993 3878 .85	-0.34 8014 396	446. 5	-436. 5	14.88	14.53
207	2.184707827	4863 0395 .99	2.36 492 E+1 5	1414 7312 8.9	-343 6681 0.45	1000 7643 1.8	-0.34 3405 6336	445. 3	-435. 3	14.84	14.51
208	2.201910251	4803 3657 .75	2.30 723 E+1 5	1416 7684 8.2	-339 4502 0.84	1002 2054 0.5	-0.33 8703 2307	444. 2	-434. 2	14.81	14.48
209	2.219112675	4742 2705 .58	2.24 891 E+1 5	1418 8251 6.9	-335 1318 4.46	1003 6602 8	-0.33 3909 6417	443. 0	-433. 0	14.77	14.46
210	2.236315099	4679 7720 .27	2.19 003 E+1 5	1420 8988 3.5	-330 7142 9.1	1005 1271 6.7	-0.32 9027 313	441. 8	-431. 8	14.73	14.44
211	2.253517523	4615 8886 .76	2.13 064 E+1 5	1422 9869 5.6	-326 1988 5.49	1006 6042 8	-0.32 4058 6806	440. 6	-430. 6	14.69	14.41
212	2.270719947	4550 6394 .09	2.07 083 E+1 5	1425 0870 0.4	-321 5868 7.24	1008 0898 2.9	-0.31 9006 1669	439. 4	-429. 4	14.65	14.39
213	2.287922371	4484 0435 .35	2.01 066 E+1 5	1427 1964 4.6	-316 8797 0.83	1009 5820 2.4	-0.31 3872 1776	438. 2	-428. 2	14.61	14.36
214	2.305124794	4416 1207 .6	1.95 021 E+1 5	1429 3127 4.9	-312 0787 5.56	1011 0790 7.2	-0.30 8659 0993	436. 9	-426. 9	14.56	14.34

215	2.322327218	4346 8911 .84	1.88 955 E+1 5	1431 4333 8.3	-307 1854 3.48	1012 5791 8.3	-0.30 3369 2968	435. 6	-425. 6	14.52	14.31
216	2.339529642	4276 3752 .93	1.82 874 E+1 5	1433 5558 2.5	-302 2011 9.41	1014 0805 7.4	-0.29 8005 1111	434. 4	-424. 4	14.48	14.29
217	2.356732066	4204 5939 .53	1.76 786 E+1 5	1435 6775 6	-297 1275 0.83	1015 5814 6.4	-0.29 2568 857	433. 0	-423. 0	14.43	14.26
218	2.37393449	4131 5684 .07	1.70 699 E+1 5	1437 7960 8.6	-291 9658 7.87	1017 0800 8.5	-0.28 7062 8214	431. 7	-421. 7	14.39	14.23
219	2.391136914	4057 3202 .63	1.64 618 E+1 5	1439 9089 1.5	-286 7178 3.3	1018 5746 7.5	-0.28 1489 2614	430. 4	-420. 4	14.35	14.21
220	2.408339337	3981 8714 .93	1.58 553 E+1 5	1442 0135 7.6	-281 3849 2.39	1020 0634 8.8	-0.27 5850 4027	429. 1	-419. 1	14.30	14.18
221	2.425541761	3905 2444 .23	1.52 509 E+1 5	1444 1076 2.1	-275 9687 2.96	1021 5447 9	-0.27 0148 4382	427. 7	-417. 7	14.26	14.15
222	2.442744185	3827 4617 .28	1.46 495 E+1 5	1446 1886 2.1	-270 4708 5.29	1023 0168 6.6	-0.26 4385 5268	426. 3	-416. 3	14.21	14.13
223	2.459946609	3748 5464 .26	1.40 516 E+1 5	1448 2541 7.6	-264 8929 2.06	1024 4780 1.5	-0.25 8563 7923	424. 9	-414. 9	14.16	14.10
224	2.477149033	3668 5218 .68	1.34 581 E+1 5	1450 3019 1.1	-259 2365 8.34	1025 9265 5.9	-0.25 2685 3226	423. 5	-413. 5	14.12	14.07
225	2.494351457	3587 4117 .36	1.28 695 E+1 5	1452 3294 8.4	-253 5035 1.5	1027 3608 4	-0.24 6752 1684	422. 1	-412. 1	14.07	14.04

226	2.51155388	3505 2400 .31	1.22 867 E+1 5	1454 3345 8.4	-247 6954 1.2	1028 7792 2.5	-0.24 0766 3434	420. 7	-410. 7	14.02	14.01
227	2.528756304	3422 0310 .7	1.17 103 E+1 5	1456 3149 3.6	-241 8139 9.31	1030 1801 0.2	-0.23 4729 823	419. 3	-409. 3	13.98	13.59
228	2.545958728	3337 8094 .74	1.11 41E +15	1458 2683 0.2	-235 8609 9.86	1031 5618 9	-0.22 8644 5446	417. 9	-407. 9	13.93	13.56
229	2.563161152	3252 6001 .66	1.05 794 E+1 5	1460 1924 8.1	-229 8381 9.02	1032 9230 3.2	-0.22 2512 4071	416. 4	-406. 4	13.88	13.53
230	2.580363576	3166 4283 .62	1.00 263 E+1 5	1462 0853 1.7	-223 7473 5.01	1034 2620 0.2	-0.21 6335 2706	415. 0	-405. 0	13.83	13.50
231	2.597566	3079 3195 .61	9482 2089 5850 346	1463 9446 9.5	-217 5902 8.06	1035 5773 0.4	-0.21 0114 9569	413. 5	-403. 5	13.78	13.47
232	2.614768423	2991 2995 .4	8947 8729 3526 297	1465 7685 4.6	-211 3688 0.39	1036 8674 7.5	-0.20 3853 2493	412. 0	-402. 0	13.73	13.44
233	2.631970847	2902 3943 .44	8423 8929 3078 659	1467 5548 4.8	-205 0847 6.08	1038 1310 8.4	-0.19 7551 8931	410. 6	-400. 6	13.69	13.41
234	2.649173271	2812 6302 .84	7910 8891 1564 468	1469 3016 2.6	-198 7400 1.1	1039 3667 3.4	-0.19 1212 5955	409. 1	-399. 1	13.64	13.38
235	2.666375695	2722 0339 .21	7409 4686 6924 471	1471 0069 5.9	-192 3364 3.19	1040 5730 6.7	-0.18 4837 0269	407. 6	-397. 6	13.59	13.35
236	2.683578119	2630 6320 .65	6920 2250 6118 778	1472 6689 7.5	-185 8759 1.86	1041 7487 5.7	-0.17 8426 8206	406. 1	-396. 1	13.54	13.32

237	2.700780543	2538 4517 .62	6443 7373 4885 176	1474 2858 5.7	-179 3603 8.27	1042 8925 2	-0.17 1983 5737	404. 6	-394. 6	13.49	13.29
238	2.717982966	2445 5202 .91	5980 5694 9203 245	1475 8558 4.2	-172 7917 5.22	1044 0031 0.9	-0.16 5508 8483	403. 1	-393. 1	13.44	13.26
239	2.73518539	2351 8651 .5	5531 2696 8545 388	1477 3772 2.5	-166 1719 7.11	1045 0793 1.8	-0.15 9004 1715	401. 6	-391. 6	13.39	13.23
240	2.752387814	2257 5140 .55	5096 3697 0993 771	1478 8483 5.7	-159 5029 9.81	1046 1199 8	-0.15 2471 037	400. 1	-390. 1	13.34	13.20
241	2.769590238	2162 4949 .26	4676 3843 0299 978	1480 2676 5.1	-152 7868 0.67	1047 1239 7.1	-0.14 5910 9054	398. 6	-388. 6	13.29	13.17
242	2.786792662	2066 8358 .79	4271 8105 4961 881	1481 6335 7.6	-146 0253 8.44	1048 0902 1.1	-0.13 9325 2059	397. 0	-387. 0	13.23	13.14
243	2.803995086	1970 5652 .22	3883 1272 9389 808	1482 9446 6.8	-139 2207 3.2	1049 0176 6.2	-0.13 2715 3365	395. 5	-385. 5	13.18	13.11
244	2.82119751	1873 7114 .43	3510 7945 7231 675	1484 1995 2	-132 3748 6.3	1049 9053 2.9	-0.12 6082 666	394. 0	-384. 0	13.13	13.08
245	2.838399933	1776 3032 .03	3155 2530 6924 126	1485 3967 9.2	-125 4898 0.33	1050 7522 6.6	-0.11 9428 5346	392. 4	-382. 4	13.08	13.05
246	2.855602357	1678 3693 .26	2816 9235 9534 161	1486 5352 0.8	-118 5675 9.03	1051 5575 6.8	-0.11 2754 2551	390. 9	-380. 9	13.03	13.02
247	2.872804781	1579 9387 .93	2496 2065 8952 959	1487 6135 5.7	-111 6102 7.23	1052 3203 7.9	-0.10 6061 1146	389. 4	-379. 4	12.98	12.59

248	2.890007205	1481 0407 .3	2193 4816 4500 865	1488 6306 9.4	-104 6199 0.82	1053 0398 9	-0.09 9350 3752 5	387. 8	-377. 8	12.93	12.56
249	2.907209629	1381 7044 .04	1909 1070 5999 606	1489 5855 4.3	-975 9856 .656	1053 7153 3.9	-0.09 2623 2758 9	386. 3	-376. 3	12.88	12.53
250	2.924412053	1281 9592 .09	1643 4194 1364 958	1490 4770 9.4	-905 4832 .501	1054 3460 1.1	-0.08 5881 0333 9	384. 7	-374. 7	12.82	12.49
251	2.941614476	1181 8346 .62	1396 7331 6770 014	1491 3044 0.5	-834 7126 .988	1054 9312 4.2	-0.07 9124 8439 4	383. 2	-373. 2	12.77	12.46
252	2.9588169	1081 3603 .91	1169 3402 9426 219	1492 0666 0.6	-763 6949 .539	1055 4704 1.4	-0.07 2355 8845 1	381. 6	-371. 6	12.72	12.43
253	2.976019324	9805 661. 274	9615 0993 0262 39	1492 7628 9.5	-692 4510 .306	1055 9629 6.1	-0.06 5575 3143 2	380. 0	-370. 0	12.67	12.40
254	2.993221748	8794 816. 99	7734 8805 8895 27	1493 3925 4	-621 0020 .112	1056 4083 6.4	-0.05 8784 2762 5	378. 5	-368. 5	12.62	12.37
255	3.010424172	7781 370. 178	6054 9721 8483 31	1493 9548 8.2	-549 3690 .385	1056 8061 5.8	-0.05 1983 8983 2	376. 9	-366. 9	12.56	12.34
256	3.027626596	6765 620. 733	4577 3623 9085 72	1494 4493 2.9	-477 5733 .1	1057 1559 2.4	-0.04 5175 2952 4	375. 4	-365. 4	12.51	12.31
257	3.044829019	5747 869. 233	3303 8000 7167 80	1494 8753 6.6	-405 6360 .711	1057 4572 9.8	-0.03 8359 5698 8	373. 8	-363. 8	12.46	12.28
258	3.062031443	4728 416. 845	2235 7925 8609 38	1495 2325 4.6	-333 5786 .093	1057 7099 6.3	-0.03 1537 8148	372. 2	-362. 2	12.41	12.24

259	3.079233867	3707 565. 243	1374 6040 0297 33	1495 5204 9.7	-261 4222 .474	1057 9136 5.6	-0.02 4711 1138	370. 7	-360. 7	12.36	12.21
260	3.096436291	2685 616. 512	7212 5360 5133 1	1495 7389 1.7	-189 1883 .378	1058 0681 6.3	-0.01 7880 5434 6	369. 1	-359. 1	12.30	12.18
261	3.113638715	1662 873. 065	2765 1468 2938 0	1495 8875 7.8	-116 8982 .555	1058 1733 2.5	-0.01 1047 1746 7	367. 5	-357. 5	12.25	12.15
262	3.130841139	6396 37.5 462	4091 3619 0530	1495 9663 2.5	-445 733. 9244	1058 2290 3	-0.00 4212 0742 48	366. 0	-356. 0	12.20	12.12
263	3.148043562	-383 787. 2513	1472 9265 4283	1495 9750 7.7	2776 48.4 934	1058 2352 2	0.00 2623 6935 61	364. 4	-354. 4	12.15	12.09
264	3.165245986	-140 7098 .48	1979 9261 3257 0	1495 9138 2.4	1000 950. 638	1058 1918 9.1	0.00 9459 0654 77	362. 8	-352. 8	12.09	12.06
265	3.18244841	-242 9993 .326	5904 8675 6294 7	1495 7826 2.9	1723 958. 473	1058 0990 8.5	0.01 6292 9776 3	361. 3	-351. 3	12.04	12.03
266	3.199650834	-345 2169 .097	1191 7471 4758 44	1495 5816 3	2446 458. 047	1057 9569 0.1	0.02 3124 364	359. 7	-349. 7	11.99	11.59
267	3.216853258	-447 3323 .316	2001 0621 4928 39	1495 3110 3.7	3168 235. 563	1057 7654 8.7	0.02 9952 1548 4	358. 1	-348. 1	11.94	11.56
268	3.234055682	-549 3153 .807	3017 4738 7494 34	1494 9711 3.2	3889 077. 435	1057 5250 4.2	0.03 6775 2751 1	356. 6	-346. 6	11.89	11.53
269	3.251258105	-651 1358 .785	4239 7793 2323 80	1494 5622 7.1	4608 770. 353	1057 2358 1.8	0.04 3592 6429 6	355. 0	-345. 0	11.83	11.50

270	3.268460529	-752 7636 .948	5666 5318 0181 20	1494 0848 8	5327 101. 349	1056 8981 1.7	0.05 0403 1681 2	353. 4	-343. 4	11.78	11.47
271	3.285662953	-854 1687 .561	7296 0426 3955 03	1493 5394 6	6043 857. 857	1056 5122 9.3	0.05 7205 7504 3	351. 9	-341. 9	11.73	11.44
272	3.302865377	-955 3210 .552	9126 3831 8525 05	1492 9265 8.1	6758 827. 779	1056 0787 5	0.06 3999 2782 4	350. 3	-340. 3	11.68	11.41
273	3.320067801	-105 6190 6.59	1115 5387 0903 297	1492 2468 8.8	7471 799. 541	1055 5979 4.3	0.07 0782 6269 6	348. 8	-338. 8	11.63	11.38
274	3.337270225	-115 6747 7.2	1338 0652 8728 642	1491 5010 9.2	8182 562. 165	1055 0703 7.6	0.07 7554 6575 1	347. 2	-337. 2	11.57	11.34
275	3.354472649	-125 6962 4.8	1579 9546 7599 282	1490 6899 7.9	8890 905. 325	1054 4966 0.4	0.08 4314 2148 6	345. 7	-335. 7	11.52	11.31
276	3.371675072	-135 6805 2.85	1840 9205 8048 655	1489 8144 0.3	9596 619. 411	1053 8772 3.2	0.09 1060 1265 7	344. 1	-334. 1	11.47	11.28
277	3.388877496	-145 6246 5.89	2120 6541 2758 076	1488 8752 8.7	1029 9495 .59	1053 2129 1.2	0.09 7791 2013	342. 6	-332. 6	11.42	11.25
278	3.40607992	-155 5256 9.66	2418 8242 3114 243	1487 8736 2.3	1099 9325 .87	1052 5043 4.7	0.10 4506 2275	341. 0	-331. 0	11.37	11.22
279	3.423282344	-165 3807 1.18	2735 0779 8395 832	1486 8104 7.2	1169 5903 .16	1051 7522 8.7	0.11 1203 9718	339. 5	-329. 5	11.32	11.19
280	3.440484768	-175 1867 8.82	3069 0410 7542 763	1485 6869 6.2	1238 9021 .33	1050 9575 2.9	0.11 7883 1779	337. 9	-327. 9	11.26	11.16

281	3.457687192	-184 9410 2.4	3420 3182 3458 745	1484 5042 8.7	1307 8475 .28	1050 1209 1.8	0.12 4542 5651	336. 4	-326. 4	11.21	11.13
282	3.474889615	-194 6405 3.27	3788 4936 9794 626	1483 2637 0.7	1376 4060 .98	1049 2433 4.6	0.13 1180 8269	334. 8	-324. 8	11.16	11.10
283	3.492092039	-204 2824 4.42	4173 1317 0157 193	1481 9665 4.6	1444 5575 .56	1048 3257 5	0.13 7796 6301	333. 3	-323. 3	11.11	11.07
284	3.509294463	-213 8639 0.52	4573 7769 9685 183	1480 6141 9.4	1512 2817 .36	1047 3691 1.2	0.14 4388 6132	331. 8	-321. 8	11.06	11.04
285	3.526496887	-223 3820 8.05	4989 9553 8931 444	1479 2081 0.1	1579 5585 .95	1046 3744 5.8	0.15 0955 3853	330. 3	-320. 3	11.01	11.01
286	3.543699311	-232 8341 5.34	5421 1742 9987 505	1477 7497 8.2	1646 3682 .27	1045 3428 6	0.15 7495 5251	328. 8	-318. 8	10.96	10.58
287	3.560901735	-242 2173 2.7	5866 9233 4784 082	1476 2408 0.9	1712 6908 .6	1044 2754 3.1	0.16 4007 5797	327. 2	-317. 2	10.91	10.54
288	3.578104158	-251 5288 2.45	6326 6749 5498 557	1474 6828 1.7	1778 5068 .69	1043 1733 2.6	0.17 0490 0639	325. 7	-315. 7	10.86	10.51
289	3.595306582	-260 7658 9.06	6799 8849 6997 909	1473 0774 9.7	1843 7967 .78	1042 0377 4.1	0.17 6941 4587	324. 2	-314. 2	10.81	10.48
290	3.612509006	-269 9257 9.19	7285 9933 1243 208	1471 4265 9.6	1908 5412 .67	1040 8699 1.3	0.18 3360 2109	322. 7	-312. 7	10.76	10.45
291	3.62971143	-279 0058 1.78	7784 4246 3579 423	1469 7319 1.9	1972 7211 .77	1039 6711 1.8	0.18 9744 732	321. 2	-311. 2	10.71	10.42

292	3.646913854	-288 0032 8.14	8294 5890 0832 111	1467 9953 2.4	2036 3175 .15	1038 4426 7.1	0.19 6093 3975	319. 8	-309. 8	10.66	10.40
293	3.664116278	-296 9155 2.02	8815 8826 1130 363	1466 2187 2	2099 3114 .63	1037 1859 2.2	0.20 2404 5465	318. 3	-308. 3	10.61	10.37
294	3.681318701	-305 7398 9.69	9347 6884 5373 385	1464 4040 6.9	2161 6843 .8	1035 9022 5.9	0.20 8676 4808	316. 8	-306. 8	10.56	10.34
295	3.698521125	-314 4738 0.02	9889 3771 0256 127	1462 5533 8	2223 4178 .08	1034 5931 0.4	0.21 4907 4645	315. 4	-305. 4	10.51	10.31
296	3.715723549	-323 1146 4.57	1.04 403 E+1 5	1460 6687 1.2	2284 4934 .8	1033 2599 1.2	0.22 1095 7237	313. 9	-303. 9	10.46	10.28
297	3.732925973	-331 6598 7.64	1.09 998 E+1 5	1458 7521 6.8	2344 8933 .22	1031 9041 7.1	0.22 7239 446	312. 5	-302. 5	10.42	10.25
298	3.750128397	-340 1069 6.36	1.15 673 E+1 5	1456 8058 9.4	2404 5994 .61	1030 5274 0	0.23 3336 7809	311. 0	-301. 0	10.37	10.22
299	3.767330821	-348 4534 0.76	1.21 42E +15	1454 8320 8.1	2463 5942 .3	1029 1311 4.8	0.23 9385 8388	309. 6	-299. 6	10.32	10.19
300	3.784533244	-356 6967 3.87	1.27 233 E+1 5	1452 8329 5.6	2521 8601 .69	1027 7169 9	0.24 5384 6919	308. 2	-298. 2	10.27	10.16
301	3.801735668	-364 8345 1.75	1.33 104 E+1 5	1450 8107 8.5	2579 3800 .39	1026 2865 3	0.25 1331 3741	306. 8	-296. 8	10.23	10.14
302	3.818938092	-372 8643 3.59	1.39 028 E+1 5	1448 7678 7.2	2636 1368 .17	1024 8413 9.8	0.25 7223 8811	305. 4	-295. 4	10.18	10.11

303	3.836140516	-380 7838 1.77	1.44 996 E+1 5	1446 7065 5.1	2692 1137 .09	1023 3832 4.3	0.26 3060 171	304. 0	-294. 0	10.13	10.08
304	3.85334294	-388 5906 1.95	1.51 003 E+1 5	1444 6291 8.8	2747 2941 .5	1021 9137 4.1	0.26 8838 1651	302. 6	-292. 6	10.09	10.05
305	3.870545364	-396 2824 3.1	1.57 04E +15	1442 5381 7.8	2801 6618 .11	1020 4345 8.5	0.27 4555 7483	301. 3	-291. 3	10.04	10.03
306	3.887747787	-403 8569 7.62	1.63 1E+ 15	1440 4359 4.2	2855 2006 .04	1018 9474 8.8	0.28 0210 7702	299. 9	-289. 9	10.00	9.60
307	3.904950211	-411 3120 1.37	1.69 178 E+1 5	1438 3249 2.4	2907 8946 .85	1017 4541 7.9	0.28 5801 046	298. 6	-288. 6	9.95	9.57
308	3.922152635	-418 6453 3.72	1.75 264 E+1 5	1436 2075 9	2959 7284 .63	1015 9564 0.1	0.29 1324 3579	297. 3	-287. 3	9.91	9.55
309	3.939355059	-425 8547 7.69	1.81 352 E+1 5	1434 0864 2.3	3010 6865 .98	1014 4559 1.3	0.29 6778 4564	295. 9	-285. 9	9.86	9.52
310	3.956557483	-432 9381 9.94	1.87 435 E+1 5	1431 9639 2.3	3060 7540 .12	1012 9544 8.1	0.30 2161 0615	294. 7	-284. 7	9.82	9.49
311	3.973759907	-439 8935 0.84	1.93 506 E+1 5	1429 8426 0	3109 9158 .87	1011 4538 8.2	0.30 7469 8651	293. 4	-283. 4	9.78	9.47
312	3.990962331	-446 7186 4.59	1.99 558 E+1 5	1427 7249 7.8	3158 1576 .78	1009 9559 0.1	0.31 2702 5324	292. 1	-282. 1	9.74	9.44
313	4.008164754	-453 4115 9.21	2.05 582 E+1 5	1425 6135 8.3	3205 4651 .07	1008 4623 2.5	0.31 7856 7039	290. 9	-280. 9	9.70	9.42

314	4.025367178	-459 9703 6.66	2.11 573 E+1 5	1423 5109 4.9	3251 8241 .76	1006 9749 4.6	0.32 2929 9982	289. 6	-279. 6	9.65	9.39
315	4.042569602	-466 3930 2.84	2.17 522 E+1 5	1421 4196 0.9	3297 2211 .67	1005 4955 5.7	0.32 7920 0137	288. 4	-278. 4	9.61	9.37
316	4.059772026	-472 6776 7.7	2.23 424 E+1 5	1419 3420 9.2	3341 6426 .46	1004 0259 4.6	0.33 2824 3319	287. 2	-277. 2	9.57	9.34
317	4.07697445	-478 8224 5.27	2.29 271 E+1 5	1417 2809 2.5	3385 0754 .68	1002 5679 0	0.33 7640 5197	286. 1	-276. 1	9.54	9.32
318	4.094176874	-484 8255 3.71	2.35 056 E+1 5	1415 2386 2.3	3427 5067 .81	1001 1232 0	0.34 2366 1325	284. 9	-274. 9	9.50	9.30
319	4.111379297	-490 6851 5.39	2.40 772 E+1 5	1413 2176 9	3468 9240 .27	9996 9361 .59	0.34 6998 7176	283. 8	-273. 8	9.46	9.28
320	4.128581721	-496 3995 6.9	2.46 413 E+1 5	1411 2206 1.6	3509 3149 .52	9982 8090 .93	0.35 1535 8172	282. 7	-272. 7	9.42	9.25
321	4.145784145	-501 9670 9.15	2.51 971 E+1 5	1409 2498 7.1	3548 6676 .03	9968 8682 .72	0.35 5974 9719	281. 6	-271. 6	9.39	9.23
322	4.162986569	-507 3860 7.38	2.57 441 E+1 5	1407 3079 0.3	3586 9703 .35	9955 1310 .13	0.36 0313 7247	280. 5	-270. 5	9.35	9.21
323	4.180188993	-512 6549 1.25	2.62 815 E+1 5	1405 3971 3.3	3624 2118 .14	9941 6144 .53	0.36 4549 6243	279. 5	-269. 5	9.32	9.19
324	4.197391417	-517 7720 4.83	2.68 088 E+1 5	1403 5199 5.6	3660 3810 .18	9928 3355 .23	0.36 8680 2294	278. 5	-268. 5	9.28	9.17

325	4.21459384	-522 7359 6.7	2.73 253 E+1 5	1401 6787 3.3	3695 4672 .46	9915 3109 .25	0.37 2703 1127	277. 5	-267. 5	9.25	9.15
326	4.231796264	-527 5451 9.98	2.78 304 E+1 5	1399 8757 8.8	3729 4601 .14	9902 5571 .09	0.37 6615 8653	276. 5	-266. 5	9.22	9.13
327	4.248998688	-532 1983 2.34	2.83 235 E+1 5	1398 1134 0.9	3762 3495 .63	9890 0902 .46	0.38 0416 1003	275. 6	-265. 6	9.19	9.11
328	4.266201112	-536 6939 6.1	2.88 04E +15	1396 3938 3.9	3794 1258 .62	9877 9262 .06	0.38 4101 4584	274. 6	-264. 6	9.15	9.09
329	4.283403536	-541 0307 8.23	2.92 714 E+1 5	1394 7192 7.4	3824 7796 .07	9866 0805 .32	0.38 7669 6115	273. 8	-263. 8	9.13	9.08
330	4.30060596	-545 2075 0.38	2.97 251 E+1 5	1393 0918 6.3	3854 3017 .26	9854 5684 .16	0.39 1118 2675	272. 9	-262. 9	9.10	9.06
331	4.317808383	-549 2228 8.96	3.01 646 E+1 5	1391 5137 0	3882 6834 .84	9843 4046 .79	0.39 4445 1753	272. 1	-262. 1	9.07	9.04
332	4.335010807	-553 0757 5.16	3.05 893 E+1 5	1389 9868 2.5	3909 9164 .83	9832 6037 .42	0.39 7648 1291	271. 3	-261. 3	9.04	9.03
333	4.352213231	-556 7649 4.95	3.09 987 E+1 5	1388 5132 1.6	3935 9926 .63	9822 1796 .07	0.40 0724 9735	270. 5	-260. 5	9.02	9.01
334	4.369415655	-560 2893 9.17	3.13 924 E+1 5	1387 0947 9.1	3960 9043 .08	9812 1458 .3	0.40 3673 6078	269. 8	-259. 8	8.99	8.60
335	4.386618079	-563 6480 3.53	3.17 699 E+1 5	1385 7333 9.9	3984 6440 .46	9802 5155 .05	0.40 6491 9912	269. 1	-259. 1	8.97	8.58

336	4.403820503	-566 8398 8.64	3.21 307 E+1 5	1384 4308 2.3	4007 2048 .53	9793 3012 .37	0.40 9178 147	268. 4	-258. 4	8.95	8.57
337	4.421022926	-569 8640 0.04	3.24 745 E+1 5	1383 1887 7.3	4028 5800 .53	9784 5151 .2	0.41 1730 1679	267. 7	-257. 7	8.92	8.55
338	4.43822535	-572 7194 8.25	3.28 008 E+1 5	1382 0088 8.4	4048 7633 .19	9776 1687 .23	0.41 4146 2197	267. 1	-257. 1	8.90	8.54
339	4.455427774	-575 4054 8.77	3.31 091 E+1 5	1380 8927 1.3	4067 7486 .8	9768 2730 .62	0.41 6424 5465	266. 6	-256. 6	8.89	8.53
340	4.472630198	-577 9212 2.11	3.33 993 E+1 5	1379 8417 3.8	4085 5305 .18	9760 8385 .89	0.41 8563 4749	266. 0	-256. 0	8.87	8.52
341	4.489832622	-580 2659 3.84	3.36 709 E+1 5	1378 8573 5.3	4102 1035 .7	9753 8751 .67	0.42 0561 4178	265. 5	-255. 5	8.85	8.51
342	4.507035046	-582 4389 4.56	3.39 235 E+1 5	1377 9408 6.8	4117 4629 .32	9747 3920 .55	0.42 2416 8792	265. 1	-255. 1	8.84	8.50
343	4.52423747	-584 4395 9.98	3.41 57E +15	1377 0935 0.3	4131 6040 .59	9741 3978 .92	0.42 4128 4572	264. 6	-254. 6	8.82	8.49
344	4.541439893	-586 2673 0.89	3.43 709 E+1 5	1376 3163 8.9	4144 5227 .68	9735 9006 .83	0.42 5694 8486	264. 2	-254. 2	8.81	8.48
345	4.558642317	-587 9215 3.2	3.45 652 E+1 5	1375 6105 6.7	4156 2152 .33	9730 9077 .82	0.42 7114 8516	263. 9	-253. 9	8.80	8.48
346	4.575844741	-589 4017 7.97	3.47 394 E+1 5	1374 9769 8.3	4166 6779 .97	9726 4258 .78	0.42 8387 3696	263. 5	-253. 5	8.78	8.47

347	4.593047165	-590 7076 1.4	3.48 935 E+1 5	1374 4164 8.5	4175 9079 .62	9722 4609 .87	0.42 9511 4136	263. 3	-253. 3	8.78	8.47
348	4.610249589	-591 8386 4.84	3.50 273 E+1 5	1373 9298 2.9	4183 9023 .98	9719 0184 .36	0.43 0486 1057	263. 0	-253. 0	8.77	8.46
349	4.627452013	-592 7945 4.82	3.51 405 E+1 5	1373 5176 6.8	4190 6589 .39	9716 1028 .58	0.43 1310 6808	262. 8	-252. 8	8.76	8.46
350	4.644654436	-593 5750 3.05	3.52 331 E+1 5	1373 1805 5.8	4196 1755 .84	9713 7181 .78	0.43 1984 4891	262. 6	-252. 6	8.75	8.45
351	4.66185686	-594 1798 6.45	3.53 05E +15	1372 9189 5.2	4200 4507 .03	9711 8676 .12	0.43 2506 9977	262. 5	-252. 5	8.75	8.45
352	4.679059284	-594 6088 7.1	3.53 56E +15	1372 7332 0.5	4203 4830 .3	9710 5536 .56	0.43 2877 7924	262. 4	-252. 4	8.75	8.45
353	4.696261708	-594 8619 2.33	3.53 861 E+1 5	1372 6235 6.6	4205 2716 .66	9709 7780 .82	0.43 3096 5786	262. 3	-252. 3	8.74	8.45
354	4.713464132	-594 9389 4.63	3.53 952 E+1 5	1372 5901 8.3	4205 8160 .85	9709 5419 .39	0.43 3163 1823	262. 3	-252. 3	8.74	8.45
355	4.730666556	-594 8399 1.73	3.53 835 E+1 5	1372 6331 0.2	4205 1161 .23	9709 8455 .43	0.43 3077 5504	262. 3	-252. 3	8.74	8.45
356	4.747868979	-594 5648 6.56	3.53 507 E+1 5	1372 7522 6.5	4203 1719 .88	9710 6884 .87	0.43 2839 7511	262. 4	-252. 4	8.75	8.45
357	4.765071403	-594 1138 7.26	3.52 971 E+1 5	1372 9475 1.1	4199 9842 .56	9712 0696 .32	0.43 2449 9736	262. 5	-252. 5	8.75	8.45

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Bibliography

Bix, Robert Alan, and Harry Joseph D'Souza. "Analytic Geometry." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 6 June 2016, www.britannica.com/science/analytic-geometry.

"Ecliptic Plane." *Orbits and the Ecliptic Plane*, hyperphysics.phy-astr.gsu.edu/hbase/eclip.html.

"Equatorial Coordinate System: COSMOS." *Centre for Astrophysics and Supercomputing*, astronomy.swin.edu.au/cosmos/E/Equatorial+Coordinate+System.

"Latitude and Longitude." *Latitude and Longitude*, www.primaryhomeworkhelp.co.uk/time/latitude.html.

National Geographic Society. "Latitude." *National Geographic Society*, 9 Oct. 2012, www.nationalgeographic.org/encyclopedia/latitude/.

The Editors of Encyclopaedia Britannica. "Sunlight." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 18 Jan. 2019, www.britannica.com/science/sunlight-solar-radiation.

"What Is Solar Noon?" *Timeanddate.com*, www.timeanddate.com/astronomy/solar-noon.html.