Determining the Hebrew Day of the Spring Equinox

The Creation Calendar and the Rule of the Equinox

The Creation Calendar at www.torahcalendar.com is a faithful restoration of the calendar used in the Hebrew Scriptures. This calendar was given by the Creator to mankind for the purpose of enabling people to properly observe and keep the Appointed Times of Elohim as found and described in Leviticus 23:1-44. The Creation Calendar consists of days, months and years that are determined precisely by the greater light and the lesser light seen in the sky. According to Genesis 1:14-16, the sun and moon were created for signs, Appointed Times, days and years. It is the wisdom of man to use the sun and moon for their intended purpose.

A Hebrew Day on the Creation Calendar begins and ends at the moment of sunset. A Hebrew Month begins at sunset on the evening on which the first visible crescent of the New Moon becomes potentially visible to the naked eye at Jerusalem. A Hebrew Month is also called a lunar month and usually consists of 29 or 30 Hebrew Days. A Hebrew Spiritual Year always begins in late winter or early spring, and continues until late winter or early spring in the next tropical solar cycle. A tropical solar cycle consists of approximately 365.25 days and is divided into four seasons: spring, summer, fall and winter.

A typical Hebrew Year has 12 Hebrew Months. However, because the total number of days within 12 Hebrew Months is about 11 days short of a tropical solar cycle, a system of intercalation is necessary in order to keep the Hebrew Year aligned with the seasons that are determined by the tropical solar cycle. The Creation Calendar occasionally intercalates, inserting a Month 13 every two or three years. A Spiritual Year always commences on Day 1 / Month 1 and it may begin in winter or spring, however when the Spiritual Year is correctly intercalated by the rule of the equinox, the entire Festival of Unleavened Bread which begins on Day 15 / Month 1 will occur in the season of spring.

The rule of the equinox always places Day 15 / Month 1 – the first day of the Festival of Unleavened Bread – on or after the Hebrew Day of the spring equinox. This rule helps ensure that the Festival of Unleavened Bread is always observed in its season from year to year as required by Exodus 13:10. Therefore, Day 1 / Month 1 may occur before, on or after the Hebrew Day of the spring equinox. The logical question that arises is: How does one determine the Hebrew Day of the spring equinox?

The Hebrew Day of the spring equinox is the Hebrew Day in which the instantaneous moment of the annual spring equinox occurs. Since Hebrew Days begin and end at sunset, the decision regarding which Hebrew Day on which the spring equinox occurs is determined at sunset. According to the Creation Calendar, the sunset ending Day 15 / Month 1 must always occur after the moment of the spring equinox in order that the entire Festival of Unleavened Bread will be observed in its season from year to year – the season of spring.

Although modern astronomical almanacs list time and date for the spring equinox, almanacs typically show times based on the Gregorian Calendar system of 24 civil hours beginning at midnight or 00:00:00 Universal Time as determined from Greenwich, England. Since the Hebrew Day of the spring equinox on the Creation Calendar is determined at sunset in Jerusalem, Israel, it may sometimes appear to be one day later than the date listed in almanacs. For example, if sunset in Israel is at 6:00 pm Israel Standard Time, and the moment of the spring equinox occurs at 6:30 pm Israel Standard Time, then a new Hebrew Day has begun whereas the Gregorian Calendar will not begin a new day until midnight.
How did the Ancients Determine the Day of the Equinox?

Modern computers can quickly, accurately and precisely calculate the timing of an equinox or a solstice using complex mathematical formulas and equations created and validated by scientists and engineers. But such advanced technology was not available to those in ancient times. So, how did ancient people determine the **spring equinox**? And more specifically, how did they determine the **Hebrew Day** of the **spring equinox**?

Several theories exist as to how the **spring equinox** was determined by those living in ancient times. Some claim that people in the ancient world used shadows cast by the sun onto a flat surface to determine the day of the equinox. Others claim they observed sunrises or sunsets. However, all ancient methods for determining the **spring equinox** had one thing in common – they were all based on **empirical observation**. And several of these methods could have successfully determined the **Hebrew Day** of the **spring equinox**.

Elohim provided the **sun** and the **moon** first and foremost for **signs**. A **sign** is something visible that can be seen and witnessed through the outward senses by an observer here on earth. So, from an astronomical perspective, the determination of the **spring equinox** in ancient times must have been based on a visual sighting or observation. Today astronomers use formulas that predict the **apparent** astronomical coordinates for the positions of the sun and moon. The **apparent** position of an object seen in the heavens differs slightly from the **actual** position when motion is involved. Due to the speed of light, the **apparent** position of an object is the position seen by an observer after the light from that object has reached the observer’s eye.

In astronomy, the term **geocentric** refers to a theoretical point located in the **center** of the earth and is a coordinate typically used for calculations for determining the orbital position of the earth around the sun. In contrast, the term **topocentric** refers to a particular location on the **surface** of the earth usually designated in latitude and longitude and is distanced from the **geocentric** position by the earth’s radius at that location. In order for the **Creation Calendar** to simulate the observation of the sun or moon from Jerusalem, it requires the use of **apparent** coordinate positioning while calculating observance from a **topocentric** perspective.

The four seasons exist due to the tilt of the earth’s axis of approximately **23.5 degrees** from a perpendicular line with respect to the ecliptic plane that contains the nearly circular orbital path of the earth around the sun. The two equinoxes and two solstices comprise the four seasonal demarcation points. These demarcations are instantaneous since the earth is constantly in motion. In the northern hemisphere, the mid-day sun gets to its highest topocentric altitude around **June 21** at the **summer solstice**, and to its lowest topocentric altitude around **December 21** at the **winter solstice**. In summer, the days are longest in the northern hemisphere and shortest in winter.

Ancient cultures were agricultural in nature. Ancient peoples were keenly aware of the seasons. They carefully observed the motion of the sun in order to determine when to plant and harvest crops. Today, we refer to the directions of due east as **90 degrees** from true north, and due west as **270 degrees** from true north as seen on a compass. The angle in degrees from true north is called the **azimuth** angle. Over the course of a tropical solar cycle, observers in **Israel** would notice that in summer, the sun would both rise and set well north of due east and due west respectively. Likewise, in winter, these same observers would notice that the sun both rose and set well south of due east and due west respectively.

As the days of the year passed, these same observers would notice the position of each setting sun appear to travel back and forth from the most southern setting position seen at the **winter solstice** to the most northern...
setting position seen at the **summer solstice**. In particular, they would notice that the change of the sunset position on the horizon each day would appear to decelerate down to a standstill, changing little from day to day when near the time of a solstice extreme, then would appear to accelerate from day to day approaching the time of either the **spring equinox** or the fall equinox. Mathematically, when plotted onto graph paper, we can see that the cyclical pattern of sunset position changes resembles the shape of a sine wave. (See Figure 2)

Ancient astronomers created simple observatories having an unobstructed view of the western horizon in order to observe sunset positions. By noting the sun setting positions from a single common reference point, these astronomers were able to aim pointing devices: one device pointed to the most southern setting point at the **winter solstice**, and another device pointed to the most northern setting point at the **summer solstice**. The two pointing devices formed a V-shaped angle that could be geometrically bisected.

It was then a simple matter of geometry to bisect the resulting angle in order to fashion a mid-position pointer aimed toward the point of the horizon for the equinox (see Figure 1). The point on the horizon for the **spring equinox** would therefore be exactly **halfway** between the two extreme solstice sunset positions. For the sake of illustration, we will refer to the midway point on the horizon as the **equinox point**.

![Figure 1](image1.png)

**Figure 1** – Illustration of how to geometrically bisect an angle in order to determine the equinox point. Notice that no numerical methods are required, just the use of a simple compass to draw arcs and a straight edge to draw lines.

During the time of the **spring equinox**, the ancients looked for the first sunset **north** of the **equinox point** to determine the **Hebrew Day** of the **spring equinox**. So if the sunset beginning a **Hebrew Day** was to the **left** of the equinox point (**south** of equinox point), and the sunset ending that same day was to the **right** of the equinox point (**north** of equinox point), that day would have been the **Hebrew Day** of the **spring equinox**.

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At the location of the temple mount in Jerusalem at latitude N31°46.8′ and longitude E35°14.1′, the most northern sunset position has a topocentric azimuth of about North 298.804 degrees at the time of the summer solstice. At the same location, the most southern sunset position has a topocentric azimuth of about North 242.367 degrees at the time of the winter solstice (see Table 2). Therefore, the resulting difference angle measures about 56.437 degrees in azimuth. When this difference angle is bisected, the resulting midpoint angle rests at a topocentric azimuth of about North 270.5855 degrees.

So when the ancient Hebrews sought to determine the Hebrew Day of the spring equinox, they looked to see if the sun set left or right of the equinox point which for Jerusalem calculates to North 270.5855 degrees. The topocentric azimuth of North 270.5855 degrees is also expressed as North 270 degrees, 35 arcminutes, 7.8 arcseconds.

At first glance, it is easy to assume that the equinox point at Jerusalem is North 270.0000 degrees. However, the equinox point is only North 270.0000 in azimuth for observers at the equator. For observers at Jerusalem the equinox point is actually North 270.5855 degrees in azimuth. The 0.5855 of a degree difference in azimuth makes all the difference in correctly determining the Hebrew Day of the spring equinox. For latitudes further away from the equator the azimuth difference angle increases. More importantly, the midpoint angle and the resulting equinox point between the solstices is seen to be northward from the azimuth of North 270.0000 degrees for observers in the northern hemisphere.

The error of assuming that the equinox point is the topocentric azimuth of North 270.0000 degrees for the latitude of Jerusalem leads to incorrect intercalation of the Hebrew Year. Some have speculated that the ancient Hebrews did not intercalate in the spring of 2 B.C.E. based on the mistaken idea that the ancient Hebrews would have observed the sun cross the equinox point on March 22, 2 B.C.E. Though we may never know how the Hebrews intercalated in 2 B.C.E., the fact of the matter is they should have intercalated.

The reason some may advance the idea that the ancient Hebrews did not intercalate in the spring of 2 B.C.E. is to promote the teaching that the Messiah was born on the evening of August 31, 2 B.C.E. which is mistakenly equated with Yom Teruah on Day 1 / Month 7. However as the Creation Calendar mathematically executes the rule of the equinox, August 31, 2 B.C.E. truthfully corresponds to Day 1 / Month 6.

In order to correctly execute the counsels of Elohim and to properly observe His Appointed Times and Festivals, it is necessary to correctly implement the rule of the equinox. This must be done in order not to trespass against the instruction in Exodus 13:10 which prohibits Unleavened Bread from occurring in winter.

The Creation Calendar Calculates the Rule of the Equinox Correctly

Observers in ancient times watched the sun’s setting positions, and determined the equinox point on the horizon by noting the most northern and southern sunset positions of both the summer solstice and winter solstice respectively. They then determined the midpoint on the horizon for the equinox point by bisecting the resulting angle formed between the two solstice extremes. The Nasi was the president of the Sanhedrin and it was his job to determine whether to intercalate or not. At the end of Month 12 the Nasi would have determined how many days it was until the spring equinox. In the spring of 2 B.C.E. it would have had been a close call. The critical sunset in question is the one that occurred on Saturday, March 22, 2 B.C.E. on the proleptic Julian Calendar.
At sunset on **Sabbath, March 22, 2 B.C.E.** the topocentric azimuth of the sun was **North 270.156** degrees (see **Table 1**). The **Nasi** would have observed that although the topocentric azimuth of the sun was greater than **270 degrees** at this moment in 2 B.C.E., it was **not** greater than **North 270.5855** degrees which is the **bisected midpoint** or the **equinox point** for determining the **Hebrew Day** of the **spring equinox** in Jerusalem. This **equinox point** would have been **established over time** by **visual observation** by the ancient Hebrews using their simple observatories with an unobstructed view of the western horizon.

**Figure 2** – Sun setting positions seen by an observer at Jerusalem, Israel change throughout the year in a sinusoidal motion, coming to a standstill and changing directions at the solstices. Note the difference between the azimuth of due west and that of the Equinox point on the horizon as seen from Jerusalem.

<table>
<thead>
<tr>
<th>Date at Jerusalem</th>
<th>Hebrew Day</th>
<th>Sunset Time (UT)</th>
<th>Sun's Apparent Longitude</th>
<th>Sun's Topocentric Azimuth</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 20, 2 B.C.E.</td>
<td>13</td>
<td>15h 49m 7.571s</td>
<td>357.290°</td>
<td>269.235°</td>
</tr>
<tr>
<td>March 21, 2 B.C.E.</td>
<td>14</td>
<td>15h 49m 43.436s</td>
<td>358.265°</td>
<td>269.696°</td>
</tr>
<tr>
<td>March 22, 2 B.C.E.</td>
<td>15</td>
<td>15h 50m 19.144s</td>
<td>359.239°</td>
<td>270.156°</td>
</tr>
<tr>
<td>March 23, 2 B.C.E.</td>
<td>16</td>
<td>15h 50m 54.712s</td>
<td>0.213°</td>
<td>270.617°</td>
</tr>
<tr>
<td>March 24, 2 B.C.E.</td>
<td>17</td>
<td>15h 51m 30.159s</td>
<td>1.186°</td>
<td>271.077°</td>
</tr>
</tbody>
</table>

**Table 1** – This table shows the position of the sun at the time of sunset as seen from Jerusalem for various dates near the spring of the year 2 B.C.E. Although on **March 22 (Hebrew Day 15)**, the sun set at azimuth **270.156°** having crossed the due west cardinal coordinate of azimuth **270.0000°**, it was still to the left and south of the required **270.5855°** equinox point. The sun's apparent longitude had not yet crossed **360°** in longitude at sunset on **March 22**. The precise moment of the **spring equinox** occurs when the sun's apparent longitude crosses **360°** which is also **0.0°**. Only on **March 23 (Hebrew Day 16)** can it be seen that the sun set at **270.617°** which is right of the equinox point of **270.5855°** making **Hebrew Day 16**, the Hebrew Day of the **spring equinox** in 2 B.C.E.
Therefore, at sunset ending Sabbath, March 22, 2 B.C.E., the moment of the spring equinox would \textit{not} have appeared to have occurred to the Nasi based on the \textit{ancient observational methods} of the Hebrews. If the skies were not cloudy that night and they had a clear view of the horizon, they would have seen that the sun set south or left of the equinox point and this would have indicated to them that they were still in the season of winter.

If the Judeans had been able to witness the New Moon at sunset on March 7, 2 B.C.E., they would have known on March 22, 2 B.C.E. that they had just completed the 15th day of that month in winter. If the Nasi had correctly intercalated a Month 13 after the New Moon on March 7, 2 B.C.E., then his decision to intercalate would have been validated at sunset ending Sabbath, March 22, 2 B.C.E. For if it was not cloudy on this evening in Jerusalem he would have known that spring had not yet begun at that time.

If the Nasi had not intercalated a Month 13 after the New Moon on March 7, 2 B.C.E., he would have known at sunset ending Sabbath, March 22, 2 B.C.E. that the first day of the Festival of Unleavened Bread had just been kept in the season of winter as spring had not yet begun. This would have been a concern for him as it was his responsibility to ensure that Israel kept the Festival of Unleavened Bread in the season of spring from year to year in order to fulfill the requirements of Exodus 13:10.

On Sabbath, March 22, 2 B.C.E. in Jerusalem, Israel the sun set at a point south or left of the equinox point of North 270.5855 degrees azimuth before the equinox point had been crossed. The Creation Calendar correctly calculated and validated the position of the sun at the moment of sunset on this day and it correctly implemented the rule of the equinox which always places Day 15 / Month 1 on or after the Hebrew Day of the spring equinox.

The sunset ending the Hebrew Day of the spring equinox always occurs after the equinox point has been crossed – on the right side of the line in an ancient observatory. At sunset ending the Hebrew Day of the spring equinox the righteous always want to be on the right side of the line. This is easy to remember if you associate it with the parable of the sheep and the goats.

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**Table 2** – This table shows the position of the sun at the time of sunset as seen from Jerusalem for various dates around the time of solstices nearest to the spring of the year 2 B.C.E. The first three lines correspond to the timing of the \textit{winter solstice} in 3 B.C.E. The last three lines correspond to the \textit{summer solstice} in year 2 B.C.E. Note that the most extreme angles for topocentric azimuth measurements are seen to occur on December 23 in 3 B.C.E. and on June 25 in 2 B.C.E. The sun's apparent longitude crosses 270° at the moment of the \textit{summer solstice}, and crosses 90° at the moment of the \textit{winter solstice}. The time of equinox occurs at the azimuth that is halfway between the azimuths of 242.367° at the \textit{winter solstice}, and 298.804° at the \textit{summer solstice}. The exact moment of the \textit{winter solstice} occurs at 7:00 (UT) on December 23, 3 B.C.E. The exact moment of the \textit{summer solstice} occurs at 9:17 (Universal Time) on June 25, 2 B.C.E. Both of these solstices are shown on their corresponding Hebrew Days on the Creation Calendar at www.torahcalendar.com.
The Creation Calendar at www.torahcalendar.com accurately simulates the observational methods that were used by the ancient Hebrews for determining the Hebrew Day of the spring equinox. Although the Creation Calendar uses 21st century methods to calculate the rule of the equinox, it simulates the observational methods used by the ancient Hebrews and accurately determines the apparent position of the sun from a topocentric perspective. The equinox point on the western horizon as seen from Jerusalem, Israel is at the topocentric azimuth of about North 270.5855 degrees.

Ancient observations can be mathematically simulated and verified today thanks to the accurate and precise retro-calculated computations of the Creation Calendar. It is one aspect of the narrow way which leads to life spoken of by יהושע Messiah. It enables those who believe in Him to walk the way that He walked and to observe the Sabbaths, New Moons and Appointed Times exactly as He did when He was last on earth.

The Creation Calendar is also a useful tool for those wishing to verify ancient dates as they search the Scriptures and study to show themselves approved unto Elohim. As Paul said – Prove all things, hold fast that which is good.

Deuteronomy 32:4  He is the Rock, His work is perfect; For all His ways are judgment, an Elohim of truth and without injustice; Righteous and upright is He.